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SYNTHETICS FOR THE PETROLEUM INDUSTRY.

By E. A. Evans (Member of Council).

A wide field is being uncovered by the aid of organic synthesis. Part of the area has been exhibited in the paper which Dr. Dunstan presented in March, 1943. Another view will be revealed in this paper. The two subjects may look very different from each other, but nevertheless both remain structural patterns from which the modern petroleum industry is being built. The naturally occurring petroleum hydrocarbons have been subjected to condensations, alkylations, and rearrangements to achieve definite results. Sometimes the success sought cannot be reached by systematic organic chemistry, consequently another avenue in this science must be explored. The two approaches may seem dissimilar, but in fact they are closely co-ordinated. They may be regarded as two of the components needed for the formation of the complex whole.

A very useful contribution to the science of petroleum has been given by the workers on chemical addition agents. The synthetic compounds which they have prepared have enabled notable victories to be won. Perhaps the most widely known additive is tetraethyl lead. Certainly its application to fuel research for the internal-combustion engine has had immense influence on the development of the I.C. engine and the affairs of man. It has now become so commonplace that we cease to marvel at it, but tetraethyl lead is only one of the organic compounds which have been used to solve problems confronting the petroleum industry. It is with these compounds that this paper deals.

The stimulus to expand the list of additives is the need to check oxidation and corrosion and to increase film strength. By looking at the long list of suggested compounds to meet these needs it will be seen that the solutions to the problems can be met in a great variety of ways, or, alternatively, there may be much conflict of opinion upon the respective merits of the individual additives. Probably both are true. The use of additives is practised in many phases of the petroleum industry, and is likely to grow.

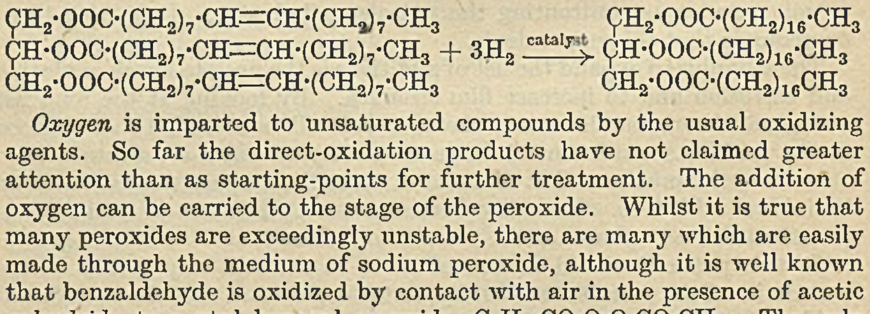
In this paper it would be out of place to attempt any review of the economics of the petroleum industry, but it can be said that the use of anti-oxidants in petrols has contributed to the low tax-free price. Although tetraethyl lead is described as an anti-knock compound, it is an anti-oxidant by virtue of its ability to reduce the very high rate of oxidation at very high temperatures. But oxidation reduction rates at high temperatures are not the only problems associated with petrol. Gum formation and oxidation at atmospheric temperatures have to be delayed. The response to chemical addition agents varies, but the most effective additives contain hydroxyl or amino-groups. Of the compounds which have been used are pyrogallol, catechol, α-naphthol, *p*-phenylenediamine, *p*-aminophenols, and benzyl *p*-aminophenol. The anti-oxidant delays oxidation by extending the induction period, or by destroying metallic or other pro-oxidation catalysts. Among the compounds which have been suggested for neutralizing pro-oxidants may be mentioned disalicylethylenediamine. It is claimed to be capable of nullifying the effect of copper or copper salts.

To prevent the darkening of the colour of petrol, tributylamine and triamylamine are recommended. Whether the anti-oxidants react with peroxides or molecular oxygen is not known.

To obtain a conception of the vast amount of work which has been conducted upon chemical addition agents it is necessary to turn to the patent literature. Unfortunately this class of literature leaves much to be desired, because it aims at making claims, and only refers to the chemistry and behaviour of the substances sufficiently to uphold the claims. Synthesis being the immediate interest, it is permissible to do scant justice to anything lying outside its ambit. So an endeavour will be made to classify the reactions involved to illustrate the types of compounds which have been made or suggested.

Synthesis by the direct addition of one or more atoms to a compound is theoretically the simplest chemical reaction, and should therefore be considered first. Some addition reactions are so simple that they occur with almost explosive violence, others need a little encouragement, but some demand much persuasion.

Hydrogen can be added by the simple expedient of treating a responsive compound with acid and a metal, or sodium and alcohol. But the great hydrogenation industry is built upon the forceful entry of hydrogen into an organic compound under the influence of heat, pressure, and a catalyst. The well-known conversion of unsaturated liquid glycerides into saturated solid glycerides by molecular hydrogen is a notable example of hydrogenation.



$$\begin{array}{l} CH_2\cdot OOC\cdot(CH_2)_7\cdot CH{=}CH\cdot(CH_2)_7\cdot CH_3 \\ CH\cdot OOC\cdot(CH_2)_7\cdot CH{=}CH\cdot(CH_2)_7\cdot CH_3 \\ CH_2\cdot OOC\cdot(CH_2)_7\cdot CH{=}CH\cdot(CH_2)_7\cdot CH_3 \end{array} + 3H_2 \xrightarrow{\text{catalyst}} \begin{array}{l} CH_2\cdot OOC\cdot(CH_2)_{16}\cdot CH_3 \\ CH\cdot OOC\cdot(CH_2)_{16}\cdot CH_3 \\ CH_2\cdot OOC\cdot(CH_2)_{16}CH_3 \end{array}$$

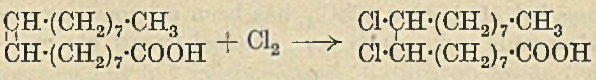
Oxygen is imparted to unsaturated compounds by the usual oxidizing agents. So far the direct-oxidation products have not claimed greater attention than as starting-points for further treatment. The addition of oxygen can be carried to the stage of the peroxide. Whilst it is true that many peroxides are exceedingly unstable, there are many which are easily made through the medium of sodium peroxide, although it is well known that benzaldehyde is oxidized by contact with air in the presence of acetic anhydride to acetyl benzoyl peroxide, $C_6H_5\cdot CO\cdot O\cdot O\cdot CO\cdot CH_3$. The only peroxide which seems to have been offered to the petroleum industry is tetrahydronaphthalene peroxide to inhibit the staining of copper by lubricating oils.[1]

Sulphur will add on to many unsaturated compounds at temperatures above its melting point. The reaction is so easily undertaken that sulphurization of cracked wax, fatty oils, fatty acids, etc., is performed on a large scale for the preparation of cutting oils and sulphur-containing lubricants. The sulphur probably adds on at the point of unsaturation.[2, 3, 4, 5] By their nature these bodies are composed of an array of sulphur-containing compounds the composition of which is vaguely known and difficult to control.

$$R\cdot CH{=}CH\cdot R + 2S \longrightarrow R\cdot CH\cdot S\cdot S\cdot CH\cdot R$$

To obtain a comparatively pure compound by addition methods divinylacetylene is heated with hydrogen sulphide under pressure, when the sulphur is freed and attaches itself at the double bond.[6]

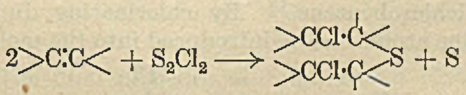
Chlorine will combine additively with nearly all ethylenic compounds to give chlorine-substituted saturated compounds. It will also react with saturated hydrocarbons if aided by a catalyst. By the chlorination of oleic acid at moderate temperatures dichlorostearic acid is produced, which when converted into its calcium salt has found widespread use as a detergent in lubricating oils for some diesel engines.[7] Aromatic hydrocarbons can also be induced to add on chlorine, yielding, for example, benzene hexachloride. Naphthalene tetrachloride crystallizes quite readily when chlorine is passed through a chloroform solution of naphthalene, even at room temperature. This compound is particularly useful when it is desirable to raise the film strength of an internal combustion engine lubricating oil without affecting the other properties of the oil.[8]



$$\begin{array}{l}CH\cdot(CH_2)_7\cdot CH_3\\ CH\cdot(CH_2)_7\cdot COOH\end{array} + Cl_2 \longrightarrow \begin{array}{l}Cl\cdot CH\cdot(CH_2)_7\cdot CH_3\\ Cl\cdot CH\cdot(CH_2)_7\cdot COOH\end{array}$$

$$C_{10}H_8 + 2Cl_2 \longrightarrow C_{10}H_8Cl_4$$

Sulphur Chloride has the power of adding both sulphur and chlorine simultaneously to the same molecule, the advantage being that frequently the combined efforts of sulphur and chlorine are greater than the efforts of either of them. Extreme-pressure bases for admixture with mineral oil have been made by treating fatty oils with sulphur mono-chloride.[9]

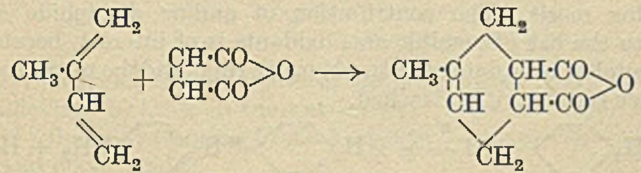


$$2{>}C{:}C{<} + S_2Cl_2 \longrightarrow \begin{array}{l}{>}CCl\cdot C{<}\\ {>}CCl\cdot C{<}\end{array}{>}S + S$$

This type of compound is elegantly converted into a hydroxy-compound by removing the chlorine by hydrolysis.[10]

Phosphorus Halides and Sulphides such as phosphorus trichloride, PCl_3, and phosphorus pentasulphide, P_2S_5, behave in an analogous way to the sulphur chlorides.[11]

Diels Alder reaction between unsaturated compounds such as quinones, unsaturated aldehydes, acids, lactones, and their esters with compounds containing conjugated double linkages, of which butadiene and isoprene are examples, is another type of addition. In this reaction the two substances when heated together in a solvent unite to form a six-membered ring. The resultant lactone yields the corresponding acid which can be esterified.[12] Probably by the interaction of a long-chain alcohol considerable oiliness properties can be obtained. Just what advantage a tetrahydro-phthalic anhydride construction has over phthalic anhydride



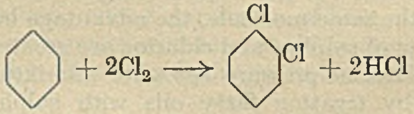
Isoprene Maleic anhydride Tetrahydro-methyl-phthalic anhydride is not clear, as diethyl phthalate has quite a distinct film-strength characteristic.

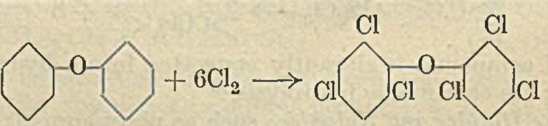
Sulphuric Acid may conveniently be taken in this group when considering the sulphonation of unsaturated complex petroleum constituents. The addition of $\cdot SO_3H$ gives rise to petroleum sulphonic acids, or the so-called mahogany acids. When they are combined with sodium they are regarded almost as an essential ingredient of soluble oil. Their heavy metal salts have found favour as detergents and anti-oxidants.[13, 14]

Perchloromethyl Mercaptan, $CSCl_4$, has been proposed as a reactant with unsaturated organic compounds, *e.g.*, cracked waxes, etc.[15]

Substitution or the preparative work of exchanging a hydrogen atom for a chlorine or a sulphur atom, or perhaps a specific group, has yielded a number of compounds which in themselves have direct application, or form the basis for other syntheses.

Chlorine.—The chlorinated saturated long-chain hydrocarbons, found in paraffin wax, have found a ready market for incorporation in cutting oils and hypoid lubricants, and a still more extended use for them is envisaged. The substitution of chlorine in the aromatic nucleus is effected by treating benzene with chlorine in the presence of the carrier iodine, giving, amongst other things, *o*-dichlorobenzene.[16] By chlorinating diphenyl ether, as many as six chlorine atoms can be introduced into the molecule.[17]

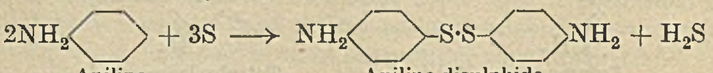




A mixture of *o*-dichlorobenzene and hexachloro-diphenyl ether is stated to be a sludge disperser, whereas the hexachloro-compound by itself is a mild extreme-pressure additive.

Of the many chloro-compounds which have been made, chlorinated dibenzyl disulphide and chlorinated methyl stearate are worthy of special notice.[18, 19]

Sulphur displacement of hydrogen has not produced any compounds of outstanding merit. The contribution of aniline disulphide and phenthiazine to the list of possible anti-oxidants is of interest, because in each case the sulphur is bridging the two benzene rings and the nitrogen in the two compounds is differently attached.



Aniline Aniline disulphide

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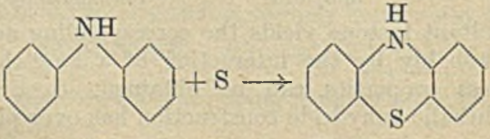
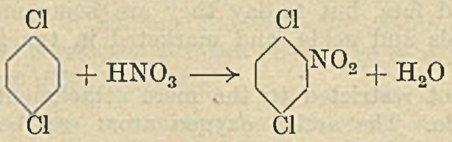
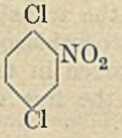


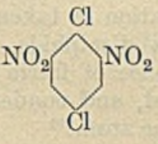
Diphenylamine Phenthiazine

21

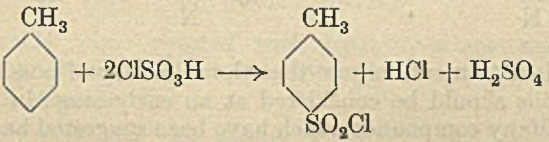
Nitration.—The activation of chlorine by substituted nitro-groups is noticeable when one nitro-group is introduced, and is maintained on the introduction of a second,[22] provided they are not in the *o*-position to the same chlorine atom. Nitro-*p*-dichlorobenzene possesses mild extreme-pressure properties, but in 1 : 4-dichloro-2 : 6-dinitrobenzene they are void. Nitration has also been applied to arylamines.[23]



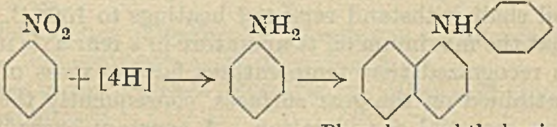




Sulphonation is a variation of sulphur substitution. By participation of chlorosulphonic acid aromatic hydrocarbons are converted into aryl sulphonyl chlorides.[24, 25] In this case there is both sulphonation and halogenation. The dual presence of sulphur and chlorine almost automatically puts the compound into the extreme-pressure category.



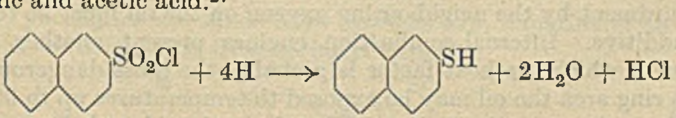
Reduction of some of the substituted compounds has led to the discovery of at least one very promising anti-oxidant. Nitrobenzene when reduced with iron and hydrochloric acid yields aniline, which readily attaches to itself a naphthalene ring when heated with α-naphthol in the presence of a little sulphuric acid.



[26]

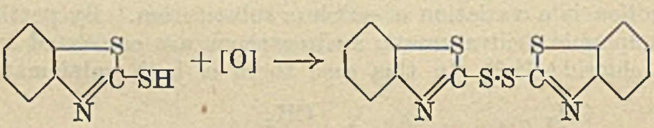
Phenyl-α-naphthylamine

Sulphonyl chlorides furnish a useful transition from compounds in the E.P. classification to those in the anti-oxidant class by simple reduction. β-Naphthyl sulphonyl chloride forms β-naphthyl mercaptan when treated with zinc and acetic acid.[27]



Oxidation opens a field of almost unlimited possibilities in the search for synthetic compounds useful to the petroleum industry. Only the fringe is being explored, but in it there are already available oiliness agents and pour-point depressants. The oxidation of petroleum hydrocarbons produces a dazzling array of alcohols, aldehydes, ketones, lactones, and acids, all possible starting-points for productive research. Until recently the oiliness compounds were sought among the glycerides of naturally occurring oils and fats, but to-day they are being manufactured from long-chain alcohols and acids, and marketed in the form of synthetic esters.[28, 29]

Oxidation is not restricted to the mere attachment of oxygen to a receptive molecule. The active oxygen atom can be instrumental in deforming a molecule by detaching from it an atom or even a group; in fact the situation can arise that by the abstraction of a single atom the residual part of the molecule is driven to condense with another residual part. This situation is taken advantage of in the transformation of a mercaptan, to a disulphide. When mercaptobenzothiazole is oxidized under the influence of ferric chloride, the hydrogen in the mercaptan-group is oxidized, and condensation follows at the free valency of the remaining sulphur atom.[30]

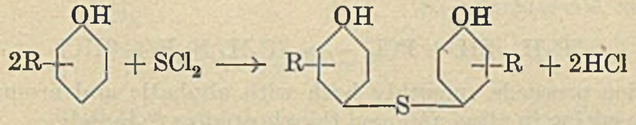


It is convenient to mention here that the solubility of possible additives in petroleum oils should be considered at an early stage in the research programme. Many compounds which have been suggested have lost much of their original novelty through their limited solubility. Sometimes their insolubility can be obviated by resort to a mutual solvent. But it is probably better to attach a group which will increase the solubility of the parent compound.

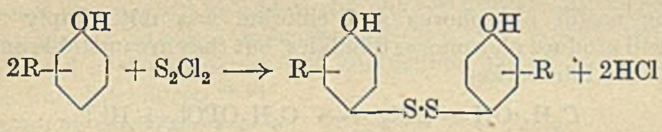
Stability is equally important. It is not necessary to define quantitatively the degree of stability for compounds in general, although compounds for specific purposes must be adaptable to the needs imposed upon them. For most hypoid gear lubricants it is necessary that the compound when dissolved in oil shall withstand repeated heatings to 150° C. for no other reason than that the maximum oil temperature in a rear axle never exceeds 135° C. It is recognized that temperatures far in excess of 135° C. are momentarily attained on the gear surfaces, consequently the time factor may become an essential consideration. A constant cascading of oil at approximately 60° C. in a turbine provides ample opportunity for oxidation at a comparatively low temperature. The highly mobile film with the interaction energy of the dissolved oxygen operating for year after year casts a responsibility on an anti-oxidant of no mean order. The effect of the bombardment by the neighbouring oxygen on the oil must be repelled by the additive. Internal-combustion engines present another set of conditions, of which the heat factor is probably the most dangerous. In the piston ring area the oil may be exposed to temperatures up to 600° F., and even be cast on to vacant sites. How the anti-oxidant behaves in this area nobody knows. We do know, however, that some compounds inhibit the oxidizing influence of the iron, its oxides, or its compounds, and others delay the latent period of oxidation of the oil. The fact emerges that the anti-oxidant must resist very high temperatures.

The replacement of hydrogen activated by electronegative groups is possible by treatment with sulphur monochloride, sulphur dichloride, or thionyl chloride. This reaction is taken advantage of in the synthesis of thioethers and certain polysulphides.

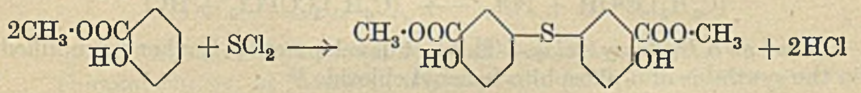
When phenols in a solvent—*e.g.*, carbon tetrachloride—are treated with sulphur dichloride, the hydrogen in the *p*-position is easily displaced, giving rise to an aryl hydroxy-thioether,



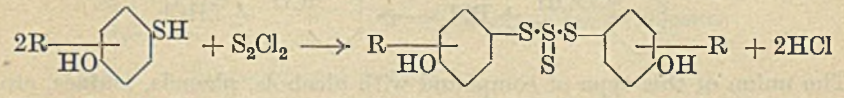
or with sulphur monochloride a disulphide,[31]



Sulphur dichloride when reacted with hydroxy-esters—*e.g.*, methyl salicylate—in the presence of a metal catalyst yields di-(3-carbomethoxy-4-hydroxy phenyl) thioether.[32]



Then there is the possibility of removing the hydrogen from the electronegative groups themselves by the action of sulphur mono- and di-chlorides on mercaptans for the building up of tri- and tetra-sulphides respectively.[33]



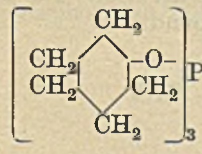
By replacing the sulphur chlorides by phosphorus trichloride a series of phosphorus-containing compounds can be prepared.

Action on alcohols in the presence of pyridine or other acid binding agent gives trialkyl phosphites.[34]

$$3CH_3\cdot(CH_2)_3\cdot OH + PCl_3 \longrightarrow \underset{\text{Tributyl phosphite}}{[CH_3\cdot(CH_2)_3O\cdot]_3P} + 3HCl$$

Tributyl phosphite is used to protect cadmium alloy bearings against oil acid attack.

Similarly, phosphites are made from *cyclo*hexanol, naphthenyl alcohols (from naphthenic acids), and trichlorobutyl alcohol.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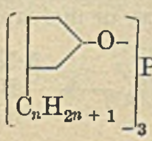
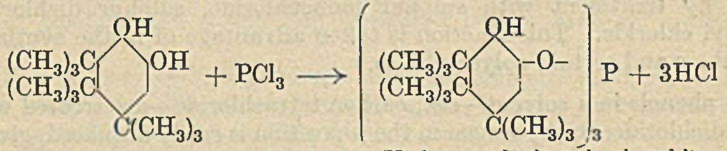

36,

$(C_4H_6Cl_3\cdot O\cdot)_3P$ 37

Action on Phenols.—Phenols react with phosphorus trichloride merely on heating the materials together.

$$3C_6H_5{\cdot}OH + PCl_3 \longrightarrow (C_6H_5{\cdot}O{\cdot})_3P + 3HCl \quad ^{38}$$

Triphenyl phosphite



[39]

Hydroxy-substituted phosphite

Action on Mercaptans.—

$$3C_5H_{11}{\cdot}SH + PCl_3 \longrightarrow (C_5H_{11}S)_3P + 3HCl$$

The reaction proceeds smoothly both with aliphatic and aromatic mercaptans, resulting in alkyl and aryl thiophosphites.[40, 41, 42, 43]

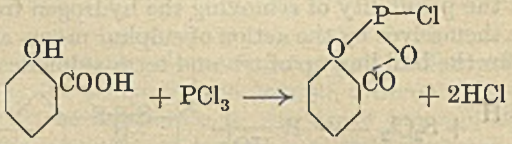
Action on Tertiary Alcohols.—The aim to synthesize a stable compound containing useful phosphorus and chlorine was not simply attained. Phenols will produce phosphorus dihalides, but they are unstable and totally unsuitable for lubrication.

$$C_6H_5{\cdot}OH + PCl_3 \longrightarrow C_6H_5OPCl_2 + HCl$$

From tertiary aromatic alcohols the goal can be won by stabilizing with several aryl groups.[44]

$$(C_6H_5)_3C{\cdot}OH + PCl_3 \longrightarrow (C_6H_5)_3COPCl_2 + HCl$$

Action on o-Hydroxy Acids.—This last development is further exemplified in the synthesis of o-phosphito-benzoyl chloride.[45]

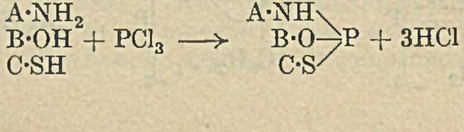


The union of this type of compound with alcohols, phenols, amines, etc., by displacement of the chlorine atom gives rise to some new and interesting derivatives of phosphorus. Doubtless the stabilizing in the former case is due to the extra weight of the multiple phenyl groups, and in the latter to the heavy group attached to the benzene ring.

Action on Ammonia and Amines.—In the extension of the study of phosphorus compounds the action of phosphorus trichloride on alkyl and aryl amines has not been overlooked.[46]

$$6(C_5H_{11})_2NH + PCl_3 \longrightarrow [(C_5H_{11})_2N]_3P + 3(C_5H_{11})_2NH{\cdot}HCl$$

A striking contribution comes from the discovery that the three groups attached to the phosphorus need not necessarily be the same, but can be derived from an amino, hydroxy or mercapto compound.[47]



$$\begin{matrix} A{\cdot}NH_2 \\ B{\cdot}OH \\ C{\cdot}SH \end{matrix} + PCl_3 \longrightarrow \begin{matrix} A{\cdot}NH \\ B{\cdot}O \\ C{\cdot}S \end{matrix}\!\!>\!P + 3HCl$$

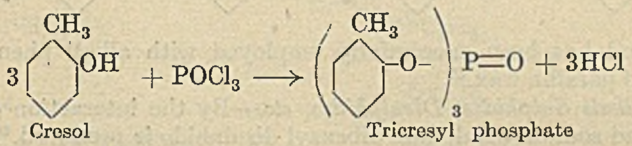
Just as the phosphites are prepared from phosphorus trichloride, so the phosphates are prepared from phosphorus pentachloride or phosphoryl chloride.

Action on Alcohols.—Almost any alkyl phosphate can be made by the action of phosphoryl chloride on aliphatic alcohols.

$$3C_4H_9{\cdot}OH + POCl_3 \longrightarrow (C_4H_9{\cdot}O{\cdot})_3P{=}O + 3HCl$$

Chlorinated alkyl phosphates are equally well prepared, and even a phosphate from castor oil.[48, 49, 50, 51]

Action on Phenols.—

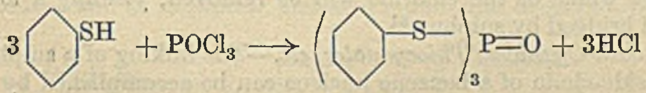


Cresol

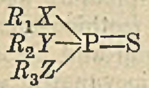
Tricresyl phosphate

Tricresyl phosphate was one of the pioneer compounds suggested to meet the needs of extreme-pressure lubrication.[52] About the same time chlorinated aryl phosphates and compounds like tri-*p*-ethyl phenyl phosphate were introduced.[53, 54]

Action on Mercaptans.—



These alkyl and aryl thiophosphates may subsequently be halogenated. Thiophosphates of a very mixed type have also been successfully synthesized.[55]

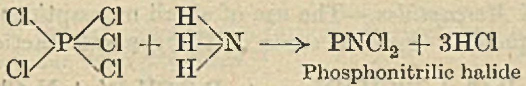


$$\left.\begin{matrix} R_1X \\ R_2Y \\ R_3Z \end{matrix}\right\rangle P{=}S$$

where R_1, R_2, R_3 = alkyl or aryl groups

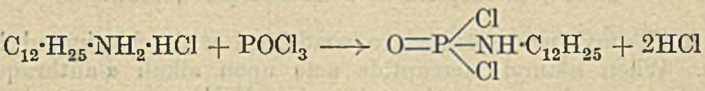
X, Y, Z = oxygen or sulphur

Action on Ammonia and Amines.—



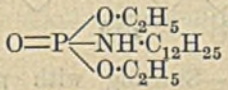
$$\left.\begin{matrix} Cl \\ Cl \end{matrix}\right\rangle P\left\langle\begin{matrix} Cl \\ -Cl \\ Cl \end{matrix}\right. + \left.\begin{matrix} H \\ H- \\ H \end{matrix}\right\rangle N \longrightarrow PNCl_2 + 3HCl$$

Phosphonitrilic halide



$$C_{12}{\cdot}H_{25}{\cdot}NH_2{\cdot}HCl + POCl_3 \longrightarrow O{=}P\left\langle\begin{matrix} Cl \\ -NH{\cdot}C_{12}H_{25} \\ Cl \end{matrix}\right. + 2HCl$$

The phosphonitrilic halides can be extended in length and complexity by polymerization and condensation with alcohols, phenols, mercaptans, etc.[56] The long-chain phosphonamide is claimed to have added advantages if the phosphorus is linked to ethoxy-groups.[57]



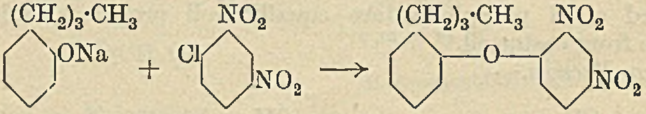
$$O{=}P\left\langle\begin{matrix} O{\cdot}C_2H_5 \\ -NH{\cdot}C_{12}H_{25} \\ O{\cdot}C_2H_5 \end{matrix}\right.$$

Syntheses involving the removal of metal atoms.

From Phenates.—By application of the Williamson synthesis

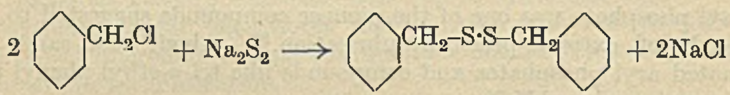
$$R{\cdot}ONa + R'X \longrightarrow R{\cdot}O{\cdot}R' + NaX$$

alkyl phenyl oxy-ethers of 2 : 4-dinitrobenzene have been prepared for use as mild extreme-pressure agents.[58]



The method has been successfully employed with alkali phenates and chlorinated paraffin wax.[59]

From Alkali Sulphides, Disulphides, etc.—By the interaction of benzyl chloride and sodium disulphide dibenzyl disulphide is produced.[60]



Chlorinated wax will also react with sodium sulphide in such a way that a part of the whole of the chlorine will be removed, yielding a long-chain compound bridged by sulphur.[61]

From Alkali Cyanides, Thiocyanates, etc.—The linking of a sulphur atom on to the side-chain of a benzene nucleus can be accomplished by treating benzyl chloride with sodium thiocyanate.

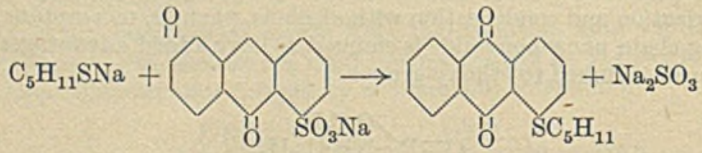
$$C_6H_5{\cdot}CH_2Cl + NaCNS \longrightarrow C_6H_5{\cdot}CH_2{\cdot}CNS + NaCl$$

Of the various thiocyanates suggested as mild extreme-pressure agents should be mentioned the higher alkyl thiocyanates and *iso*thiocyanates. Also the reaction products containing a thiocyanate group and chlorine atoms resulting from the reaction between alkali thiocyanates with chlorinated hydrocarbons. Ethylene cyanide alone has even been included in the list.[62, 63, 64]

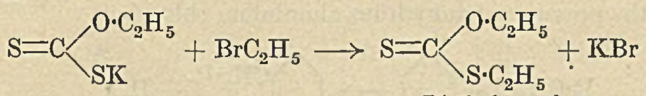
From Alkali Mercaptides.—The use of alkali mercaptides follows almost in natural sequence. Specific cases of the general reaction occur when

$$R{\cdot}Cl + R'CH_2SNa \longrightarrow R{\cdot}S{\cdot}CH_2R' + NaCl$$

n-butyl and amyl mercaptides are condensed with chlorinated hydrocarbons. When *n*-amyl mercaptide acts upon alkali α-anthraquinone sulphonates an analogous reaction takes place.[65, 66]

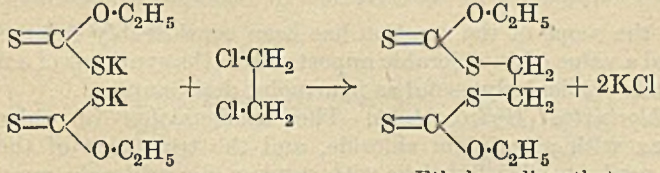


From Alkali Xanthates.—Starting with potassium ethyl xanthate a series of compounds can be synthesized having extreme-pressure properties.



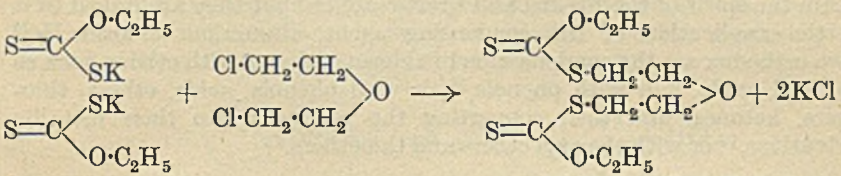
Diethyl xanthate

67



Ethylene dixanthate

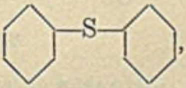
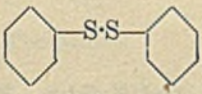
68



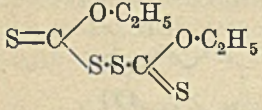
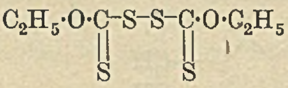
Diethyl xanthyl ethyl ether

69

Before advancing it is necessary to deflect slightly to a patent which claims alkyl mono- and di-sulphides, and aryl mono- and di-sulphides.[70]

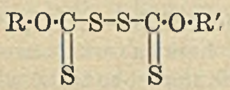
$C_nH_{2n+1}\cdot S\cdot S\cdot C_nH_{2n+1}$, , 

This invention of using an alkyl disulphide reveals the possibility of combining two thiocarbonate radicals to produce xanthic disulphides. Although these compounds are mentioned in the patent specification, they do not appear in the claims.

 or 

$$C_2H_5\cdot O\cdot \underset{\underset{S}{\|}}{C}-S-S-\underset{\underset{S}{\|}}{C}\cdot O\cdot C_2H_5 .$$

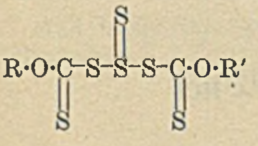
The rearrangement of the grouping in the formula is given because the use of bis-alkyl xanthogen has been patented.[71]



$$R\cdot O\cdot \underset{\underset{S}{\|}}{C}-S-S-\underset{\underset{S}{\|}}{C}\cdot O\cdot R'$$

RR′ = alkyl or aralkyl radicals

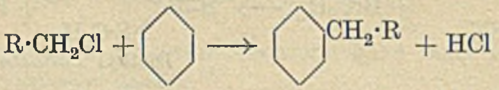
Having succeeded in introducing two atoms of sulphur into a molecule, and then four, it caused no surprise to see the announcement of xanthogen tetrasulphide which contains six.[72]



$$R\cdot O\cdot \underset{\underset{S}{\|}}{C}-S-\overset{\overset{S}{\|}}{S}-S-\underset{\underset{S}{\|}}{C}\cdot O\cdot R'$$

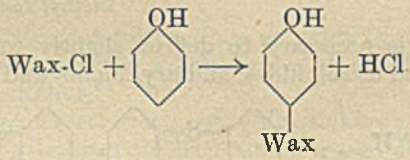
RR′ = alkyl, aryl, aralkyl or *cyclo*alkyl radicals

Friedel and Craft's reaction, when introduced in 1877, was applied to the formation of alkylbenzenes through the interaction of alkyl halides with benzene in the presence of anhydrous aluminium chloride.

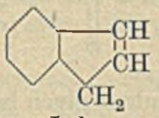


Since then the scope of the reaction has been considerably enlarged, and has assumed a value of considerable importance in the synthesis of a number of compounds particularly useful as pour-point depressants.

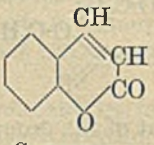
With Chlorinated Hydrocarbons.—The condensation of chlorinated paraffin wax with aluminium chloride, and the treatment of the polymerization products of *iso*butylene with sulphur monochloride, may not be within the spirit of the Friedel and Craft reaction, but they are linked to it by the application of the condensing agent, aluminium chloride.[73, 74] More orthodox are the condensation of chlorinated wax with ethers, such as diphenyl oxide,[75] or with phenols,[76] or with phenols, acids, ethers, thioethers, ketones, and then converting the products into their metallic derivatives,[77] or with the aryl ethers and thioethers.[78]



With Acyl Halides.—By the aid of acyl chlorides, R·CO·Cl, long chains can be added to complex aromatic compounds to give compounds of the nature of acylated polymerized indenes, of which stearyl indene [79] is an example, or acylated coumarone polymers.[80] A more complicated condensation consists of combining chlorinated wax with aromatic hydrocarbons,



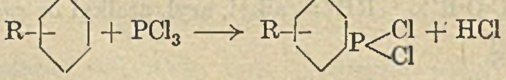
Indene



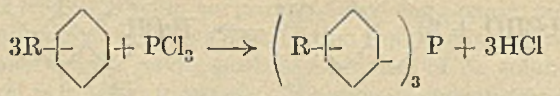
Coumarone

and further condensation with dicarboxylic acid halides—*e.g.*, phthalyl chloride.[81] The condensation of naphthenyl halides with aromatic petroleum extracts [82] will come as a special item of interest to those who are in petroleum refineries. All these large molecule compounds are offered as pour-point depressants, viscosity-index improvers, or oiliness agents.

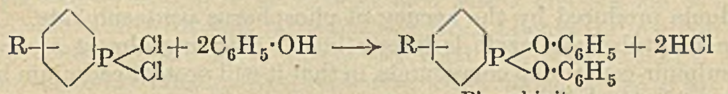
With Phosphorus Halides and Related Halides.—Alkyl benzenes will react with phosphorus trichloride under the influence of aluminium chloride to give alkyl benzene dichlorophosphines,[83]



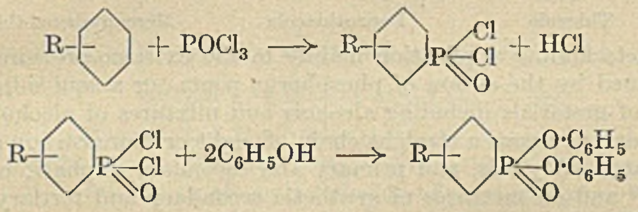
or in the presence of an excess of hydrocarbon aryl phosphines.[84, 85, 86] By a suitable choice of material phosphine oxides and sulphides have been synthesized.



Phosphinites are obtained by the reaction of dichlorophosphines with phenols, alcohols, etc.[87]


Phosphinite

In an analogous manner, phosphoryl chloride will react with aromatic hydrocarbons in presence of aluminium chloride, and the product when treated with an alcohol or phenol yields a phosphinate.


Phosphinate

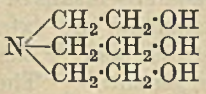
Less definite compounds arise when $PSCl_3$ acts upon lubricating oil stocks.[88] Arsenic and antimony are alternatives to phosphorus in this series of compounds, as we see in such a compound as triphenyl arsine sulphide, made by heating triphenyl arsine with sulphur,[89] or triphenyl stibine.[90]

Other Condensation Reactions.—Most of these condensations are based upon well-established processes. Carboxylic acids will react directly with the hydroxyl group of an alcohol to yield acyl derivatives. The reaction

$$R{\cdot}COOH + HO{\cdot}R' \longrightarrow R{\cdot}COOR' + H_2O$$

is restricted to primary and secondary alcohols, but polyhydric alcohols condense with polycarboxylic acids.[91]

The condensation of ammonia with aliphatic alcohols has given us the valuable ethanolamines and their fatty acid salts and esters.[92]

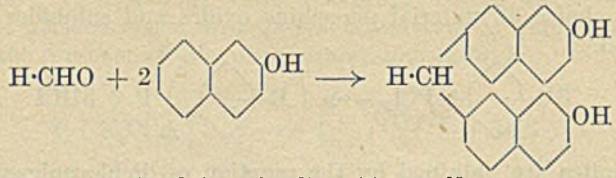


$$N(CH_2{\cdot}CH_2{\cdot}OH)_3$$

And lastly the condensation products of aldehydes with polyhydric alcohols [93]

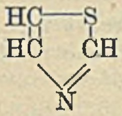
$$R{\cdot}CHO + 2R'OH \longrightarrow \underset{\text{Acetal}}{R{\cdot}CH(OR')_2} + H_2O$$

with phenols to give compounds such as methylene di-β-naphthol,[94]

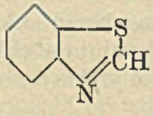


and with hydroxy-acids of the salicylic acid type.[95]

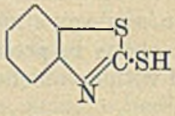
Of the unclassified types may be mentioned the thiazoles, and all the products produced by the agency of phosphorus pentasulphide. The use of mercaptobenzothiazole is interesting as standing almost alone among the sulphur-containing compounds, in that it will protect cadmium bearings from acid attack.[96]



Thiazole



Benzothiazole



Mercaptobenzothiazole

Products finding application mainly in the extreme-pressure field may be obtained by the action of phosphorus penta- or sesqui-sulphides on a variety of materials including alcohols and mixtures of alcohols, wherein at least one possesses a straight chain of eight or more carbon atoms,[97, 98] unsaturated fatty oils, and primary and secondary aliphatic or aromatic amines,[99] and on mixtures of synthetic secondary and tertiary alkylated phenols.[100] Other products suitable as oxidation and corrosion inhibitors have been prepared by the action of these phosphorus sulphides on alcohols and phenols,[101] and on mixed naphthenyl alcohols.[102]

Compounds of metals were advocated as far back as 1887.[103] Many years later metallic stearates were patented for use in castor oil,[104] but it was not until 1926 that any comprehensive publication was made on the value of metallic soaps in mineral oils.[105] Since then there has been almost a flood of compounds containing metal ions.

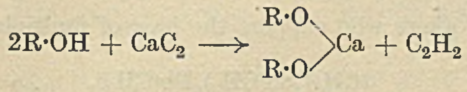
From Acids.—By the simple process of neutralizing an alkaline solution with a fatty acid, and adding thereto an aqueous solution of a soluble metallic salt, a metallic soap is precipitated. Oleates of lead,[106] tin,[107] chromium,[108] and mixtures of chromium and tin [109] or nickel [110] have all been applied to mineral oils. Naphthenates of calcium,[111] manganese, lead, zinc, copper, aluminium, and cobalt and tin [112] were natural sequences.

From Substituted Fatty Acids.—Soaps of sulphurized fatty acids,[113] chlorinated fatty acids (*e.g.*, calcium dichlorostearate),[114] and of fatty acids arylated at the double bond by means of aluminium chloride, of which phenyl stearic acid is an example, are extensions of the simple soaps. The calcium salt of phenyl stearic acid [115] has been mentioned specifically, and its other metallic salts in general.[116] The substituted stearic acid salts have been extended to include calcium chlorophenyl mercaptostearate,[117] and aluminium α-benzalstearate.[118] Soaps of the ether-substituted fatty acids are obtained by the action of sodium phenate on chlorinated fatty acids.[119]

From Other Acids.—The aluminium soaps of acids from oxidized sweated wax were doubtless prepared to obviate some of the difficulties encountered with aluminium oleate,[120] and metallic salts of wax-substituted aromatic acids and hydroxy-acids to provide very long-chain molecules.[121] Zinc di*iso*propyl salicylate [122] has been chosen from the metallic salts of alkylated aromatic carboxylic acids, probably because of its solubility in oil. The use of zinc is a little unusual. The recent appearance of soaps of rosin acids [123] and hydrogenated rosin acids [124] suggests that the non-substituted acid soaps may be finding new supporters.

Instead of using fatty acids combined with a metallic ion, it is possible to displace the hydrogen in a phenol to give a phenate or in a mercaptan to give a mercaptide. Most of the patented lubricant additives are made from alkali-insoluble phenols possessing alkyl chains by one of the following methods.

Action of Metallic Carbides on Phenols.



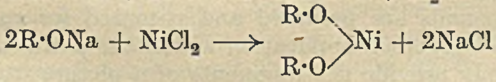
$$2R\cdot OH + CaC_2 \longrightarrow \begin{matrix}R\cdot O\\ R\cdot O\end{matrix}\!\!>Ca + C_2H_2$$

Direct Action of the Metal on the Phenol in an inert solvent.

$$6R\cdot OH + 2Al \longrightarrow 2Al(OR)_3 + 3H_2$$

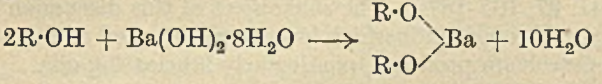
Double Decomposition.—By dissolving the phenol in alcohol and converting it into the sodium phenate by adding sodium, and forming the derived metal salt by adding an alcoholic solution of the appropriate chloride.

$$2R\cdot OH + 2Na \longrightarrow 2R\cdot ONa + H_2$$



$$2R\cdot ONa + NiCl_2 \longrightarrow \begin{matrix}R\cdot O\\ R\cdot O\end{matrix}\!\!>Ni + 2NaCl$$

Direct reaction between the phenol and the hydroxide of an alkaline earth metal in an inert solvent—*e.g.*, benzene. The water formed is removed continuously.



$$2R\cdot OH + Ba(OH)_2\cdot 8H_2O \longrightarrow \begin{matrix}R\cdot O\\ R\cdot O\end{matrix}\!\!>Ba + 10H_2O$$

Via Metallic Alcoholates.—Magnesium ethylate will react directly with a phenol to give a phenolate,

$$Mg(OC_2H_5)_2 + 2R\cdot OH \longrightarrow Mg(OR)_2 + 2C_2H_5OH$$

The long-chain substituted products appear again in this group as wax-substituted phenols and their derivatives,[125] metal alkyl phenates of the calcium cetyl phenate class,[126] and metallic derivatives of alkylated phenols containing nitro-, amino- or alkylamino-substituents.[127]

Similarly, the alcohols and thio-alcohols have been converted into metallic alcoholates and thio-alcoholates.[128, 129, 130]

True organo-metallic compounds are probably too expensive to be contemplated as chemical addition agents to lubricants in the present state of our knowledge. True, tetraethyl lead is used extensively in petrol, but only a few ml. per gallon. The concentration of additives required for oils covers the range 0·07 to 10·0 per cent. Tetraethyl lead can be synthesized by the action of ethyl chloride on a lead–sodium alloy in the presence of water or alcohol and a catalyst, which may be pyridine. The Grignard reaction has been used for the preparation of tin tetrabutyl.[131] A

$$R{\cdot}Cl + Mg \xrightarrow[\text{ether}]{\text{dry}} R{\cdot}MgCl$$

$$4R{\cdot}MgCl + SnCl_4 \longrightarrow R_4Sn + 4MgCl_2$$

link with the thioethers is found in the organo-metallic compounds of bismuth, tin, or antimony used in conjunction with a hydroxy-substituted thioether. In an endeavour to increase the effectiveness of the metal it has been suggested that two atoms of metal joined together are better than one:[132]

$$(CH_3)_3SnNa + (C_6H_5)_3SnCl \longrightarrow (CH_3)_3Sn{\cdot}Sn(C_6H_5)_3 + NaCl$$

whereas other workers who support the idea of multiple atoms prefer to divide them.[133]

$$(CH_3)_3Sn(CH_2)_5Pb(CH_3)_3$$

Metallic Complexes.—The interest in organo-metallic compounds has been extended to the metallic complexes to be in keeping with the trend to explore in a general way the substances which are getting farther and farther away from those synthesized by simple chemical reactions. How far it is possible to go, and still remain within the economic field, is difficult to forecast. The probings into the unfathomable depths of organic chemistry must continue now that the pace has been set and the demand created. At times compounds are prepared and patented for specific uses, with little prospect of practical application within the petroleum industry, but which collectively provide the fragments of a picture from which a composite whole may ultimately be evolved, or a surprise arise. In this paper no attempt has been made to correlate structure with application. The author has already approached this subject in a previous paper (*J. Inst. Petrol.*, 1941, 27, 165–187). The sole object of this discussion is to review, and classify, the compounds which have been patented as chemical addition agents for petroleum products, particularly lubricating oils.

Complex organo-metallic addition compounds are producible by interacting inorganic or organic metallic compounds, containing no free hydrocarbon radicals, with alkyl or aryl compounds of the elements in groups 5–6 right-hand columns, or with their acids or esters.[134]

$$Cu_2Cl_2{\cdot}(C_4H_9)_2S, \qquad (C_{17}H_{33}{\cdot}COO)_2Ni(C_3H_7)_3PO_3$$

The preparation of extreme-pressure agents has been made by combining heavy metal compounds of alcohols, ketones, esters, and mercaptans with completely alkylated or arylated compounds of nitrogen, phosphorus, and sulphur, or alkyl or aryl phosphites.[135]

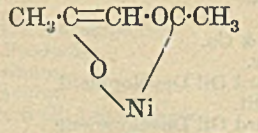
$$(CH_3)_3CSAg{\cdot}C_5H_5N$$

Cuprous butyrate diethyl sulphide[136] is an example of the class of complex

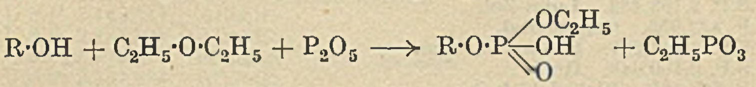
$$CuOOC{\cdot}C_3H_7{\cdot}C_2H_5{\cdot}S{\cdot}C_2H_5$$

resulting from metal oxides or hydroxides with (*a*) an organic compound containing replaceable hydrogen, and (*b*) an organic compound of group 5–6 with atomicity >1.

The multiplying instances of the application of nickel are further reflected in the β-diketone complex.[137]

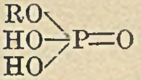


Metallic Phosphorus Compounds.—Some of the usefulness of the phosphorus atom is combined with the metallic atom by introducing them into the same molecular structure. This can be accomplished by refluxing higher alcohols or phenols in ether with phosphorus pentoxide.



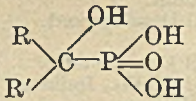
$$R\cdot OH + C_2H_5\cdot O\cdot C_2H_5 + P_2O_5 \longrightarrow R\cdot O\cdot P\begin{matrix} OC_2H_5 \\ OH \\ O \end{matrix} + C_2H_5PO_3$$

The ether solution is decanted and the $C_2H_5\cdot O$ group is hydrolysed.



R >12 carbon atoms

The resultant acid is dissolved in aqueous sodium hydroxide, and the calcium, magnesium, chromium, etc., salts prepared by precipitation. Calcium cetyl phosphate is prepared in this way.[138] A metallic alkyl phosphate can then be used in conjunction with a metallic alkyl phenate.[139] By treating nonadecane-2-one with phosphorus trichloride in acetic acid, and subjecting the sodium salt of the resulting acid to double decomposition, calcium 2-hydroxynonadecane-2-phosphonate can be obtained.[140]



Dialkyl 2-hydroxy phosphonic acid

In the petroleum industry special interest centres round the differences between pure petroleum products and those which are treated with chemical compounds. The ever-growing demand for less active and yet more active lubricants seems paradoxical, but we have to admit its truth. Lubricants must be resistant to enemy attack, whether it be by oxidation, pressure, or heat. The preferential destruction of part of the lubricant can be reduced by the imposition of barriers, and the more inert fractions have their feebleness of action countered by an intermingling of bodies of known chemical structure and activity. This aiding and abetting will continue until the treatment of petroleum products has advanced sufficiently to render the use of additives unnecessary.

My thanks are due to J. S. Elliott, M.A., for much valuable help.

C. C. Wakefield & Co., Ltd.,
Hayes, Middlesex.

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[15] U.S.P. 2,197,781. Socony Vacuum.

[16] B.P. 453,114. Lubri-Zol.

[17] U.S.P. 2,150,079. Lubri-Zol.

[18] U.S.P. 2,153,482. Lubri-Zol.

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[20] U.S.P. 2,162,207. Socony Vacuum.

[21] U.S.P. 2,190,648. Gulf.

[22] B.P. 538,159. Wakefield & Co.

[23] B.P. 455,304. du Pont.

[24] B.P. 449,311. Shell.

[25] U.S.P. 2,149,788. Gulf.

[26] U.S.P. 1,988,299. General Electric.

[27] U.S.P. 1,966,050. Standard Oil Development.

[28] U.S.P. 2,110,078. Alox Chemical Co.

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[38] B.P. 475,445. Socony Vacuum.

[39] B.P. 523,524. Standard Oil Development.

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[45] U.S.P. 2,259,452. Socony Vacuum.

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[51] B.P. 528,847. Levi.

[52] B.P. 446,567. Atlantic.

[53] B.P. 448,424. Atlantic.

[54] B.P. 475,787. Continental.

[55] U.S.P. 2,157,452. Standard Oil Co., California.

[56] U.S.P. 2,109,490. Atlantic.

[57] U.S.P. 2,151,380. du Pont.

[58] U.S.P. 2,134,436. Gulf.

[59] U.S.P. 2,236,896. Continental.

[60] U.S.P. 2,208,161. Lubri-Zol.

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[63] U.S.P. 2,202,641. Socony Vacuum.

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[66] U.S.P. 2,109,463. Gulf.
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[68] U.S.P. 2,161,566. Socony Vacuum.
[69] U.S.P. 2,161,584. Socony Vacuum.
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[72] B.P. 522,189. Standard Oil Development.
[73] B.P. 510,173. Lubri-Zol.
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[75] B.P. 440,916. Resinous Products.
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[77] B.P. 532,876. Socony Vacuum.
[78] U.S.P. 2,128,109. Standard Oil Development.
[79] B.P. 539,186. Armour.
[80] B.P. 537,122. Armour.
[81] B.P. 521,776. Standard Oil Development.
[82] B.P. 548,723. Standard Oil Development.
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[84] B.P. 545,519. Standard Oil Development.
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[89] U.S.P. 2,139,725. Tide Water.
[90] U.S.P. 2,177,561. Tide Water.
[91] B.P. 470,580. Shell.
[92] U.S.P. 1,888,023. Standard Oil Co., Indiana.
[93] B.P. 516,182. du Pont.
[94] B.P. 497,385. Shell.
[95] B.P. 503,177. Shell.
[96] B.P. 488,390. Wakefield & Co.
[97] U.S.P. 2,005,619. du Pont.
[98] U.S.P. 2,142,998. Pure Oil.
[99] U.S.P. 2,146,584. Atlantic.
[100] U.S.P. 2,157,479. Gulf.
[101] U.S.P. 2,167,867. du Pont.
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[111] U.S.P. 2,001,108. Standard Oil Co., California.
[112] B.P. 510,496. Texas.
[113] U.S.P. 2,237,096. Dearborn.
[114] B.P. 513,774. Union Oil.
[115] U.S.P. 2,147,155. Sinclair.
[116] U.S.P. 2,197,153. Union Oil.
[117] U.S.P. 2,223,127. Lubri-Zol.
[118] B.P. 509,097. Shell.
[119] U.S.P. 2,198,307. Socony Vacuum.
[120] B.P. 502,335. Standard Oil Development.
[121] B.P. 532,876. Socony Vacuum.
[122] B.P. 536,827. Shell.
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[126] B.P. 537,816. Standard Oil Co., California.
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[133] U.S.P. 2,236,910. Continental.
[134] B.P. 462,793. Shell.
[135] B.P. 476,329. Shell.
[136] U.S.P. 2,150,349. Shell.
[137] U.S.P. 2,161,184. Leo Corporation.
[138] B.P. 538,474. Standard Oil Co., California.
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THE INSTITUTE OF PETROLEUM.

A MEETING of the Institute was held at the Royal Society of Arts, John Adam Street, W.C.2, on Thursday, 29th July, 1943.

Mr. C. Dalley, President, occupied the Chair.

The following paper was presented :—

"Synthetics for the Petroleum Industry." By E. A. Evans (Member of Council) (see page 333).

DISCUSSION.

PROFESSOR GARNER, in opening the discussion, congratulated Mr. Evans on the presentation of a co-ordinated scheme from the mass of literature, particularly patent literature, on this subject of additives.

Apart from the reference to lead tetraethyl, most of the references given were to the lubricating oils, but there were a number of additives for fuels. Mr. Evans mentioned in the paper that the only peroxide which seemed to have been offered to the petroleum industry was tetrahydronaphthalene peroxide. There were, however, other peroxides which had been offered in connection with diesel fuels. It would be remembered that amyl nitrate and nitrite had been amongst the first substances suggested for improving the ignition qualities of diesel fuels, but in addition some of the organic peroxides, such as aldehyde or ketone peroxides, including acetone peroxide, had been suggested. (E.P. 428,972). These diesel fuel additives were required in proportions of 1 or 2 per cent, so they had not been extensively used for improving the ignition quality of diesel fuels, although they might be of value in connection with starting.

One rather interesting application in connection with lead tetraethyl, which had been brought out in a paper read before the *American Petroleum Institute* in 1940 (21, (III) 6), was the utilization of lecithin to improve the storage qualities of gasoline containing lead tetraethyl. Lecithin was a phosphatide and could be obtained by solvent extraction from soya beans; it was used in the proportion of 1 to 15 lbs. per thousand barrels. In the course of the discussion on that paper it was stated that a large group of glycerides such as corn oil or fish oil which had been activated by a suitable process, such as treatment with sulphur or ozone, could be used for the same purpose. A measure of the effect of these compounds in improving gasoline stability in sunlight had been given by the fact that 1 part to 40,000 might keep an unstable gasoline containing lead tetraethyl clear up to eight hours' exposure to sunlight, whereas otherwise it would become slightly cloudy in half an hour.

There was another interesting application, again on the fuel side rather than on the lubricating side, in connection with colour stability, and reference had been made in the paper to the fact that tributylamine and triamylamine were recommended to prevent the darkening of the colour of petrol. The discoloration of certain types of water white gasolines and kerosines when held in storage for prolonged periods had been a serious problem, and this type of colour stability in the dark was thus different from that mentioned above which was colour instability in the light. Rather and Beard (*Oil and Gas Journal*, 14.5.36, 209) showed that a kerosine which had gone off colour could be restored nearly to the original colour by the addition of hydroquinone in a suitable solvent. The proportion of the polyhydroxy benzenes such as hydroquinone, catechol or pyrogallol that was required was quite small. For example 1 lb. of hydroquinone dissolved in 1 gallon of a suitable solvent, such as *iso*propyl alcohol, could be mixed with 2,000 to 15,000 gallons of kerosine. The colour was removed by that treatment, but if intimately mixed with water the colour returned so that it looked as though an addition compound was formed from the hydroquinone and the colour-body in the kerosine. The discoloration process was associated with oxidation, as samples stored in an inert atmosphere in the absence of oxygen maintained their colour for a longer period than samples in the presence of air. A number of important papers on this subject appeared in the *Proceedings of the 1st World Petroleum Congress* (II) (708 *seq.*).

Dr. Dunstan said that he also would like to congratulate Mr. Evans on his success in preparing such a meticulously careful summary of a chemically exasperating subject.

One question had occurred to him which he thought the organic chemist would find of primary interest. If one considered the formula, for example, of ethylene, C_2H_4, one could write a complete thesis on the behaviour of that substance. One could calculate its boiling point, its density, its viscosity, and so forth, and could tell precisely what it would do under innumerable variations of chemical and physical conditions. One of the great boons that organic chemistry had conferred upon chemists was to demonstrate the relationship between structure and properties, *i.e.* between chemical constitution and properties. But the structure of large numbers of substances dealt with in the paper did not appear to be related in any way, as far as he could judge, with the particular physical properties that Mr. Evans had demanded; for instance, very specially the ability of the substances to improve the film strength of an oil. The question he wished to ask was this: Were the individual compounds mentioned in the paper related in any shape or form one to the other or to some desired fundamental definite physical property, or was the whole thing sheer empiricism from beginning to end? Was there any rhyme or reason in the selection of the reactants and the sort of substance that would be obtained? Had the substances been investigated from the point of view of modern molecular physical technique? Was it known, for example, whether the additive was concerned primarily with the lubricating oil or with the surface on which the lubricating oil was going to act? That was the kind of question which he would like Mr. Evans to discuss in detail.

Mr. Harold Moore, in congratulating Mr. Evans on his paper, said it was largely a compilation, and he thought a compilation was at least as valuable as experimental work. Personally he much preferred compilations, because they covered a larger field. He would like to suggest that Mr. Evans should collect all his data in a book, in which he might answer some of Mr. Dunstan's questions and try to explain the type of behaviour associated with the various substances with which he was dealing.

There was no mention in the paper of the paratone type of additive agent. Personally he knew only of paratone and a new product of the methacrylate type as agents for increasing viscosity and viscosity index. He would like to ask Mr. Evans whether he knew of other products for this purpose. He considered the viscosity increasing agents as of particular importance, perhaps even greater than the extreme pressure additives. The field for new viscosity raising additives appeared to be very open as probably many of the new plastics might serve this purpose if polymerized to the correct extent, both the paratone and the methacrylic acid being plastic polymers, and probably for the purpose of lubricating oil additives the polymerization was not carried as far as when making normal plastics.

He was very interested in Mr. Evans' reference to thioethers and to the compound phenthiazine, the anthracene type of structure containing a sulphur and NH group. He had recently tried out thianthrene, a compound possessing the same formula as anthracene in which the two middle carbons were substituted by sulphur atoms. It had been synthesized by the reaction of benzene with sulphur but he had not found it a satisfactory extreme pressure lubricant and its insolubility made it unsatisfactory as an anti-oxidant. As an extreme pressure lubricant he presumed the sulphurs were bound too tightly.

An interesting point in connection with synthetic work of this type was that the new process of aromatization enabled one to obtain pure samples of the higher aromatics containing 3, 4 or 5 benzene rings and they might form a very good basis for the preparation of compounds containing very heavy aromatic hydrocarbon groups. He wondered whether such heavy aromatic nuclei, perhaps containing sulphur or coupled up with other reactive groups, were likely to find a field in the preparation of additive agents.

Dr. Dunstan asked which was the fundamental property that Mr. Moore wanted, length of side chain or total mass. He did not think the benzene rings *qua* benzene rings were any good.

Mr. Moore said that many of these bodies had naphthalene in them.

Dr. Dunstan thought that some very useful information might be obtained from the modern chemical methods. For example the electron diffraction apparatus gave a remarkably accurate picture of the lubricating oil molecule. Taking a very simple sort of substance, *e.g.* an ordinary fatty acid, it could be shown that the carboxyl group attached itself head first into the bearing surface and there remained a long hydrocarbon chain sticking up vertically like the pile of a carpet.

Mr. W. J. Kempton said he thought that if one oxidized a transformer oil, for instance, it was only some of the oil molecules which took up the oxygen and then they acted as a catalyst to oxidize the rest of the molecules. That question had probably been discussed at previous meetings of the Institute, but he thought that, in dealing with the nucleus, it was well to realise that if one could stop the elementary oxidation one would probably hold back the whole reaction for the remaining amount of the oil. With regard to the way in which the inhibitor compounds in question were related to one another, it might be found that the relation was bound up with the preliminary oxidation being retarded, and that the products formed between inhibitor and oil were related one to another in the hydrogen carbon structure. He put this forward as a suggestion arising out of some work which he had done, but it was very difficult to separate many of the compounds, and one usually ended with emulsions and various products of which one could not determine the values.

Dr. Dunstan said that the question mentioned by Mr. Kempton had been discussed by the Institute about twenty years ago, and the point had then been made that the lubricating oil *qua* lubricating oil was mainly a vehicle incorporating or containing a certain amount of reactive material, because the more thoroughly and completely the lubricating oil was refined the less reactive material one had, and hence the need for the additive.

Mr. Harold Moore said he had always been informed that the effect of the anti-oxidants was not to reduce the rate of oxidation throughout the entire period of oxidation but simply to delay oxidation by postponing the first attack of the oxygen, and that after the agent itself had been oxidized the oils underwent oxidation very much in the same way as if no agent had been present. He did not know whether this was in line with recent experience and he would like to know whether Mr. Evans had found the effect of anti-oxidants to be of that type, namely, the delay of preliminary oxidation afterwards followed by oxidation at the normal rate.

Dr. Dunstan: You mean there is no permanent effect?

Mr. Moore: Yes.

Dr. Dunstan: I think that is quite true.

Mr. J. S. Elliott, referring to what Professor Garner had said about lecithin, said that this material had been proposed recently for use in lubricating oils as an anti-oxidant with a fair amount of confidence. He had no knowledge as to whether or not it had been used in practice by the patentees. From his own laboratory experience he could say that it was effective in stabilising oil against oxidation, particularly at the lower temperatures, and that it reduced the deposition of insoluble matter and, to some extent, the rise in acidity consequent upon such oxidation.

With reference to the point raised by Dr. Dunstan about the relation between the effect of an addition agent and its structure, he realised that there was much yet to be learnt, but there seemed to be certain features which were common to the various groups of additives. Extreme pressure agents, for example, almost invariably contained either sulphur, chlorine, or phosphorus, the aim being to synthesize compounds containing these elements in a form readily available yet not unduly active. Among the sulphur compounds, for instance, it was considered desirable to load the molecule with as much sulphur as possible consistent with stability considerations, or alternatively to stimulate the activity of the sulphur by the introduction of other electronegative radicals.

The reference to thianthrene was interesting, as although in this case the sulphur was too firmly bound to be of value, other useful substances could be prepared by analogous reactions involving the treatment of certain simple materials with sulphur or the sulphur chlorides. In many cases one could not tell exactly what the product would be like. As had already been pointed out, phenols reacted in chloroform solution with sulphur dichloride giving the corresponding di(hydroxyaryl) thioethers. If sulphur monochloride were used the product might be a disulphide (as from β-naphthol), or a mixture of thioether and free sulphur, or a mixture of thioether and trisulphide (as from *p*-chlorophenol), or even in some cases a mixture of thioether and tetrasulphide. Furthermore if free sulphur were added to the reaction mixture it could in certain cases be urged into chemical combination, a fair yield of di(*p*-chlorophenyl) trisulphide being obtainable from *p*-chlorophenol by this means. It was clear therefore that even such simple reactions as these required further study both for their own sake and in view of the possible usefulness of the products.

Mr. E. A. Evans, in replying to the discussion, said that Professor Garner had referred to the many types of compounds in use which were not mentioned in the paper, but he felt that 140 different patents were quite enough to deal with in one paper. He would like to remind the members present that the subject of additives was a very new one. A reference to the dates of the patents dealt with in the paper would show that very few of them were before 1935 and extraordinarily few before 1933, and it must be realized that there had been four years of war in which it had not been possible to do as much work on the subject as one would have liked to do. Therefore nearly all the development work had been done in about six years, clearly there was a great deal more to do before Dr. Dunstan's questions could be answered, as Dr. Dunstan himself knew.

Dr. Dunstan had asked whether there was any rhyme or reason in the selection of the reactants and the sort of substance that would be obtained. Different people had gone along different routes. Looking at the patents, it would be seen that one research organization had followed certain lines of thought, whilst another had followed other well-defined lines of thought. One school had dealt with phenols, another with amines, and yet another with thioethers. One school was paying much attention to the long-chain waxy compounds, whereas other chemists had decided to employ a shorter group such as *iso*propyl. The tendency at the present moment, he thought, was to employ the alkyl long-chain compounds, perhaps because they were more soluble. There was little doubt that such basic things as anthracene and phenanthrene would be useful He was giving that subject some thought and found that he was being led up a fairly interesting street. Questions of cost and solubility had to be considered. Some people had difficulty in making soluble compounds. This difficulty could sometimes be alleviated by the introduction of a long group. He thought that if some of the compounds mentioned in the paper were analysed with those thoughts in mind, it would be seen how some of the patentees had got over their stumbling-blocks.

It must be realized that the anti-oxidants had their own spheres of temperature. Some of them would act only up to 100 deg. C. and others only up to 80 deg. C., whilst others would do very well up to 150 deg. C., but would fail when put into an internal combustion engine, because the heat in the piston ring zone would cause them to break up. He did not think there was sufficient evidence to say how long the anti-oxidants would last; they were being used practically in power stations, and had been in continuous use for several years. There were better ones available now, which would last much longer than those which had been used in the past, and which would easily stand 150 deg. C. An anti-oxidant which would only stand 100 deg. C. might very well outstrip any of the others at that temperature.

The President, in proposing a vote of thanks to Mr. Evans for his paper, said that the paper, with the discussion which had followed it and written contributions to the discussion which would probably be sent in later, would form a most valuable publication in the *Journal.*

The vote of thanks was accorded with acclamation, and the meeting then terminated.

CORRELATION OF I.P. LOVIBOND AND SAYBOLT CHROMOMETER COLOUR MEASUREMENTS ON MOTOR FUELS AND REFINED PETROLEUM.

Report by the Colour Panel of Standardization Sub-Committee 3.—Liquefied Petroleum Gases, Gasoline, Kerosine, and Light Distillates.

Two methods for determination of the colour of motor fuels and refined petroleum oils are described in Standard Methods for Testing Petroleum and its Products (1942 Edition)—namely, by the Lovibond Tintometer, using the 18-inch cell (method I.P.-17/42) and by the Saybolt Chromometer (method I.P.-18/42).

It is often desirable to be able to convert with approximate accuracy readings obtained on one instrument to the corresponding readings on the other.

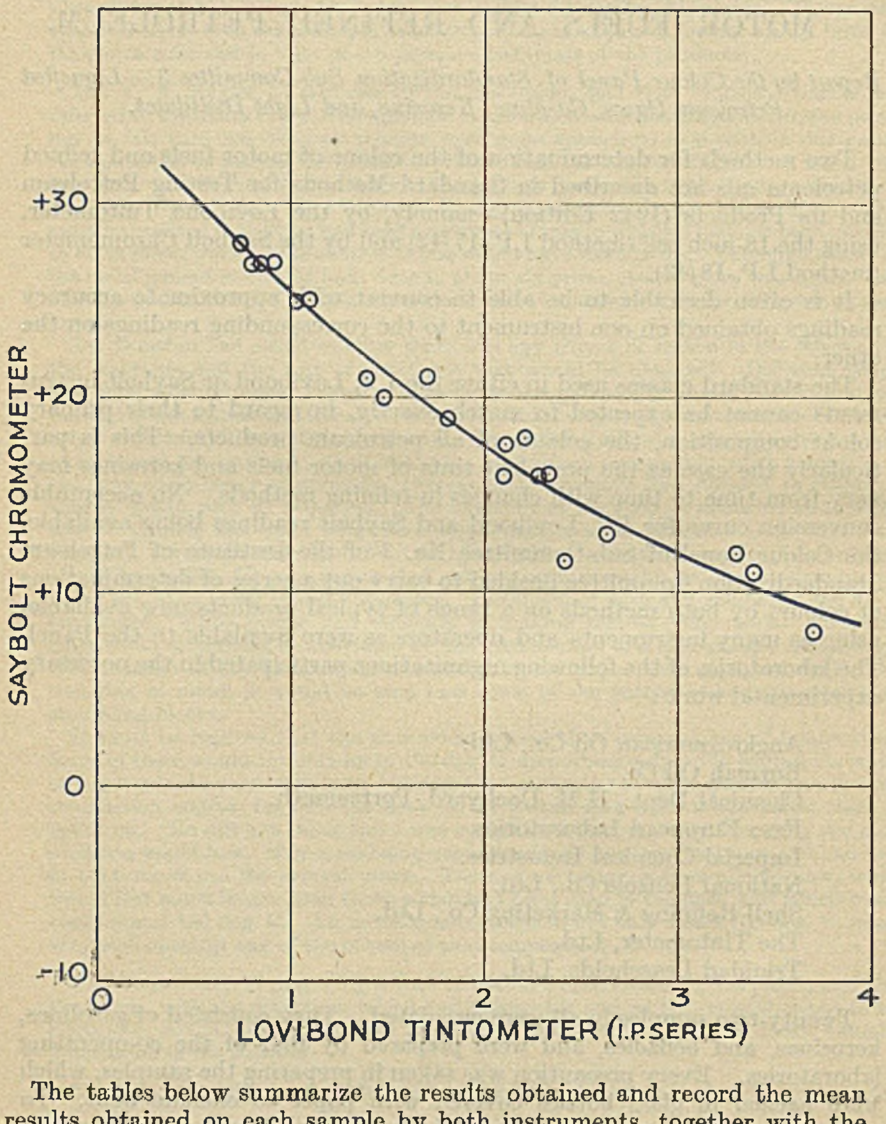
The standard glasses used in either the I.P. Lovibond or Saybolt instruments cannot be expected to match exactly, in regard to their primary colour composition, the colours of all petroleum products. This is particularly the case as the prevalent tints of motor fuels and kerosines may vary from time to time with changes in refining methods. No acceptable conversion curve for I.P. Lovibond and Saybolt readings being available, the Colour Panel of Sub-Committee No. 3 of the Institute of Petroleum Standardization Committee decided to carry out a series of determinations of colours by both methods on a range of typical products now available, using as many instruments and operators as were available to the Panel. The laboratories of the following organizations participated in the necessary experimental work :—

Anglo-American Oil Co., Ltd.
Burmah Oil Co.
Chemical Dept., H.M. Dockyard, Portsmouth.
Esso European Laboratories.
Imperial Chemical Industries.
National Benzole Co., Ltd.
Shell Refining & Marketing Co., Ltd.
The Tintometer, Ltd.
Trinidad Leaseholds, Ltd.

Twenty-two samples in all were circulated. They consisted of gasolines, kerosines, and benzoles, and were prepared by four of the co-operating laboratories. Every precaution was taken in preparing the samples, which were packed in glass bottles covered with paper to exclude light. To minimize any discrepancies which might have arisen from colour change in storage, the tests were carried out by all laboratories during pre-arranged periods of a few days, so that the time interval between dispatching and testing was substantially the same in all cases.

Eleven operators in all measured the colours of the samples by the

Saybolt Chromometer, and twenty-three operators carried out measurements with the Lovibond instrument using the I.P. Standard Glasses. The standard procedures (I.P. 17/42 and I.P. 18/42 respectively) were followed in all cases.



The tables below summarize the results obtained and record the mean results obtained on each sample by both instruments, together with the maximum variations from the means. The results on sample N.3 have been omitted from the curve showing the relationship between the mean values. The colour of this particular sample is not suitable for comparison with the standard glasses used for refined petroleum.

SAYBOLT CHROMOMETER.

Sample.	A.	B.	C.	D.	E.	F.	G.	N1.	N2.	N3.	S1.	S2.	S3.	S4.	S5.	S6.	A2.	B2.	C2.	D2.	E2.	F2.
Average Colour	+27	17·6	11·6	28	19	16	8	+27	+16	Zero	+27	+25	+16	+21	+20	+12	+11	+18	+13	+21	+25	+16
Diff. from Average Lowest	− 1	−0·6	−0·6	−2·0	−1·0	−1·0	−3·0	− 2	− 1	− 5	− 1	− 2	− 2	− 3	− 1	− 4	− 3	− 2	− 3	− 2	− 3	− 3
Diff. from Average Highest	+ 1	+0·4	+1·4	+1·0	+1·0	+1·0	+2·0	+ 1	+ 2	+ 4	+ 2	+ 2	+ 2	+ 1	+ 2	+ 2	+ 3	+ 4	+ 4	+ 2	+ 2	+ 2

LOVIBOND (I.P. SERIES) (18″ CELL).

Sample.	A.	B.	C.	D.	E.	F.	G.	N1.	N2.	N3.	S1.	S2.	S3.	S4.	S5.	S6.	A2.	B2.	C2.	D2.	E2.	F2.
Average Colour	0·83	2·1	2·4	0·75	1·8	2·3	3·7	0·81	2·09	2·96	0·90	1·07	2·09	1·69	1·46	3·29	3·39	2·2	2·62	1·39	1·02	2·32
Diff. from Average Lowest	0·58	0·60	0·15	0·50	0·80	0·30	0·95	0·31	0·09	0·46	0·40	0·57	0·59	0·69	0·46	1·04	0·89	0·70	0·37	0·39	0·52	0·32
Diff. from Average Highest	0·17	0·15	0·35	0·25	0·45	0·45	0·30	0·19	0·16	0·04	0·10	0·43	0·16	0·31	0·04	0·71	0·61	0·05	0·88	0·61	0·48	0·43

It will be seen from the results that a very reasonable correlation has been obtained. The relationship should be of use in making approximate conversions for comparative purposes, but it must again be emphasized that as colour measurements of this kind are based on comparison with arbitrarily selected standards, conversion with a high degree of accuracy is not possible.

In carrying out correlation work of this kind it became obvious that certain precautions were very necessary and should always be observed in connection with colour measurements. These precautions may be summarized as follows, and apply more particularly to the Lovibond instrument.

1. Operators should be tested for colour perception. The eyesight of all laboratory workers is not suitable for this work.

2. Fatigue of the eye should be avoided. Only a few observations should be made at a time; a series of short confirmatory observations is better than prolonged gazing at a colour.

3. Tests should be made in a room with diffused white light.

4. The least number of glasses possible to obtain the correct value should be used.

5. Apparatus should be properly set up and a clear field of view obtained in the eyepiece. The cell should be so placed that no part of the sides or end is visible in either mirror.

6. Apparatus should be kept scrupulously clean, attention being given to white reflecting opal screen, colour glasses, mirrors, and white internal paint in the light cabinet.

DEFINITIONS FOR WAXES, ETC., DERIVED FROM PETROLEUM.

Report by the Nomenclature Panel of Standardization Sub-Committee No. 8.—Petroleum Waxes.

INTRODUCTION.

(1) THE term "petroleum wax" has been chosen to comprehend all waxes derived from petroleum, and the attached diagram illustrates the relationship of the various products. Petroleum waxes are divided, mainly on the basis of crystal size, consistency, and method of manufacture, into three groups: the "paraffin wax" group, the "petrolatum" group, and the "petroleum ceresin" group. The two latter groups include waxes previously classed as "microcrystalline" or "amorphous." The current use of these terms is, however, so loose and erroneous as to make their abandonment advisable.

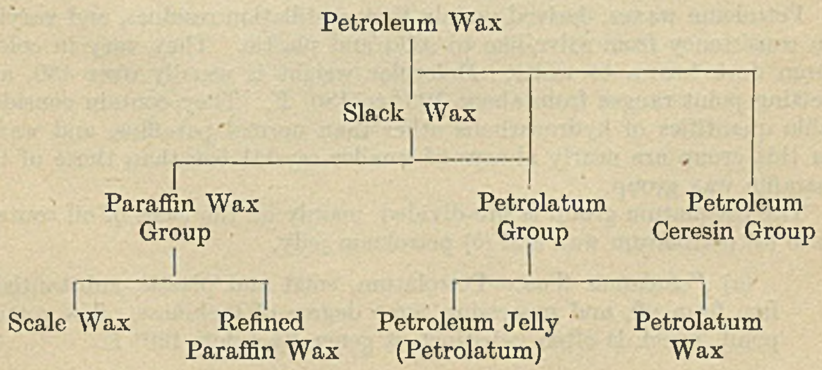
"Slack wax" is shown on the diagram as a petroleum wax, but is nevertheless placed outside the three groups. It is intended to indicate that the term is usually applied to an oil–wax mixture in which the wax is of the paraffin-wax group. The term is, however, not restricted to this application.

(2) The definitions are intended for petroleum products, but it is common practice to apply the same terms to comparable products from shale, etc.

(3) Descriptions of consistency, etc., throughout the definitions refer to characteristics at ordinary temperatures.

(4) Natural or artificial mixtures of these classes and sub-classes may be met (*e.g.*, a mixture of petroleum ceresin, petrolatum wax, and refined paraffin wax). In view of this, caution must be exercised in applying the classification, particularly as the petroleum ceresins have the power of conferring in some degree their small crystal size on paraffin waxes, thereby destroying the characteristic structure of the latter.

Diagram to Illustrate the Relationship of the Products Considered.



DEFINITIONS.

Petroleum Wax.

Wax-like materials, derived from petroleum, comprised of normal and branched paraffins and possibly hydrocarbons of other series. Molecular weight ranges from about 225 to 1000, and setting point from about 60° F. to 220° F. Consistency may be soft, semi-solid, or solid, and crystal size and form may vary widely.

Slack Wax.

Mixtures of crude petroleum wax and oil, usually obtained by separation from waxy oil. Consistency may be soft or semi-solid, and oil content is normally from 10 to 50 per cent. The term is usually applied to distillate products.

Oil in Wax.

Oil in wax can be defined only in relation to temperature, and is that part of an oil–wax mixture which is liquid at a specified temperature.

Note.—This definition can be made more precise only when a method for estimating oil in wax has been standardized.

Group I—Paraffin Wax Group.

Petroleum waxes, derived from distillates, comprised mainly of normal paraffins, of solid consistency, and having a relatively pronounced crystalline structure. Molecular weight ranges from about 225 to 450, and they have setting points up to about 160° F.

The paraffin wax group is sub-divided, mainly on the basis of oil content, into (*a*) scale wax and (*b*) refined paraffin wax.

> (*a*) *Scale Wax.*—Paraffin wax, usually obtained by the process of sweating the greater part of the oil from slack wax. Scale wax contains up to 10 per cent. of oil, and is often a crumbly solid. Setting points range from about 90° to 140° F.
>
> (*b*) *Refined Paraffin Wax.*—Paraffin wax of very low oil content, highly refined, white, with some degree of translucency, almost tasteless and odourless, and not more than slightly greasy to the touch. Setting points range from about 90° to 160° F.

Group II—Petrolatum Group.

Petroleum waxes, derived mainly from distillation residues, and varying in consistency from salve-like to solid and plastic. They vary in colour from dark brown to white. Molecular weight is usually over 450, and setting point ranges from about 100° to 180° F. They contain considerable quantities of hydrocarbons other than normal paraffins, and waxes of this group are nearly always of smaller crystal size than those of the paraffin wax group.

The petrolatum group is sub-divided, mainly on the basis of oil content into (*a*) petrolatum wax and (*b*) petroleum jelly.

> (*a*) *Petrolatum Wax.*—Petrolatum, solid and plastic, substantially free from oil, and possessing some degree of tackiness. The setting point, which is often indistinct, is generally below 180° F.

(*b*) *Petroleum Jelly* (*Petrolatum*).—Petrolatum, soft and salve-like, consisting of certain petrolatum waxes in admixture with a substantial proportion of oil.

Note.—For the purpose of this classification the term " petroleum jelly " is preferred to " petrolatum," so as to avoid possible confusion with " petrolatum wax."

Group III—Petroleum Ceresin Group.

Petroleum waxes, usually derived from distillation residues, essentially free from oil, and hard and brittle. They vary in colour from dark brown to white. Molecular weight ranges from about 450 to 1000, and the setting point is usually above 160° F. Generally the crystal size is much smaller than that of paraffin wax. Their hydrocarbon constitution is at present obscure.

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

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

Geology and Development.

1097. Proven Reserves Continue Decline with Important Discoveries in Three Areas. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 90.—During the first half of 1943 discoveries and extensions are estimated to have added 437,963,000 brl. to reserves, or 271,807,000 brl. less than the production in the same period. Ellenburger discoveries in Winkler County, Texas, may lead to an improvement later this year, and it seems likely that in 1943 the discoveries will be about 300,000,000 brl. below the production. This year discoveries have exceeded production in Wyoming, Upper Gulf area of Texas, North Louisiana, Kentucky, and Ohio.

In District 1 the only Pennsylvania grade discovery was in Muskingum County, Ohio. In Ohio, as in eastern Kentucky and the Appalachian fields, the main interest is the discovery of gas, and a fair measure of success has been obtained in Ohio, but the new supplies are not adequate. Six new pools have been found in the West Kentucky sector of the Illinois basin. Most of them produce from the Chester, but one gives oil from the Mansfield (Pennsylvanian) and another from the McClosky. In Illinois the new pools were in the old producing area within the basin.

New fields continue to be found in the northern sector of Michigan. A well found oil in the Bartlesville of Atchison County, Missouri, in the Forest City basin, but it was not completed as a commercial producer. The Carmi pool was the centre of interest in Kansas. It lies well down the flanks of the Central Kansas uplift, and may be on a new trend. On the other side of this high two discoveries were made in Saline County, one in the Mississippi lime and the other in the Viola. The West Edmond field opened in Oklahoma seems to be a stratigraphic trap. A well in eastern Mississippi reports 100 ft. of oil-saturated Tuscaloosa sand, which is correlated with the Woodbine. It has yielded oil at Tinsley and Natchez, Seventy-six wildcats gave only four oil and two gas discoveries in North Louisiana and Arkansas. Oil has been found in the Katy field of the Texas Gulf Coast, but the quantity associated with this gas-distillate field, which has a 45-ml. perimeter, is uncertain. A large structure has been opened in the old Slick pool of Goliad County. Chief attention is being paid to the Lower Cretaceous pays in East Texas, and finds have been made at Manziel, New Hope, and Scroggins.

The Ellenburger discoveries of Winkler County, West Texas, are deep and expensive, so that development may be slow. The Embar-Tensleep production of the Oregon Basin of Wyoming has been followed by drilling in the Elk Basin which has revealed 6 sq. ml. of virtually proven production. The Sundance has proved to be an important producer at Steamboat Butte. Two oil-fields and four gas-fields were found in California, the Pleasant Valley field producing from the Eocene.

Tables give by States and districts the proven oil reserves on 1st July, 1943.

G. D. H.

1098. Crude-Oil Production Responds to Rising War Requirements by Setting New Peak. W. V. Howard. *Oil Gas J.*, 29.7.43, 42 (12), 93.—During the first half of 1943 crude production in U.S.A. reached the record level of 709,770,000 brl., 31,232,000 brl. more than in the corresponding period of 1942. Noteworthy increases amounting to 57,909,000 brl. were recorded in Texas, California, and Kansas. Oklahoma fell to the fourth place among the producing States. Illinois and Michigan also suffered declines. Marketing and transportation effects led to increases in the coastal district of Texas, East Texas, and the Panhandle. The West Texas decline was due solely to artificial causes, and that of South Central, West Central, and North Texas was the result of natural causes.

Arkansas, Colorado, and Wyoming appear likely to reach new peaks.

The present U.S. production is not a sign of steady growth, but to some extent the result of the over-production of certain areas in order to meet current demands which it may not be possible to satisfy much longer from domestic sources.

The annual production for the years 1937–1942 inclusive, and the production during the first halves of 1942 and 1943 is listed by States. G. D. H.

1099. Major Fields Called Upon to Supply Disproportionate Share of Nation's Oil. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 94.—The 75 largest U.S. fields increased their production by 34,539,000 brl. in the first half of 1943, while the total U.S. production was only 31,232,000 brl. above that for the first half of 1942. Of the 75 fields, 23 showed a decline of 25,503,000 brl., so that the remaining 52 fields increased their production from 225,729,000 brl. to 285,751,000 brl. This year the 75 largest fields have produced 53·3% of the U.S. oil for the half-year, compared with 55·1% in the corresponding period of last year. This year 84 fields are producing more than 10,000 brl./day, and such fields account for 57·8% of the country's oil.

In the Permian basin and Wyoming major fields have been or are being developed which can take up some of the burden of greatly increasing production, but the type of oil and remoteness from transportation centres raise additional problems.

The major fields are listed with their age and output during the first halves of 1942 and 1943. Fields which have been added to or removed from the list this year are noted. The fields are also grouped according to their outputs, and according to the production trends. G. D. H.

1100. Era of Abundant Production Fading. D. R. Knowlton. *Oil Gas J.*, 29.7.43, **42** (12), 103.—For the past fifteen or twenty years it has been necessary to restrict oil production to some extent, but now the era of plenty is being succeeded by one of scarcity and unmet quotas. Except for a few fields on the Gulf Coast and in West Texas, every U.S. field is producing at or above its maximum efficient capacity. There is a fear that the present high rates, and perhaps higher rates in the near future, will damage producing ability and ultimate recovery. In Kansas the high rates of flow have been accompanied by the appearance of water in Arbuckle limestone wells which supply 80% of the State's oil. The present rate of 780,000 brl./day seems to be California's maximum efficient capacity, although two years ago there were claims that it could produce 3,000,000 brl./day. Arkansas, Oklahoma, Michigan, Mississippi, and Illinois are producing at higher rates than appear desirable from the point of view of operating efficiency, and the same is true of most of Texas and Louisiana.

In June the crude production was about 3,980,000 brl./day, and in July the rate may be 100,000 brl./day higher, with a further rise probable in August.

Larger amounts of steel are being allotted to the producing branch of the oil industry, and it may now be possible to drill some of the deferred wells. In some areas closer spacing is being allowed—California, eastern Kansas, eastern and southern Oklahoma, North Texas, Cut Bank, and Kevin-Sunburst.

Apart from the discovery of new fields, the most important source of increased productive capacity lies in secondary recovery. 3,000,000,000 brl. of oil recoverable by secondary methods is believed to be available at existing or slightly higher prices. In water-flooding it seems that about 50% of the reserves are obtained in the first two years of operation. G. D. H.

1101. All Methods of Discovery Are Needed to Reverse Trend of Petroleum Reserves. W. B. Heroy. *Oil Gas J.*, 29.7.43, **42** (12), 105.—From 1900 to 1925 the volume of proved reserves was generally near the current annual production, but for the period 1925–1931 the volume of new reserves discovered substantially exceeded production. In 1930 East Texas was discovered, and for several years it overshadowed all other development. In 1932 and 1933 less oil was discovered than was produced. The advent of proration had a stabilizing action, and in the 1934–1938 period 9,600,000,000 brl. of oil was discovered, and 5,800,000,000 brl. was produced. At the end of 1938 the total reserves were 17,400,000,000 brl., or more than fourteen times the 1938 production. Much of the rapid building-up of reserves was due to the application of geophysics, and in the latter part of the 1934–1938 period an average of 250 geophysical crews were constantly at work.

The reserves found in 1939 were about a third of those found in 1938. In 1940 nearly as much oil was found as was produced, but 1941 fell back to the 1939 level. It seems likely that the 1942 discoveries will provide reserves equal to about a half of that year's production. In this last period production was about 5,400,000,000 brl. and discoveries may not have exceeded 3,900,000,000 brl., although at its end about 330 geophysical crews were in the field. 44% more wildcats were completed in 1941 than in 1937, and there was a corresponding increase in the number of successful wells and fields found. However, the size of the new fields fell from an average of 11,000,000 brl. in 1938 to 2,000,000 brl. in 1942.

It seems probable that most of the structural traps containing important oil-fields have been located, due to the efficiency of geophysics.

At the present rate of wildcatting it seems that about 3350 wildcats will be drilled in 1943, but with the existing volume of reserve added per wildcat, the discovery of a volume of oil equal to the current production would require 5600 wildcats in 1943. P.A.W. has urged the drilling of 4500 wildcats this year, hoping thereby to increase the number of random wildcats and to encourage the testing of the best available prospects. G. D. H.

1102. War Hastens New Concept on Value of Nation's Natural Gas. E. H. Poe. *Oil Gas J.*, 29.7.43, **42** (12), 106.—Return of gas to the reservoir assures to-morrow's supply of both gas and oil. Unitization has sometimes proved impossible, and an alternative method of conservation has been to shut in high gas/oil ratio production or to connect the gas to a consumer instead of wasting it. Even in California a 20% gas saving has been effected in the past year. The use of underground storage adjacent to consuming centres has proved highly successful in meeting heavy seasonal demands. The depleted Playa del Rey field is an example of such technique. In District 1 gas delivery will be supplemented by 50–100 million cu. ft./day by additional looping of a line from Texas to Michigan, and by a 120-ml. interconnection with the East Ohio Gas Co.'s properties. A 240-ml. extension will draw 140,000,000 cu. ft./day from the Hugoton field to District 2's industrial area.

Industrial research has been concentrated on the utilization of the more abundant light hydrocarbon fractions. 11% of last year's marketed natural-gas production was used in carbon-black production, and improved methods are giving increased yields.

A new condensate-bearing area, with promising potentialities, has been found in the Permian basin. G. D. H.

1103. World Production Reviving. J. P. O'Donnell. *Oil Gas J.*, 29.7.43, **42** (12), 114.—The world production in the first half of 1943 is estimated at 1,043,532,000 brl., about 4,716,000 brl. less than in the same period of 1942. Improvements of the transport situation caused production revivals in some areas which had previously shown marked declines. U.S. had a rise of 25,939,000 brl., which offset about 80% of the decline shown elsewhere in the world when compared with 1942 figures. U.S. produced 68% of the world's oil in the first half of 1943.

Venezuelan production in the first half of 1943 was slightly over 400,000 brl./day, less than 50% of the country's proven potential. In the same period Colombia's output was only a quarter of that for the first half of 1942. Colombia has a large potential which still lacks outlet. Mexico's production in the first half of 1943 was only two-thirds of that for the same period in 1942.

The production of the Ural–Volga region is estimated to be 125,000 brl./day. The temporary loss of the fields of the western Caucasus caused the European output in the first half of 1943 to be below that for the same period of 1942.

Asiatic production may have risen in the first half of 1943 because of the greater demand for Near Eastern oil and the opportunity Japan has had to restore production in the East Indies.

The estimated outputs in the first six months of 1942 and 1943 are tabulated by fields. G. D. H.

1104. Drilling Decline Continues with Few Prospective Active Areas. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 131.—Of the 7819 wells drilled in the first half of 1943, 3283 were east of the Mississippi, and of them 1791 gave oil and 637 gas. Apart from those in Mississippi and Michigan, the wells east of the Mississippi are expected to be small. A thousand producers were drilled in the Appalachian States, mostly in the Bradford field. In addition, about 900 input wells were drilled. 75% of the U.S. gas wells were in the eastern districts; the majority have a capacity less than 500,000 cu. ft./day.

Excluding the eastern States, 1430 wildcats were drilled, and these gave 181 new fields, extensions or new sands, and 31 new gas-pays. Louisiana has 15 discoveries, Texas 65, 46 of them in the north-central and south-western districts, and Kansas 35. Most of the Kansas discoveries may prove to be extensions to old fields.

About 25% of the development wells in the first half of 1943 were dry, the majority being marginal walls. Michigan, North-central Texas, Southwest Texas, and Louisiana had a disproportionately large number of dry holes.

In Kansas, the Carmi and Lindsborg fields are developing rapidly. They lie outside the main producing belt on the Central Kansas uplift. There has been considerable activity at Cumberland and Velma in Oklahoma. Nearly three-quarters of the development drilling in the Rocky Mountain area was at Oregon Basin, Cut Bank, and Kevin-Sunburst. A great part of the drilling in Illinois took place in fields discovered during the past eighteen months.

Tables summarize the wildcat and development drilling, and the total completions in the first half of 1943. G. D. H.

1105. Permian Basin Panhandle, New Mexico : Ellenburger Discoveries in Winkler County Are of Major Importance. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 136.—Three new Ellenburger discoveries have opened up the entire west side of the Permian basin for Ordovician exploration. All three are in Winkler County, and two are less than 4 ml. apart, although on separate structures. The third well, completed just after the new year, was 14 ml. south-east of the others. Continued drilling in the Embar–Ellenburger pool and the Barnhart pool gave further encouragement to Ordovician development in the entire area. The search for Ordovician oil has spread throughout the entire southern half of the Permian basin ; there has been relatively little Ordovician prospecting in the northern sector.

A Clear Fork discovery on the east side of the Permian basin opened up the eastern side for deeper exploration. Most of the production in the area is from the San Andres lime. Five other discoveries in the Permian basin were relatively unimportant, the wells not being large, and producing from pays already known to be productive.

Early in 1943 P.A.W. ruled that no more gas-wells could be drilled in the Texas Panhandle area. Routine oil-well drilling continued. No important extensions were recorded. An Ellenburger test is under way in Armstrong County between the Panhandle and Permian basin districts.

Wildcatting and field work were light during the first half of 1943 in south-eastern New Mexico. The bulk of the drilling was in the Jackson–Grayburg, Square Lake, and Maljamar pools. A well in Lea County was carried to 9594 ft.. and tested at many points. The most promising zone was in the Lower Permian at 4859 ft., while the Simpson showed possibilities at about 8200 ft. A small discovery was made in Eddy County.

Tables summarize the completions by fields for the first half of 1943, and the production is given for the first halves of 1942 and 1943. G. D. H.

1106. California : Record Demand Combined with Low Rate of Discovery Drops Coastal Reserves. L. P. Stockman. *Oil Gas J.*, 29.7.43, **42** (12), 142.—In 1941 California's crude reserves fell 116,162,000 brl., in 1942, 156,295,000 brl., and in the first half of 1943 about 100,000,000 brl. Two oil-fields and three gas-fields were opened in the first half of 1943. The Wheatville oil discovery is of doubtful value, but the Eocene at Pleasant Valley is quite prolific. Commercial gas discoveries were made at Lodi, Mendota, and Thornton, thus maintaining the gas reserves of the State, and it seems likely that a new deeper productive zone has been found at Rio Vista.

658 wells were completed in the first half of 1943, 525 giving oil and 14 gas. Most of the current drilling is in proved fields, especially in those giving a heavy crude. Development work is expected to increase in the second half of this year. The daily average production of 772,606 brl. during the first half of 1942 was the highest since 1929.

One of the most important undeveloped reserves is the Ford zone of the Long Beach Harbour section of the Wilmington field. The tar zone also contains much oil. The extent of the Sentous zone at Inglewood is undetermined. Several other fields have good deep-zone possibilities which have not been tested (Ten Section, Newhall-Potrero, San Miguelito, and Ventura Avenue). South Belridge still produces from the Pleistocene and Pliocene, and its productive limits have been extended. North Belridge produces from the Pliocene, Miocene, and Eocene.

A wildcat is under way on the line of folding which contains the Rio Bravo and

Greeley fields. There are several favourable structures in the Tejon district in the extreme south of the San Joaquin Valley.

The production in the first halves of 1942 and 1943 is tabulated by fields, and completion data are presented for the first half of 1943. G. D. H.

1107. Texas Gulf Coast : Discovery of Oil in Katy Distillate Field Is Outstanding Gulf Coast Development. T. F. Smiley. *Oil Gas J.*, 29.7.43, **42** (12), 147.—An excellent oil-sand has been found at Katy which was previously supposed to be a gas and distillate field only. The discovery well is 2½ ml. from the nearest gas-well, and after finding gas and distillate in three different horizons it located oil at the 6600-ft. level which had not been tested in the other wells.

Conroe, the prolific Cockfield producer, is to have a deep Wilcox test. The Wilcox gave minor oil shows in a previous test. In January the Stowell field was extended 2 ml. to the north by a well, located on geophysical and subsurface data, which reported 120 ft. of productive Frio. A Frio well was completed at a depth of 10,258 ft. to open the Hall's Bayou area in Brazoria County. A large gas-well opened the Sterling field in April. It lies 3½ ml. south-east of Ganado, and flowed 46,700,000 cu. ft./day from 4910 to 4940 ft.

Tables give a summary of the wildcat and other completions in the first half of 1943, by fields, as well as the production in the first halves of 1942 and 1943. G. D. H.

1108. Illinois : Covington, North Calvin, and Belle Rive Best New Fields. J. McIntyre. *Oil Gas J.*, 29.7.43, **42** (12), 150.—818 wells were completed in the first half of 1943, 485 being oil-wells. The corresponding figures for 1942 were 833 and 480. The most important discoveries seem to have been Covington, Belle Rive, and North Calvin. Covington has five oil-wells with an average initial production of 159 brl./day. Seven oil and four dry wells have been drilled at Belle Rive, where the initial outputs averaged 170 brl./day. The five successful wells at North Calvin averaged 106 brl./day initially. The greatest activity was at Bible Grove, Friendsville, New Harmony, Iola, Phillipstown, South Lawrence, and Walpole. Twenty-two wildcats found oil, some proving extensions, and others new fields, as at Belle Rive, Covington, North Calvin, Bennington, North Schnell, West Mount Carmel, Mount Auburn, Scheller, West Frankfort, North Phillipstown, North Hoodville, Logan, and North Herald.

The Flora pool was extended ¾ ml. to the south-west, and Phillipstown was extended 1 ml. to the north, both extensions being McClosky producers. Devonian production has been found in the old Patoka pool. Allendale and North Calvin were extended. Extensions were made at Mount Erie and Akin, a new pay being found in the latter pool. Rosiclare production has been found at South Mason, and a new pay, the Mansfield sand, has been opened at Phillipstown.

Tables give the completions and types of completions by fields, the wildcat completions, and the production and number of wells producing in the first six months of 1942 and 1943. G. D. H.

1109. South-west Texas : Major Wilcox Discovery Made in Slick Area, Goliad County. T. F. Smiley. *Oil Gas J.*, 29.7.43, 42 (12), 158.—Thirteen out of 56 wildcats succeeded in the Lower Gulf Coast area, where there were 192 completions in the first half of 1943, compared with 291 in the same period of 1942. South Texas had 190 completions, against 277 in the first half of 1942 ; South Central Texas had 36 completions in the first half of 1943.

In the old Slick field area of Goliad County a 249-brl. well has been completed in a thick sand, and this has been described as the largest Wilcox sand discovery in the South-west Texas. Geophysical and other data indicate that the structure is unusually large. A gas-field was found at Cabeza Creek, the discovery well having an initial open flow of 19,000,000 cu. ft./day.

Six producers have been drilled in the Hobson field of Karnes County, and oil has been found at Hondo Creek. Karnes County had two other less significant finds.

Several wildcats are drilling or to be drilled in the Rio Grande Valley. Two new fields and two extensions have been opened in Starr County, while Duval County had one new field and one new sand discovery.

Tables give by fields and counties the production in the first six months of 1943 and 1942, together with the number of wells producing on 1st July, 1942, and 1st July, 1943. Summaries are also given of the well completions and wildcats in the first half of 1943. G. D. H.

1110. Eastern Texas : Wood County Paluxy Yields Important Discoveries. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 166.—During the first half of 1943 wildcatting in East Texas was centred round Wood County, due to the interest caused by the Quitman Paluxy discovery of last year. Of the five wildcats in this area one succeeded and opened the Manzial (Cartwright) pool. 25 wells (19 producers) were completed in the Hawkins Woodbine pool, and 17 wells (16 producers) in the Quitman pool. The latter pool is not yet defined in any direction.

The New Hope pool may be a major field. It produces from the Rodessa (7295–7305 ft.) and the Travis Peak (7902–8089 ft.). A Paluxy sand discovery in Hunt County has opened up a considerable area to deep production.

The Kildare pool, which produces from the Gloid lime, was extended 1 ml. northwards.

Of 62 wildcats in widely scattered areas, only four were successful. The Smackover lime, which lies below the deepest known producing horizon in this region, was attracting attention.

Tables give production and completion data by fields for the first half of 1943. G. D. H.

1111. Louisiana Gulf Coast : Deep Sands Provided More New Oil Than New Fields ; Deepest Producer Drilled. T. F. Smiley. *Oil Gas J.*, 29.7.43, **42** (12), 169.—The world's deepest production has been obtained in the De Large field, where a well flowed 5,970,000 cu. ft. of gas and an unestimated volume of distillate from 13,475 to 13,490 ft.

170 wells were completed during the first half of 1943, compared with 270 wells in the same period of 1942, and 94 wells found oil. The greatest activity was at Pine Prairie where Wilcox production has been found and Sparta lime production opened on the south of the dome. Major-scale distillate production is foreshadowed in the Erath field. All the wells are to be perforated in the 8700-ft. level, and it is reported that some of the shallower sands are even more prolific in their distillate yield than are the deep zones. Production is in the Miocene.

The Bear field was opened in April, finding production in a new Frio sand zone. Miocene production has been established on the east flank of the Napoleonville dome. The abandoned non-commercial Perkins gas-field now seems to have excellent oil prospects. It is hoped that a similar transformation may take place in the Bayou des Glaise field. Four dry holes have been drilled in the Bully Camp gas-field.

Tables give the production and completions by fields during the first half of 1943, as well as a summary of the wildcats. G. D. H.

1112. North Central Texas : Discoveries in Mississippi and Caddo Lime Maintain Production. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 172.—During the first half of 1943, 433 wells were completed, but only 179 yielded oil. The most concentrated activity was in the Thornberry field which includes several lenticular sand pools.

The best wildcat completion was 4 ml. north of Archer City, the well being completed in the Caddo lime at 4881–4891 ft., with a potential of 763 brl./day. The discovery well of the Buffalo Springs pool produces from the Mississippi lime at 6011–6049 ft., its potential being 483 brl./day. Several wildcats have started in the vicinity. The Ellis pool, a Caddo lime field, was opened in January. The Peek pool is also a Caddo lime producer, with oil at 4575–4589 ft.

The Walnut Bend pool has been extended in the upper Strawn, and a deeper pay has been found in the lower Strawn. Lower Strawn and upper Bend production has been added in the Hildreth pool, which produced from the Simpson. A 12,096-brl. well was brought in in the Mississippi lime at 5985 ft. in the Joy pool. This well extended the pool ½ ml. northwards, and lies 6 ml. from the Buffalo Springs discovery.

Tables summarize by fields and months the completions during the first half of 1943, and also give the production during the first halves of 1942 and 1943. G. D. H.

1113. West Central Texas. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 174.—During the first half of 1943, 111 tests were drilled in proven areas and 43 were successful; four of the 50 wildcats found oil. The most important successful wildcat was the discovery of Mississippi lime production in the Eliasville pool. The discovery well flowed 4284 brl./day from 6 ft. of pay at 4236 ft. In June, Marble Falls production was found on the Corbett ranch in north-eastern Stephens County. The pay was topped at 3938 ft., and the well flowed at the rate of 840 brl./day.

Tannehill production has been obtained in the Patterson pool of Jones County. This field holds possibilities of Cisco production.

Tables show the production by fields during the first halves of 1942 and 1943, and the completions during the latter period. G. D. H.

1114. Oklahoma : Discovery Record for Half-Year Fails to Offset Production Decline. C. Hoot. *Oil Gas J.*, 29.7.43, **42** (12), 182.—Discoveries in Oklahoma during the first half of 1943 have offset very little of the decline in production, and a number have had discovery wells with a high potential followed by offsets with water. A fourth pay has been added at Cumberland, and finds which may become fields of major importance have been made in the Cromwell sand in Okfuskee County and in the Hunton lime in Oklahoma County. After finding the Mississippi lime dry, oil was obtained from the Layton at 100 brl./hr. in the discovery well of the Big Bend pool, which lies 6 ml. south-east of the Ponca City.

Medrano sand production was added in the south-west corner of the Cement pool, and the Byars pool has been extended 1 mile to the south. Pauls Valley has been extended to the north-west, north-east, and south-east.

Total completions in 1943 are 14·8% down, and oil-wells 18% down. No important wells have been drilled this year in the Anadarko basin and western Oklahoma, and operations in North-east Oklahoma have slackened considerably. In this last area repressuring and water-flood programmes have been completed.

Tables summarize the completions and wildcat completions by fields and counties, respectively, and the production is given by fields for the first half of 1943 and 1942. G. D. H.

1115. Rocky Mountain Area : Much Activity Promised by Steamboat Butte and Elk Basin Discoveries. T. R. Ingram. *Oil Gas J.*, 29.7.43, **42** (12), 187.—166 wells were completed in the Rocky Mountain area during the first half of 1943, 17 more than in the first half of 1942. 108 oil producers and 23 gas-wells were drilled. The total initial production of the completions was 21,008 brl./day. Of 26 wildcats, eight found oil and three gas. The outstanding oil discovery was on the Steamboat Butte structure, where a 623-brl. well was completed in the Sundance sand. The well was originally intended to test the Tensleep, which produces at Pilot Butte to the north.

The Elk Basin field is an old Frontier producer, and last year the Tensleep gave a 100 brl./hr. well. The Tensleep producing area is probably 4 ml. long and 1–2 ml. wide, with its limits still undefined. 12 ml. east of Elk Basin a Madison discovery has been made which showed 840 brl./day initially. Madison oil was also found in the Oregon Basin field. Gas was found on the Douglas Creek structure, while the Fulcher Basin gas-field was extended.

Tables summarize the drilling and wildcatting by fields, months, and counties, and show the production by fields in the first half of 1943. G. D. H.

1116. North Louisiana, Arkansas : Haynesville Development Continues Most Important in Sabine Area. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 193.—Probably the most important development in North Louisiana and Arkansas in the first half of 1943 was the expansion of the Haynesville pool, which produces from the Pettit lime at an average depth of 5450–5475 ft. Of the three successful wildcats in North Louisiana in 1943 only that between the Clayton gas-field and the St. John pool was a good well. Major extensions or new pays were found at New London, Nick Springs, Midway, and Stephens in Arkansas. Geophysics is said to have revealed a few promising areas in Arkansas.

119 wells, 70 of them oil producers, have been completed in Arkansas during the

first half of 1943, and 151 wells, with 60 oil-wells and 18 gas-wells, in North Louisiana. North Louisiana had five successes out of 44 wildcats, and Arkansas one out of 32.

Tables give completion, wildcat, and production statistics. G. D. H.

1117. Mississippi. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 194.—16 ml. north-west of Waynesboro a wildcat has penetrated 100 ft. of oil-saturated Tuscaloosa sand at 6760 ft. A well in Adams County has found oil in Wilcox cores between 4000 ft. and 4200 ft.

At the beginning of the year oil-flow at the rate of 360 brl./day was obtained in the Tuscaloosa at depths of 10,281–10,285 ft., 6 ml. south-west of Natchez, in Adams County, but tests at lower levels permitted salt-water intrusion.

A monthly summary of the completions is appended. G. D. H.

1118. Michigan: New Fields in Northern Area Hold Up Production. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 197.—246 wells were completed in Michigan during the first half of 1943, 96 being oil-wells and 13 gas-wells. In the corresponding period of 1942 there were 333 completions, with 170 oil-wells and 28 gas-wells. The Evart, Fork, Richfield, and Prosper pools in Osceola, Mecosta, Roscommon, and Missaukee Counties, respectively, were opened in the second half of 1942, and did much to increase the northern crude output from 7,342,000 brl. in the first half of 1942 to 8,311,000 brl. in the same period of 1943. In the southern district the output fell from 2,933,000 brl. in the first half of 1942 to 2,215,000 brl. in the first half of 1943.

Early in 1943 Gordon and Rowmoor 1 Reams in Missaukee County produced 67 brl. in the first hour from the Dundee at 3816 ft., and on the Enterprise structure a further Dundee test gave oil, but the rate soon declined. Four miles north of the Winterfield shallow gas-field a well came in at 3,650,000 cu. ft./day from the Michigan stray gas-sand at 1285 ft.

The Ohio Oil Co.'s 1 Zimmerman in Osceola County has produced at a good rate from the Dundee at 3829–3834 ft. The Aetna-Prosper field was opened by a 1250-brl. well in the Dundee at 3835–3837 ft., but a second well was dry. South of the Woodville pool a well in Goodwell Township came in at about 650 brl./day in the Traverse at 2722–2732 ft.

The Fork field has been extended about ¼ ml. to the South, and North Winterfield was extended a mile to the south-east. The extension well produced 4,000,000 cu. ft. of gas/day at 1270 ft. A 425-brl. well was completed in the Dundee at 2800 ft. in the Kawkawin pool.

Tables give by fields the production in the first halves of 1942 and 1943, and the number of wells operating on the 1st July in both years; and the completions by fields and months, as well as the wildcats by fields. G. D. H.

1119. Canada: Rapid Extension of Fort Norman Gives Canada Second Large Field. V. Lauriston. *Oil Gas J.*, 29.7.43, **42** (12), 198.—In the first half of 1943 the Fort Norman field has provided the outstanding development in Canada, and is now the Dominion's second largest field. The drilling was undertaken by an arrangement between the Canadian and U.S. Governments, and a pipe-line to Whitehorse in the Yukon Territory is planned, together with expansion of the refining facilities. During the first four months of 1943 the output was 57,729 brl., compared with 131 brl. in the same period of 1942. In April, 1943, the output was 19,692 brl. Pending completion of the pipe-line a number of wells are closed in. So far the limits of the producing area have not been defined.

The experimental plant for extracting oil from the Athabaska tar-sands has been taken over by the Government, and it is to be expanded.

New completions at Turner Valley have not offset the production decline of the older wells, and the output in the first half of 1943 was 4,555,545 brl., compared with 4,907,442 brl. in the first half of 1942. The field has been extended ¼ ml. north of last year's limits. The most satisfactory completion this year is a well which gave 1948 brl./day initially. Drilling in Turner Valley has slackened this year, but elsewhere in Alberta the number of tests has increased. Taber is Alberta's second largest producing field, due mainly to one well. Tests in the Ross Lake area and the Blood Indian Reserve have proved negative. In an outlying area of the Tilley field a dry hole was completed near Grantham, while a little Ellis sand production was found in another test. Attempts to find oil in outlying areas of the Kinsella gas-field have yielded a gasser at 1975 ft. Processing of the heavy oil from the Vermilion field has been resumed. Deca 2 in the Athabaska district is to test a promising oil-sand at 1651 ft. Ram River Oils 2, on the Ram River–Clearwater structure, is testing Devonian limestone oil-shows at 4250 ft. On the Jumping Pound structure, west of Calgary, a well has reached a depth of 10,332 ft.

In Saskatchewan, a well has been abandoned at 7958 ft. owing to drilling difficulties, after passing through the Madison and Devonian limestones. A well 12 ml. north and 25 ml. to the west is at 7688 ft., and is to test Madison, Devonian, and Ordovician horizons. Other tests are to be made, and in the Kamsack district, near the Manitoba boundary, thirty wells are planned to produce from a gas-sand 187–210 ft. deep.

In Ontario attempts are being made to revive the abandoned Dutton field, which has small pumping wells 400–500 ft. deep. There has been considerable drilling for gas. South-east of the Dawn field a well has had a production of 974,500 cu. ft. of gas/day. G. D. H.

1120. Eastern Fields : Discoveries Limited to Small Oil and Shallow Gas Pools. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 202.—Deep Lower Devonian tests in South-west Pennsylvania during the first half of 1943 were all disappointing. In various counties local lenses added some fair shallow gas production, and in one case oil. A 25-brl. Clarion sand well was drilled in Monroe Township, 4 ml. from the nearest oil-pool in Clarion County. An 8685-ft. dry well was drilled on the Chestnut Ridge in Fayette County. In the shallow area good gas-wells were completed, notably in Springhill Township, where three wells have been completed in the Injun sand with an initial open flow of 1,000,000 cu. ft./day.

Several Dunkard sand oil-shows were found and produced in Greene County in Monongahela and Cumberland Townships. A small gas-show was noted in the Lockport dolomite in an abandoned deep wildcat in Lawrence County. G. D. H.

1121. Two Small Fields Found in Indiana. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 205.—Only one well has been completed in the Rogers pool of Posey County. It produces from the Clore sand at a depth of 1900 ft. Three productive wells have been drilled in the North Owensville pool, Gibson County, where the McClosky is productive.

107 wells were completed during the first half of 1943, 43 producing oil, and 7 gas, while the corresponding figures for the first half of 1942 were 207 completions, 80 oil-wells, and 10 gas-wells.

The completions during the first half of 1943 are summarized by counties. G. D. H.

1122. West Virginia. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 206.—There have been no new oil discoveries in West Virginia during the first half of 1943, but for a time heavy distillate yields in some of the Oriskany tests in the Ripley district, Jackson County, led to speculations regarding probable deep sand oil. All those proved disappointing, but many good shallow sand gas-wells were obtained. In the Poca district of Kanawha County the Big lime-pool has been extended. Deep tests in the Union district, Mason County, Browns Creek district, McDowell County, Union district, Pleasants County, and Marsh Fork district, Raleigh County, failed to obtain Oriskany production. Two wells in the Pocatalico district of Putnam County have given over a million cu. ft. of gas/day. Deep tests are under way in the Dry Fork district of Tucker County and in the Tucker district, Wirt County.

The completions and types of completions are tabulated by months for the first half of 1943, with comparative totals for the first half of 1942. G. D. H.

1123.* Canadian War-time Oil Project is Herculean Undertaking. L. J. Logan. *Oil Wkly*, 9.8.43, **110** (10), 13.—Drilling at Fort Norman, previously thought to be a comparatively small field, has revealed a rich oil reserve. " Scores " of wells are said to have been successfully completed. The oil is light and has a high gasoline content. Some 42 producing wells were reported in May to have been capped pending the construction of a pipe-line. During the first four months of 1943 wells in the North-west Territories produced 57,729 brl. of oil; the corresponding figure for 1942 was 131 brl.

Various roads are being constructed in this northern region, and the building of a pipe-line from Norman to Whitehorse has been begun. A refinery is being erected at Whitehorse, and there will be pipe-lines to points on the Alaskan highway.

The first Fort Norman well was drilled in 1921, and a small refinery made oil products for local use.

Dry gas in quantity is reported to have been found in the Fort Nelson area of northern British Columbia. This gas was struck while drilling for water 250 ml. north-west of Fort St. John.

Semi-official reports mention programmes for extensive drilling in areas adjacent to the Fort Norman field, much wildcatting in promising areas in the North-west Territories outside the Norman area, probable further testing of fields in northern Alberta and British Columbia, and geological search for potential oil-bearing areas in the Far North. Additional developments of the Athabasca tar-sands are suggested. 1,000,000,000 brl. of oil are said to be recoverable from the tar-sands accessible by open-cast workings, and it is claimed that plant capable of giving 75,000 brl. of oil per day could be erected for $50,000,000. Already oil is being extracted from the tar-sands on a small scale.

Farther south in Alberta there are two minor oil-fields, Vermilion and Wainwright, east of Edmonton. Turner Valley gives the bulk of the Canadian oil production, and in May 1943 provided 25,618 brl./day from 240 wells (Alberta's total was 26,000 brl./day from 268 wells). The producing area is 20 ml. long and about 1 ml. wide at its maximum. The wells at the northern end are much more productive than those in the centre or the south. There are 10,000 acres of gas production and 7000 acres of oil production. Two separate producing zones occur in the Mississippian at 7350–8000 ft.

The Red Coulee field extends across the Canadian border into Montana. In May it gave only 22 brl./day from seven wells. Wainwright was discovered in 1922, and has long-lived small wells in Lower Cretaceous sands. In May six wells produced an average of 56 brl./day. Vermilion also produces from the Lower Cretaceous. It was discovered in 1940, and gave 80 brl./day from 12 wells in May. The wells are about 1850 ft. deep.

The Alberta oil output is tabulated monthly by fields for the first five months of 1942 and 1943. The numbers of producing wells and completions are given.

G. D. H.

1124.* July Completions Follow June Trend: Work Off 20% for Seven Months. Anon. *Oil Wkly*, 9.8.43, **110** (10), 45.—During July U.S. well completions were at the rate of 375 per week, the June figure having been 382 per week, and that for the first five months of 1943 under 350 per week. In the first seven months of 1943, 10,248 wells were completed, against 12,835 in the corresponding period of 1942. The average depth of 3220 ft. for the 1943 completions is much less than in former years.

Kentucky has drilled 177 wells, compared with 82 in the first seven months of 1942. Colorado, Montana, Wyoming, and Kansas have each completed more wells than in the same period in 1942. Texas has completed 2230 wells, as compared with 3489 in the first seven months of 1942, and there were declines also in Louisiana (39%), New Mexico (39%), Oklahoma (15%), Mississippi (56%), Illinois (17%), Indiana (36%), Michigan (24%), Ohio (19%), Pennsylvania (35%), West Virginia (18%), and New York (2%).

The numbers of completions and completions of different types are tabulated by States for July and for the first seven months of 1943 with comparative totals for earlier months and years.

G. D. H.

1125.* New Gas-Well Reported in British Columbia. Anon. *Oil Wkly*, 9.8.43, **110** (10), 48.—A gas-well is reported to have been brought in in the Pouce Coupe district of British Columbia.

Dominion 5, at the north end of Turner Valley, is stated to be making 850 brl./day. Home Millarville 13 is under test, and will make a good producer, while Home Millarville 15 is drilling at 7300 ft. Bonaventure 1, Maryland Pete 1, and Devonian Test 1 are on test, and several more are expected to come in. In the south of Turner Valley, Brown 6 is on test and has opened up a new area for production.

Taber-Providence 1 is giving 240 brl./day, and Taber-Providence 37-18B is on test. The Deca well is nearing the productive zone in the Athabaska field. East of Turner Valley in the Heronton field a test is nearing the Madison at about 6200 ft. If this formation is barren the well will be drilled to the Devonian. G. D. H.

1126.* Gas-Flow in Canadian Test Near Athabaska. Anon. *Oil Wkly*, 9.8.43, **110** (10), 48.—6 ml. west of Athabaska a heavy gas-flow, which blew out, was struck recently in Deca 2 at a depth of 1687 ft. Several more wells have been planned in this area. G. D. H.

1127. Colombian Production Hits Peak in General South American Rises. J. P. O'Donnell. *Oil Gas J.*, 12.8.43, **42** (14), 32.—In the early part of July the Venezuelan production approached 500,000 brl./day, 25% more than the average for the first four months of 1943. However, the output is still only two-thirds of the peak value reached before marine traffic was disrupted. It is predicted that Venezuela's output will be doubled within a year. The Aruba and Curaçao refineries are now reported to be operating at or near capacity, after a long period of curtailment.

Colombia's output for June is given as 2,455,720 brl., an all-time peak monthly total, although the daily average for February 1942 (83,428 brl.) exceeded the daily average for June 1943 (81,857 brl.). The rise in Colombia's production this year has been astounding. January's total was doubled by March, and the March total almost doubled by May, while June more than doubled the May total.

In May the Dificil wildcat found oil in what may become one of Colombia's largest fields. Four producing wells have been completed at Socuavo in the centre of the Barco concession. The Casabe field, 225 ml. south of El Dificil, still lacks a pipe-line outlet. The nearness of the Dificil wildcat to the coast is important.

The Colombian production is given monthly from July 1941. G. D. H.

1128. Oil Zones of the United States : Lower Cretaceous. Anon. *Oil Gas J.*, 12.8.43, **42** (14), 68-C.—The principal Lower Cretaceous production is from fields around the margins of the East Texas basin. The oldest beds were the Hosston (Travis Peak) which produce in Arkansas and to a small extent in North Louisiana. The Sligo or Pettit limestone of the " Glen Rose " series is important on the north and east flanks of the Sabine uplift. The Rodessa has several pay-zones which give much oil and gas at Rodessa, and in other pools low on the west flank of the East Texas basin. The Paluxy, the uppermost member of the Lower Cretaceous, appears to be the most widespread Lower Cretaceous pay, and gives distillate, high-, and low-gravity crude. The Buda produces in a few small fields near the Balcones–Mexia fault zone, while the Edwards limestone is the main producing horizon farther south-west.

The Lower Cretaceous Lakota is a minor producer in the Powder River and Wind River basins of the Rocky Mountain area. The Cut Bank or Sunburst sand is the basal member of the Kootenay, laid down in a sea advancing from the north. It is the main pay at Cut Bank and a minor pay at Kevin-Sunburst.

Deep drilling along the Wilcox trend in Texas and Louisiana offers good chances of finding productive Lower Cretaceous beds. The Mexican production in the Tampico–Tuxpan area is of Edwards age, suggesting a possible continuation of this productive trend with that of the San Antonio area.

At Cut Bank the former shore-line is on the down-structure side, and the upper limit of the field is a transition to impervious beds. There may be other similar reversed traps. There may be stratigraphic traps in southern Montana and northern and central Wyoming.

Deep drilling will probably locate Lower Cretaceous beds east of the Sabine uplift.

A map shows the Lower Cretaceous fields and outcrops, and areas which are deemed favourable and unfavourable for Lower Cretaceous production. G. D. H.

1129. Completions and Drilling Wells Increased in July. Anon. *Oil Gas J.*, 19.8.43, **42** (15), 105.—1552 wells were completed in U.S.A. in July, compared with 1490 in June, and 1578 in July 1942. 856 produced oil and 143 gas, the corresponding figures for June being 796 and 158. In most districts the July figures are on a 5-week basis, and those for June on a 4-week basis.

The numbers of completions are listed by States and districts, with the total footage, and numbers of wells of different types and in different depth ranges. G. D. H.

1130. Oil Zones of the United States : Upper Cretaceous. Anon. *Oil Gas J.*, 2.9.43, **42** (17), 36-B.—The Upper Cretaceous seas invaded the continent from the north, extending into Minnesota, Kansas, and the Rocky Mountain States, and on the whole this embayment became continuously smaller. Thus the Dakota sandstone occupies the greatest area. There was still a connection with the sea in the western part of the area, and some marine beds are found in the uppermost Cretaceous and early Eocene. The basins, which lie between uplifted areas throughout this region, were thus areas of deposition, involving advances and retreats of the sea with the possible development of marginal stratigraphic traps and blanket sands on structures within the basins. The Dakota is the main blanket sand, but subsequent deformation and erosion have reduced its oil possibilities, and transformed much of it into a source of artesian water. The Muddy sand produces in fields around the Powder River and Green River basins and in Colorado, while the Frontier formation produces farther north, especially in the Powder River and Big Horn basins. The Wall Creek sands yield oil in the Powder River basin and to a less extent elsewhere in Wyoming. The Eagle sandstone is the main gas reservoir in Central and Eastern Montana.

The Chico formation of California yields gas, and is believed to have oil possibilities. The Gulf Coast area had three major embayments in Upper Cretaceous times. In the westernmost embayment (Rio Grande basin) the Austin chalk, a weathered volcanic rock above the Austin, and stray sands in the Navarro yield oil. In the middle embayment (East Texas basin), which merges with the Mississippi embayment, the Woodbine sand, partly eroded before deposition of the overlying Eagle Ford, produces from the eastern flank of the basin, within the basin and along the Mexia fault zone. Sands in the Austin, Taylor, and Navarro produce locally.

The Tuscaloosa offers promise of production in the Mississippi embayment, and at Tinsley several sands in the Eutaw yield oil.

A map shows the Upper Cretaceous outcrop areas with indications of the oil possibilities. G. D. H.

1131.* Drilling and Production of Caribbean Nations to be Increased Sharply. Anon. *Oil Wkly*, 6.9.43, **111** (1), 33.—As a war measure the P.A.W. has approved a stepping up of the oil output in the Caribbean area, where a production of 1,134,000 brl./day is expected by the beginning of 1945. This will involve an increase of several hundred thousand barrels/day in the production of Trinidad, Venezuela, and Colombia. The drilling of 600 wells has been authorized in these three countries, thus permitting a doubling of the present drilling rate. The distribution of the increased output is 70,000 brl./day in Colombia, 60,000–65,000 brl./day in Trinidad, 370,000 brl./day in Eastern Venezuela, and 630,000 brl./day in Western Venezuela. There is some doubt about the ability of Eastern Venezuela to achieve this increase.

The refinery capacity of the Caribbean area is about 650,000 brl./day, and 350,000 brl. of crude/day may have to go to U.S.A. for refining when the production attains its expected rate.

The Petroleum Reserve Corporation has been formed to investigate and carry out, with Army and Navy approval, whatever foreign projects it finds desirable in assuring sufficient oil supplies for fighting the war over the whole world. It will be interested in all branches of the industry.

Expansion of operations in Venezuela and Colombia will no doubt be carried out by private companies, but as a war measure the U.S. Government has recently undertaken a programme of aiding in the revival and expansion of the Mexican oil industry.

There has been some recovery in the Colombian producing rate, which had fallen from 67,000 brl./day in 1941 to 7000 brl./day early in 1943, mainly due to decreased exports. Similar conditions caused the Venezuelan output to fall from 610,000 brl./day in 1941 to 300,000 brl./day in the second half of 1942. The Venezuelan output averaged about 400,000 brl./day in the first half of 1943. Mexico consumes 66,000 brl./day, and the output has averaged less than 90,000 brl./day in the first half of 1943. In 1941 Mexico produced an average of 113,000 brl./day. G. D. H.

1132.* Permian Basin Assumes Greater Importance as a Source of Oil. H. H. King. *Oil Wkly*, 6.9.43, **111** (1), 43.—Fourteen structures in the West Texas part of the Permian basin have from one to 85 Ordovician wells producing, five areas having been added in the past fifteen months. The latter lie on the west flank of the central platform. The majority of the Ordovician fields are not productive in the regular Permian. Recent discoveries have been 7800–10,650 ft. deep. Hard beds make drilling slow in places, and Ellenburger wildcats are estimated to cost $12–$15/ft. overall.

Ordovician producing possibilities were shown first at Big Lake in 1928, when wet gas was found at 8525 ft., and later the well gave as much as 5000 brl./day of oil. Here 26 Ordovician producers have averaged over 1,100,000 brl. each to date.

In 1936 Simpson, and later prolific Ellenburger, production was found at Sand Hill. Ordovician production was found at Apco-Warner in 1939 and at Abell in 1940. Heiner and Wentz were added to the Ordovician list in 1941, but do not seem outstanding, and the latter has shown Cambrian production. On the west flank of the central platform Ordovician production has been found at Monahans, Embar, and Kermit, the discovery well in the last field having a potential of 6788 brl./day and over 131 ft. of oil-zone. 16½ ml. north of east from Monahans is the Wheeler field, another Ellenburger producer.

A test in Lea County, south-east New Mexico, found non-commercial oil in the Simpson and Ellenburger. A test in Roosevelt County entered granite without meeting Ordovician.

Some of the Ordovician areas yield sweet oil comparable with Mid-Continent grades.

G. D. H.

1133.* Deep Discoveries in West Texas Add New Oil Empire. Anon. *Oil Wkly*, 6.9.43, **111** (1), 57.—Recent important deep strikes in the Lower Permian and Ordovician make it appear likely that numerous deep fields will be found in West Texas under established pools producing from shallower beds, and also in structures which are dry in these shallower beds. The original Ordovician producing area of West Texas has given an average of 700,000 brl./well, and there are indications that recent discoveries will be equally satisfactory. The Ordovician crudes are sweet and of high gravity, unlike the sour Permian crudes.

The discoveries have already increased the amount of wildcatting, and the deep drilling campaign is likely to expand. Pipe-line proration has been lifted and the capacity of some pipe-lines increased. Consequently production allowables have been increased in recent months. Additional outlet facilities are planned.

Tables give West Texas Ordovician development, production, and reserve data by fields, and a list of the West Texas Ordovician discovery wells with initial production, producing depth, and the top of the pre-Permian markers. The West Texas Ordovician failures are listed with the location, elevation, depth of pre-Permian markers, total depth, and completion data. A map of the Permian basin shows the dry holes, and Permian and Ordovician producing areas. G. D. H.

1134.* New Russian Oil-Fields of Ural–Volga Area Highly Promising. J. Scott. *Oil Wkly*, 13.9.43, **111** (2), 14.—Russian authorities estimate the reserves of the Ural–Volga region at 19,413,000,000 brl., or 32% of the total Soviet reserves, which are said to be 56·1% of the world's reserves. Oil production in the Ural–Volga region began in 1929 in the Perm district, and in 1931 deep wells were drilled in the Ishimbaevo region. In 1934 the production was 360,000 brl., a new field having been found in the Ishimbaevo region, and one at Syzran. In 1935 oil was found at Krasnakamsk while drilling for water, at Tuimaz and Buguruslan in 1937, and at Severokamsk, Polazna, and in the Ishimbaevo area in 1938. By 1939 twelve fields were producing commercially, and 28,760,000 brl. of oil had been produced.

The oil from the Ural–Volga region has a high benzine and sulphur content, and it comes mainly from the Bashkirian fields around Ishimbaevo, the Tuimaz fields, the Kamensk fields, and the Buguruslan fields. Six fields are producing in the Ishimbaevo area, and in 1942 the output was 40,000,000 brl. The oil is in limestone at depths of 1000–2950 ft. There are two oil horizons about 50 ft. apart at Tuimaz, at depths of 3450–3775 ft. Four fields are exploited in the Perm area (Chusovsky Gorodok, Krasnakamsk, Severokamsk, and Polazna). The last three are in an area, about 35 ml. long, which has good possibilities.

The Buguruslan field covers about 4000 acres, and produces from a sand at a depth of 1000 ft. The Syzran field and the Stavropol field, 35 ml. to the north-east, are similar. In 1938 they produced 544,000 brl. of oil. There are several other fields in this area. The Syzran field covers 5000 acres, and produces from two zones, one at 1650–2000 ft., and the other, the principal oil zone, at 3250–3400 ft.

A map is appended. G. D. H.

1135.* Wells Being Completed and Capped at Fort Norman. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—Recently the twenty-fourth well was completed at Fort Norman. There are three more producers on two islands in the river, and another on the opposite shore. A few wells have been drilled up and down the river miles from the location of the discovery well on the river-bank at Norman wells. They have been dry or have produced only small quantities of oil. G. D. H.

1136.* Norman Produces 89,929 Barrels in Half-Year. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—During the first six months of 1943 Canada produced 5,037,870 brl. of oil, compared with 5,240,038 brl. in the same period of 1942. The North-west Territories, mainly producing from the Fort Norman wells, gave 89,929 brl. in the first half of 1943 and 9674 brl. in the corresponding period of 1942. The New Brunswick output was 13,713 brl., and that of Ontario 66,737 brl., compared with 12,017 brl. and 73,865 brl., respectively, in the first six months of 1942. Alberta provided 4,867,491 brl. in the first half of 1943 and 5,144,482 brl. in the first half of 1942.

In June, Alberta produced 793,022 brl. of crude and gasoline, 777,761 brl. being from Turner Valley, 720 brl. from Red Coulee, 1455 brl. from Wainwright-Ribstone, and 13,086 brl. from other fields.

24,274,382,000 cu. ft. of gas was produced during the first half of 1943, the output in the first half of 1942 having been 23,444,782,000 cu. ft. G. D. H.

1137.* Four New Drilling Wells at Vermilion, Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Vermilion field now produces about 500 brl./day from wells which are about 1700–1900 ft. deep. Four new wells are to be begun shortly. G. D. H.

1138.* Taber Field Output Over 100,000 Barrels. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Taber field has now produced over 100,000 brl. of oil, about half of it having been obtained this year. Some 60% of the total has come from the discovery well, Taber-Providence 1. G. D. H.

1139.* Drilling Is Planned for Taber Field in Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—During July the Taber field of southern Alberta produced 8956 brl. of oil. Mid-Continent Oil and Gas, Ltd., which holds the largest acreage of any independent company in the field, has let a contract for drilling two wells immediately. G. D. H.

1140.* Development Is Active in Western Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Ram River well has been producing at the rate of 33 brl./day, flowing by heads. The well is to be acidized. It is thought to be producing from the Devonian limestone. Locations have been made for two more wells.

At Del Bonita, Pacific Oil and Refining Company's No. 1 has reached a depth of 4300 ft.

Survey parties are said to be at work over a wide area in the Three Hills area of Alberta. G. D. H.

1141.* Deep Drilling Planned in Northern Ontario. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The testing of large oil-shale deposits in the Moose River basin, James Bay district of Northern Ontario, is planned. A 1500-ft. well may be drilled to test the oil possibilities of the district. G. D. H.

1142.* Completions Are Up Slightly in August to New 1943 High ; Off 16% for Year. Anon. *Oil Wkly*, 13.9.43, **111** (2), 56.—An average of 408 wells per week were completed in U.S.A. in August. The rate was 12 wells higher than the July weekly average, and 18 wells higher than for August 1942. 12,367 wells have been completed during the first eight months of 1943, compared with 14,785 in the corresponding period of 1942. While some districts have shown increases in drilling this year, the country as a whole has shown a 16% decline. California has completed 1048 wells, compared with 486 wells in the first eight months of 1942. The average depth of the 1943 wells in California is 3200 ft., whereas in 1942 the average depth was 4267 ft. This year rises in completions have taken place in Arkansas (3·5%), Kansas (2·1%), Colorado (160%), Kentucky (145%), and Wyoming (46%). Texas has had 31·5% fewer completions than in the first eight months of 1942, Louisiana 38% fewer, Mississippi 55% fewer, Pennsylvania 33% fewer, and New Mexico 41% fewer.

A table gives by States a summary of the completions in August, and in the first eight months of 1943, with comparative figures for earlier months and years.

G. D. H.

1143.* Wildcatting in August at Highest Level of Year. D. L. Carroll. *Oil Wkly*, 20.9.43, **111** (3), 11.—384 wildcats were completed in U.S.A. in August, 88 more than in July and 46 more than in May, the previous record month. 52 oil producers were completed, one distillate producer and eight gas-wells. Illinois had 17 new oil-wells, Texas 11 oil- and two gas-wells, Oklahoma six oil discoveries and two gas discoveries, and Kansas seven oil finds.

Up to the end of August 2316 wildcats had been completed in 1943, 419 of them being producers. 780 were drilled in Texas, 331 in Illinois, 314 in Kansas, 210 in Oklahoma, 147 in Michigan, and 138 in California.

The rate of discovery of new oil-fields is 12·5% below the 1942 figures; new pay discoveries are 24·5% down.

Tuscaloosa sandstone production has been found in North Louisiana in the new Holly Ridge field, Tensas Parish. This opens a new trend. The single August distillate discovery was a 1-mile extension of the St. Gabriel field, South Louisiana, where a new but thin Frio pay was tapped at 9700 ft.

A Clear Fork lime discovery was made to open the Union field in Andrews County, West Texas, the single well indicating a reserve of 320,000 brl. The North Hilger field of Reno County, Kansas, found 100 ft. of oil-saturated Viola limestone below 4099 ft. The Maplegrove field of Illinois has been extended ½ ml. to the south-east by a 758-brl. McClosky producer. A 480-brl. well in an unidentified Eocene sand has been put down in the Raisin City area of California. The Rio Vista gas-field has been extended by a 5,700,000-cu.-ft. well. There are several pay-horizons in a 650-ft. zone, which is believed to be co-extensive with the Upper Emigh gas-zone.

A new pay in the Dakota sandstone has been opened in the Cole Creek field of Wyoming. This is at 7931 ft., and adds about 320 acres of production.

The August discovery wells are listed with depth, producing horizon, initial production, structure, etc., and a table gives a summary of the wildcatting results by States in August, and during the first eight months of 1943. G. D. H.

1144.* October Crude-Oil Production Order 4,638,000 Barrels Daily—New High. Anon. *Oil Wkly*, 20.9.43, **111** (3), 43.—P.A.W. certifications call for the record output of 4,638,700 brl./day of natural gasoline and condensate, and will be 86,600 brl. above the September certification, and 523,300 brl. more than the production in October 1942.

October allocations will absorb practically all the remaining excess efficient productive capacity in all areas except West Texas. In District 1 increases are scheduled in Pennsylvania and West Virginia; in District 2 an increase in Kentucky; in District 3, increases in Arkansas, Louisiana, and Texas; and in District 4, increases in Colorado, Wyoming, and Montana. The Texas output is scheduled to be 1,999,000 brl./day.

The scheduled productions and changes in production are given for most of the States, together with estimates of the natural gasoline and condensate withdrawals.

G. D. H.

1145.* Crude-Oil Production Continues Breaking Record. Anon. *Oil Wkly*, 20.9.43, **111** (3), 48.—In the week ending 15th September the U.S. crude production reached a new high of 4,358,755 brl./day. This was 17,600 brl./day more than in the preceding week, which was the previous record. The Texas output of 1,838,200 brl. was a new high. Rises also took place in New Mexico, Kansas, California, Indiana, Michigan, and Wyoming. Most of the Eastern States showed decreases in output. Illinois also showed a decline. G. D. H.

1146.* Foreign Oil Operations Must Be Expanded. J. P. O'Donnell. *Oil Gas J.*, 23.9.43, **42** (20), 90.—An expansion of the foreign exploration and production activities of American oil companies will be necessary after the war, for the U.S. reserves have declined, and discoveries in the first half of 1943 were 271,807,000 brl. less than the production. Large domestic discoveries, the likelihood of which might be increased by higher prices, might correct this position. From 1932 to 1940 there was an average yearly increase of 60,000,000 brl. in the domestic demand for petroleum products, and if this rate continues to 1950, the annual requirements will be about 1,900,000,000 brl. in that year.

The U.S. oil consumption in 1939 was twice as much as that of the fourteen other major consuming countries combined, and six times as much as the consumption of the British Empire.

The U.S. Government should endeavour to secure equal and equitable treatment for American oil companies in their operations abroad. Such operations may make the countries self-sufficient as regards oil, and may also provide new industry and revenue. They may also prevent the disappearance of the U.S.A. as a major market for their oil.

U.S. companies control about 60% of the world's total reserves, British companies 25%, and Russia 10%. Outside U.S.A. American companies control 25–30% of the reserves, British companies 50%, and Russia 20%.

Excluding Russia, Latin America and the Persian Gulf will probably be the areas of earliest and most extensive post-war development, and acceleration in operations is already under way in these areas.

Half a dozen fields have been proved in Iran, and two in Saudi Arabia. Oil production has been developed in Bahrein Island, and reserves of several hundred thousands of barrels are reported after drilling in Kuwait. There are prospects of large reserves on the Qatar Peninsula.

Rehabilitation of the Far East fields will be undertaken as soon as possible.

In Russia there are large reserves in the Ural–Volga and North Central Siberian areas, as well as in the Caspian basin. New discoveries have been made in Hungary and Austria, and there may be developments in Rumania. India, Burma, Egypt, China, and Canada all have oil possibilities which do not seem to have been adequately examined. G. D. H.

1147.* Oil and Gas Fields of Jackson County, Texas. J. B. Eby. *Oil Wkly*, 27.9.43, **111** (4), 20.—Eleven oil- and gas-fields have been opened in Jackson County since the beginning of 1940, seven between 1934 and 1940, and one gas-field, the Edna pool, in 1921. Nearly half of the 20,975,479 brl. of oil produced in this area was obtained in 1942. The wells have an average depth of 6000 ft.

The beds thicken towards the coast, and this is especially true of the Anahuac wedge, the marine shale series which many geologists place just below the base of the Miocene. This wedge is 1600 ft. thick at the south-east corner of the county, and feathers out near the north-west corner. It is a lithological and not a time unit, and it directly overlies the main oil-producing sands. It shows up conspicuously in drilling and electric logs. The Anahuac wedge serves to hold much of the oil in the Upper Frio sand. A small amount of oil comes from the Catahoula at the base of the Miocene.

No salt-domes are known in Jackson County, and the main oil-field structures are anticlines (West Ranch, Lolita, Maubro), fault (Cordele, West Ganado, Ganado, Collier) and stratigraphic traps (Mauritz, West Mauritz, Harmon, Mayo). Except for Cordele and Collier all the fields produce from the Frio, in which most of the production lies between the 4500-ft. and 5500-ft. contours.

The stratigraphic traps are sand lenses and stringers, frequently without any structural bending.

A map, a series of cross-sections, and a table giving production and other statistics are appended. G. D. H.

1148.* Mexico Has Produced 2,722,023,000 Barrels. Anon *Oil Wkly*, 27.9.43, **111** (4), 56.—Production south of the Rio Grande was initiated in 1904, and up to the end of August this year the total Mexican production was 2,722,023,000 brl. of oil. G. D. H.

1149.* Vermilion Field Expands Rapidly. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Vermilion field was opened in 1939, and has now produced 23,958 brl. of oil. Twenty-one wells have been drilled this year. The wells are shallow. G. D. H.

1150.* Fort Norman Oil Beats Estimates. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—In 1941 the Fort Norman production was 23,664 brl., in 1942 82,324 brl., and in the first six months of 1943, 89,929 brl. The boundaries of the producing area are still unknown.

A pipe-line from Fort Norman to Whitehorse, Yukon Territory, where there are refinery facilities, is practically complete. The initial oil requirements of the U.S. Army in this region have been met. G. D. H.

1151.* New Canadian Field at Ram River Indicated. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The presence of oil and gas in promising quantities has been established in the Ram River well, which has now been acidized. The oil is 40·1° A.P.I., and has a high percentage of lubricating oil. Two other wells are planned. G. D. H.

1152.* Colombia Output Up with Increased Demand. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—Colombia produced 2,450,000 brl. of oil in June this year. This is almost a record. There has been rapid expansion in output each succeeding month this year. In November and December 1942 the output was only about 6000 brl./day. The average production in 1941, when exports to Canada and U.S.A. were high, was a little over 2,000,000 brl./month.

The Casabe and El Dificil fields seem to be of considerable importance. The former now has 10 wells, and its reserve is estimated at 135,000,000 brl. It is in the same area as the Infantas and La Cira pools. G. D. H.

1153.* Prospecting is Scheduled for Northern Mexico. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Mexican Government intends to carry out oil exploration in the north-east, adjacent to the Texas border. Prior to 1938 extensive geological and geophysical work had been carried out in this region, and there had been limited drilling on promising prospects, a number of gas-wells having been completed by private companies. G. D. H.

1154.* Colombia's Socuavo Field on Barco Extended to East. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Socuavo field on the Barco concession has been extended eastwards by a 500-brl. well, and it now has several wells giving high-gravity oil. G. D. H.

1155.* Alberta With More Drilling Has Less Oil. Anon. *Oil Wkly*, 27.9.43, **111** (4), 58.—At present 32 wells are being drilled in Alberta, 16 being at Turner Valley. Two are in the Kinsella and Medecine Hat gas-fields, three in the Vermilion field, and one at Taber.

The current production is 26,948 brl./day, compared with 27,054 brl./day a year ago. G. D. H.

1156.* Alberta Drilling Sets Record During 1942. Anon. *Oil Wkly*, 27.9.43, **111** (4), 58.—In 1942, 501,940 ft. of hole was drilled in Alberta, 250,975 ft. being at Turner Valley. 496,335 ft. was drilled in 1941, 279,379 ft. in 1937, and 96,904 ft. in 1936, when crude was found at Turner Valley.

25 ml. west of McCleod, Maxmount 1 reached a depth of 9430 ft. last year. G. D. H.

Drilling.

1157. Cementing Troubles Start During Drilling. H. F. Simons. *Oil Gas J.*, 12.8.43, **42** (14), 65.—Many causes of failure of the cement placed behind the casing to perform its proper functions are either created or are present during the drilling of a well.

The principal obstacle to a satisfactory job is the enlargement of the hole, and it may be that drilling holes to gauge will be as important in the next 10 years as straight-hole drilling has been during the past decade. This article deals with the origin of many cementing failures. No attempt has been made to describe equipment and methods used in cementing oil-wells or to detail the characteristics of the various types of cement available. No calculations are presented, because those involved have to do only with volumes.

The greatest single bar to a successful cementing job, according to one major oil company engineer who has been in charge of cementing over 1000 wells, is the fact that few bore-holes are drilled to gauge. A 7¾-in. bit may be run in the well, and all the engineer is sure of is that the hole is at least that large. How much larger it is he does not know. As the amount of cement required depends on the height behind the casing to which it is required to rise, any increase in the diameter of the well results in miscalculation. There is a tool and a method available which will give some indication as to the hole diameter throughout its length. The most positive means for measuring cavities which are not too large is the hole caliper, a set of fingers which ride on the wall of the hole while their position (and the diameter of the hole) is recorded at the surface. This tool has other uses, but it is a major contribution to successful completion of a well when it measures the diameter of the hole. With it the engineer can have available the dimensions necessary for computing volume.

The method for determining whether the hole has cavities is to use a telltale in the mud, either a dye, easily identified chemical, or a solid having the approximate density of the mud. The time required for the telltale to make a trip down the drill-pipe and up the annulus gives some indication of the volume of the hole. It will not show the extent of large cavities, as the mud-stream follows the drill-pipe and has a diminishing effect as the distance from the drill-pipe increases. Nor will the telltale show the location of the cavities. A cavity 8 ft. in diameter would require 125–150 times as much cement slurry to fill it as the average annular space between a hole drilled to gauge and the casing. Only a few feet of cavity of such diameter is required to use up the cement allotted to the well. Equally as bad is the enlargement of the hole diameter of only a few inches extending over several hundred feet vertically. Both phenomena are more common than is generally believed. Causes of cavitation and their indications during drilling are discussed. Temperature surveys during cementing will indicate to what height the cement has risen. Besides these specific troubles due to caving, others more generally known are briefly reviewed. Such are those due to channelling and to trapping air under the plugs. Remedies are indicated.

A. H. N.

1158. Patents on Drilling. R. K. Hertel. U.S.P. 2,323,326, 6.7.43. Appl. 9.1.42. Latch mechanism for hooks.

J. Neufeld. U.S.P. 2,323,484, 6.7.43. Appl. 12.5.41. Well-logging method and apparatus using radioactivity.

L. L. Hardeman. U.S.P. 2,323,992, 13.7.43. Appl. 7.5.41. Well-shaft.

L. Horvitz and E. E. Rosaire. U.S.P. 2,324,085, 13.7.43. Appl. 21.12.39. Geochemical well logging during drilling.

R. M. Lilly. U.S.P. 2,324,096, 13.7.43. Appl. 5.6.41. Well hoisting device attached to the derrick V-door.

L. C. Miller and R. F. Bolton. U.S.P. 2,324,102, 13.7.43. Appl. 9.2.40. Means for directional drilling of wells.

L. C. Miller. U.S.P. 2,324,103, 13.7.43. Appl. 19.12.40. Well-survey apparatus protective housing.

A. L. Rodgers. U.S.P. 2,324,174, 13.7.43. Appl. 3.5.40. Weight indicator using a spring.

A. S. Foster. U.S.P. 2,324,379, 13.7.43. Appl. 4.9.40. Portable pipe vise.

R. De Long. U.S.P. 2,324,682, 20.7.43. Appl. 26.3.41. Side-wall coring tool for wells.

M. L. Hart. U.S.P. 2,324,698, 20.7.43. Appl. 21.9.40. Well measuring device for ascertaining depths.

A. Sowders. U.S.P. 2,324,886, 20.7.43. Appl. 26.2.42. Well tool.

B. W. Sewell. U.S.P. 2,324,956, 20.7.43. Appl. 25.11.40. Borehole tool for slotting pipes in well.

C. C. Brown, J. R. Dodson, Jr., and F. L. Scott, Jr. U.S.P. 2,325,104, 27.7.43. Appl. 30.6.41. Outside pipe cutter for wells.

F. L. Haushalter and L. L. Horchitz. U.S.P. 2,325,132, 27.7.43. Appl. 28.10.41. Protector for drill-stem.

J. H. Schreiber. U.S.P. 2,325,429, 27.7.43. Appl. 16.7.41. Joint-breaker and cathead.

B. G. Goble. U.S.P. 2,325,503, 27.7.43. Appl. 2.1.41. Combination sand-pump and boiler.

R. L. Crum. U.S.P. 2,325,745, 3.8.43. Appl. 20.6.39. Rotary drilling-bit with toothed cutters.

I. Jacoel. U.S.P. 2,325,777, 3.8.43. Appl. 12.12.42. Tool for splicing cable and tightening strands therein.

C. F. Terrell, Jr. U.S.P. 2,325,811, 3.8.43. Appl. 2.10.41. Drilling-sleeve for rotary drilling-strings.

D. R. Moore. U.S.P. 2,326,052, 3.8.43. Appl. 13.4.42. Pipe-handling and racking platform for oil-well derricks.

J. T. Hayward. U.S.P. 2,326,219, 10.8.43. Appl. 30.12.39. Well depth recording in combination with drilling-string.

J. G. Richey. U.S.P. 2,326,394, 10.8.43. Appl. 22.11.39. Combined safety-joint and jar.

I. M. Spangler. U.S.P. 2,326,404, 10.8.43. Appl. 15.3.41. Setting-tool for bridging plug.

L. Spencer. U.S.P. 2,326,405, 10.8.43. Appl. 2.6.41. Side-wall sampling device for well bores.

F. A. Taylor and L. Spencer. U.S.P. 2,326,411, 10.8.43. Appl. 22.4.40. Setting-tool for cement retainers.

P. T. Bynum. U.S.P. 2,326,435, 10.8.43. Appl. 24.5.40. Coring apparatus.

J. U. Teague and G. E. Cannon. U.S.P. 2,326,577, 10.8.43. Appl. 1.1.43. Removal of mud cake in casing-cement jobs.

R. F. Davis. U.S.P. 2,326,640, 10.8.43. Appl. 29.1.41. Apparatus for determining the dip in the earth's substrata by electrical logging.

P. T. Bynum. U.S.P. 2,326,827, 17.8.43. Appl. 15.4.40. Coring apparatus for side-wall operations.

E. B. Williams, Jr. U.S.P. 2,326,908, 17.8.43. Appl. 29.5.42. Drill-bit.

H. S. Dauner. U.S.P. 2,327,023, 17.8.43. Appl. 23.12.41. Side-wall drilling and sampling tool.

B. H. Barnes and B. S. Minor. U.S.P. 2,327,088, 17.8.43. Appl. 9.3.42. Apparatus for installing protectors on drill-pipes.

J. W. Botkin. U.S.P. 2,327,092, 17.8.43. Appl. 21.4.41. Apparatus for cementing wells by the squeeze method.

J. D. MacKnight. U.S.P. 2,327,118, 17.8.43. Appl. 28.12.40. Submersible barge for use in oil-well producing operations in a body of water. A. H. N.

Production.

1159. Formulæ for Calculation of Sucker-Rod Loads. J. Zaba. *Oil Gas J.*, 12.8.43, **42** (14), 69.—Three formulæ are available for the calculation of well loads. These are discussed. The first formula, suggested by J. C. Slonneger, is recommended by the American Petroleum Institute for calculations of peak loads for designing of surface pumping equipment. The formula is as follows :

$$P = (W_r + W_f)\left(1 + \frac{S \times S.p.m,}{5400}\right)$$

where P = peak polished-rod load (lb.); W_r = weight of rod-string, neglecting buoyancy ; W_f = weight of fluid load = $0{\cdot}034D^2L$. ; D = effective diameter of plunger (in.) ; L = depth of pump (ft.) ; S = polished-rod stroke (in.) ; and $S.p.m.$ = strokes/minute. The formula was evolved for average conditions, and is particularly useful because of its simplicity. It is entirely satisfactory for normal conditions and for slow speed of pumping. It has been reported, for instance, that the average peak polished-rod load calculated with this formula for 32 wells on the west side of the East Texas field was 10,115 lb., while the average actual load as determined by dynomometer was 7549 lb. At higher speed of operation the formula appears to give too low values for peak load, and a substantial safety factor would have to be used under such conditions. In comparing the A.P.I. formula with the Langer formula (given in this instalment), Dralle and Lamberger suggest that a safety factor of the order of 1·6 would be needed at high speeds for the A.P.I. formula. Other authors suggest the factor of 25%.

The second formula is that suggested by Kenneth N. Mills. It is based on two primary assumptions : (1) That the motion imparted to the well is simple harmonic. Although this is not strictly true, the error resulting from this assumption is not great so far as maximum acceleration is concerned. (2) That the acceleration of fluid contributes little to the peak well-load. This assumption is justified by the difference of the rate of transmission of stresses in sucker rods and in the fluid and by the comparatively high degree of compressibility of the fluid. The formula is as follows :

$$P = W_0 + W_r\left(1 + \frac{LN^2}{70{,}500}\right)$$

where P = peak polished-rod load (lb.); W_0 = weight of fluid (lb.); W_r = dry weight of rods (lb.) ; L = length of stroke (in.) ; and N = number of strokes/minute. The formula, like the A.P.I. formula, has the advantage of simplicity. It agrees fairly well with actual load measurements. In a group of wells tested the formula agreed with actual load measurement in 58% of cases with accuracy of from 90% to 100%, in 25% of cases with accuracy of from 80% to 90%, in 17% of cases with accuracy of from 0% to 80%. The formula is widely used.

The third formula is Langer's, recently developed from the results of over 200 carefully controlled tests on a single well. The formula is exhaustive in its treatment, and was therefore approximated into a simpler form for field work. The formula is :

$$P = W_r - W_{rb} + W_{0d} + 0{\cdot}75LN\ [17A_r\ Tan.(0{\cdot}0004DN)^\circ + A_0],$$

where P = peak polished-rod load (lb.) ; W_r = weight of rods in air (lb.) ; W_{rb} = weight of fluid displaced by full length of rod-string (lb.) ; W_{0d} = differential fluid load ; L = length of polished-rod stroke (in.) ; N = number of strokes/min. ; A_r = area of sucker rods (in.^{2}) ; D = length of rod-string (ft.) ; and A_0 = net plunger area (in.^{2}).

Results obtained from the use of this formula agreed quite closely with actual load measurements on the test-well previously mentioned. The main objections raised in discussion of this formula were that it was tested only in one well of a given depth.

A. H. N.

1160. Benefits of Slow Pumping Rates. N. Williams. *Oil Gas J.*, 19.8.43, 42 (15), 49.—Production practices in western Kansas until recent years were generally characterized by comparatively high rates of fluid withdrawals. Under those practices most wells were completed with large-sized tubing and pumps and heavy-duty pumping equipment with a view to handling large volumes of fluid. This was induced to a great extent by the procedure which then existed of basing allowables on physical potential tests, in which wells were pumped at capacity over 24-hr. periods. With the large-sized equipment operated at high speeds and long pumping strokes, greater fluid capacity could be shown and, in turn, higher allowables obtained. This drew water in rapidly, accentuating natural encroachment, and as the rate of water intrusion increased, it followed that increasingly large volumes of fluid had to be lifted to maintain oil allowables. General adoption of the drawdown method of determining well productivity has been an important factor in retarding water encroachment. This method, involving calculations based on fluid levels at various low rates of production, eliminates occasion for pumping wells at capacity during tests, and so forestalls pulling a lot of water into the wells at those times. It also has made possible the use of much smaller pumping equipment, tubing, and pumps in completion of wells, which has been an incentive towards lifting smaller volumes of fluid during regular pumping operations. However, with water increases in wells, many operators continue to resort to relatively high rates of fluid withdrawals to recover the oil, with the result that the rate of water increase in turn mounts rapidly.

Production records of a lease in Kansas are given and studied in some detail. Estimates are made for potential production, and show an additional 131,300 brl. of oil produced at the low rates more than at the higher rates studied. The case of a well is detailed. In this case during the period the well was produced at the rate of approximately 15 brl. of fluid/hr., the oil recovery was at the rate of only 168 brl./1% increase in water production. When the withdrawal rate was reduced to approximately 9 brl. of fluid/hr., the recovery rate was increased to 938 brl. of oil/1% water increase. After the well had produced slightly over 20,000 brl. of oil, the withdrawal rate was increased to approximately 11 brl. of fluid/hr., resulting in a reduction in the oil-recovery rate to 388 brl./1% water increase. A. H. N.

1161. Design of Sucker-Rod Strings. J. Zaba. *Oil Gas J.*, 19.8.43, **42** (15), 60.—There are two general methods of designing a sucker-rod string. The first is to assign to each of the graduated sections of the string its maximum stress. In other words, a point in the string is determined at which the stress in the rod equals the arbitrarily selected maximum safe working stress, and from this point up a larger-size rod is used. The second method consists of designing the string in such a manner that the unit stresses are equal in the top rod of each of the different size sections of the string. The second method is safer, since it provides for a greater safety margin as far as corrosion pitting is concerned.

The first method gives :—

$$R_1 = \frac{Sa_1 - AWL\left(1 + \frac{b^2s}{g}\right)}{W_1\left(1 + \frac{b^2s}{g}\right)}$$

$$R_2 = \frac{Sa_2 - Sa_1}{W_2\left(1 + \frac{b^2s}{g}\right)}$$

$$R_3 = \frac{Sa_3 - Ss_2}{W_3\left(1 + \frac{b^2s}{g}\right)}$$

where R_1, R_2, and R_3 = lengths of bottom, second, and third sections of rods respectively (ft.) ; S = permissible unit stress in rods (lb./sq. in.) ; a_1, a_2, and a_3 = areas of bottom, second, and third sections respectively (sq. in.) ; A = area of plunger (sq. in.) ; W = hydrostatic pressure exerted by 1 ft. of fluid = 0·43 lb./sq. in. for water ; W_1, W_2, and W_3 = weight/ft. of bottom, second, and third sections ; b = angular velocity (radians/sec.) ; s = one-half the polished-rod strokes (ft.) ; and L = setting depth of pump (ft.).

The second method gives

$$\frac{W_f + W_1(L - R_2)}{a_1} = \frac{W_f + W_1(L - R_2) + W_2R_2}{a_2}$$

where $W = AWL$.

In this case R_2 is calculated and R_1 is found by difference.

Since the fatigue of rods is affected both by peak load and range of loadings, attempts have been made, particularly in case of heavy wells, to level out the normal peak loads imposed on sucker rods by normal operations and the shock loads resulting from any one of many possible causes. Several devices designed to accomplish this purpose are commercially produced and successfully used. The basic principle is to eliminate the rigid connection between rod-string and beam by arranging for an elastic, compressible link between polished rod and the beam. This can be accomplished in several ways. For instance, a rubber-cushion device is set between the carrier bar of the beam hanger and the polished-rod clamp. When any load is picked up suddenly, the rubber is compressed, causing the polished rod to lag behind the action of the beam, decreasing the impulse acceleration factor. The energy stores in the compressed rubber is then gradually released, causing the load to be spread over longer period. The device using compressed air as a cushioning medium consists of a cylinder attached to the beam with the rod-string connected to the rod of a piston which moves in the cylinder. Sufficient air pressure is maintained in the cylinder under the piston to support the piston at the top of the cylinder against the weight of rods. When the fluid load is picked up, the piston is drawn down part way, through the cylinder, thus decelerating the speed of polished rod in relation to the beam. When the peak load is passed, the compressed air pushes the piston to the top of cylinder, increasing the load. The result is more even distribution of loads, and therefore the reduction of peak loads. A. H. N.

1162.* Individual Acid Treatment for Thin Multiple Zones. F. B. Taylor. *Oil Wkly*, 23.8.43, **110** (12), 18.—Separated multiple zones of saturation in Dayton Pool, Phillips County, North-west Kansas, has forced the development of a new acid-treating procedure. Production in the field is from Lansing–Kansas City lime (Pennsylvanian) with saturation in from 1 to 10 benches irregularly distributed through 300 ft. of formation. The productive benches are generally between 1 and 9 ft. in thickness.

Completion practice is to cement 5½ in. on top of the bottom break. Before setting pipe it is customary to make an electrical log of the hole, and to use this with sample analyses to determine casing spot and zones of the formation to be acid treated. The first part of the treatment of the formation is normal, with the acid being run in through the casing. This stage takes care of the bottom break of the formation which remains open below the casing spot. On a typical well the next step is to set a removable bridging plug in the casing above the top of the lower break which has just been treated. The next higher break is then opened by ripping the casing, and this break is then treated down the casing in a conventional manner. This process is continued up the hole until each saturated bench indicated as a prospective pay section is treated. Each treatment is individual by backing the removable plug up the hole and opening the casing in the next zone to be isolated. Treatment has also been made through tubing, as in one instance where the casing was ripped in three spots and two packers were run in on the tubing string. The packers were set between the casing areas ripped open, and the lower break was then treated. Following this, the tubing was raised and the second break treated; the third break was then treated, after the tubing had been raised through the position of the upper packer. In this last-described series the treatments were made through the tubing in three separate injections.

As is usual practice, the acid is run into the hole under an oil load, surface pressure being from 500 to 800 lb., as required. Acid volumes vary according to the thickness of the sections to be treated, but in most instances are between 250 and 1000 gal./section. A. H. N.

1163. Plunger Travel of Pumps. J. Zaba. *Oil Gas J.*, 26.8.43, **42** (16), 66.—With sucker rods considered a long elastic system, with one end fixed and the other vibrating with 1° of freedom, the plunger stroke becomes the amplitude of a forced vibration resulting from the effect of: (1) the disturbing force (the force available for moving the plunger), (2) the frequency of natural vibrations of rods, and (3) the damping forces present in the system. The motion of the plunger is out of phase with, and lagging behind, the motion of the polished rod.

The normally expected and calculated length of plunger travel under given set of pumping conditions (speed of pumping, length of stroke, size of plunger and rods, and depth of operation of the pump) can still be altered to a considerable extent by a number of other factors. Among these factors changes in pump friction and handling of free gas may bring about considerable changes in the length of plunger travel. The matter of pump friction is difficult to determine. While the coefficient of friction of different cup materials against the different metals of working barrel are known, the degree of lubrication present is an unknown factor. Furthermore, the abrasive matter, frequently handled by the pump, may increase the coefficient of friction above the value for perfectly dry surfaces. In case of cup pumps the frictional load depends on the depth of operations of the pump, since the load is a function of the coefficients of friction and of the pressure by changing the loads handled by the plunger.

Three formulæ are given for calculating plunger travel from polished-rod travel. These are Coberley's, Rieniet's, and Langer's formulæ. The last formula, when simplified for field work, is :—

$$E.S.P. = \frac{S}{\cos(0{\cdot}0004LN)^{\circ}} - \frac{W_{OD}L}{2(10)^{6}}\left(\frac{1}{A_R} + \frac{1}{A_T}\right)$$

where $E.S.P.$ = effective plunger stroke (in.) ; S = polished-rod stroke (in.) ; W_{OD} = differential fluid load (weight of net fluid head on full area of plunger) (lb.) ; L = length of rod-string (ft.) ; A_R = cross-sectional area of rod (sq. in.) ; A_T = cross-sectional area of tubing (sq. in.), and N = number strokes per minute. A. H. N.

1164. High-Pressure Corrosion Controlled by Chemicals. H. F. Simons. *Oil Gas J.*, 2.9.43, **42** (17), 29.—An unusual type of corrosion is being experienced in some of the wells at Opelika, a high-pressure distillate pool in Henderson County, Texas. The corrosion is severe, and occurs in the christmas-trees and surface connections to a point just beyond the line-valve. Corrective measures have been inaugurated while the fundamental causes are being sought. The corrosion is being controlled by the injection of chemicals into the wells.

Despite the absence of identifiable corrosive compounds, the appearance of the corroded parts and their location leads to the belief that it is due to direct chemical attack aggravated or concentrated by physical conditions. It may be due to instantaneous but continuous formation of water containing corrosive elements at the points affected. After the internal surface has been destroyed the moisture is more readily retained and the corrosion speeds up. What part turbulence, stream-velocity changes, and pressure drops in the christmas-tree play is difficult to determine. The latter, while appreciable, would not be great, the drop from tubing hanger to beyond the line valve not being much over 50 lb./sq. in. at maximum flow-rates. Preventive measures consist at present of injecting chemical into the wells so that it travels down the annular space and back through the tubing. The chemical mixture used consists of soda ash containing sodium hexametaphosphate as its principal ingredient and a commercial inhibitor commonly used for protection of steel equipment. The soda ash, being strongly basic, corrects the *p*H value ; the object of the hexametaphosphate is to prevent precipitation of calcium carbonate at the formation, and the inhibitor counteracts, or at least reduces, the action of acids or acidic waters on the steel. The amount of soda ash to use was determined quantitatively so as to raise the *p*H of the produced water to 6–6·5 range. The chemical solution is prepared at the plant with all ingredients being carefully weighed to ensure that proper concentrations are obtained. The completed solution of proper concentration is then hauled by tank-truck to the individual wells, where the required amounts of solution are delivered to storage tanks. The injection pumps take suction directly from these tanks. Details are given for quantities, etc.

The present treatment is producing results, and the regular inspection indicates that the corrosion is materially reduced. Inspection periods have been 30 days, but are being increased to 60 days. There may still be precipitation of calcium carbonate at the formation due to the introduction of the soda ash, but the acid treatment previously tried can be used to remove this deposition if it becomes troublesome. Complete solution of the problem will depend on the establishment of the corrosion cycle, and the reason why the corrosive influences are present only in the well-head connections, and not throughout the entire tubing strings and gathering system. This will require extensive work with control measures being used until a positive cure is developed. A. H. N.

1165. Plunger Travel from Cards. J. Zaba. *Oil Gas J.*, 2.9.43, **42** (17), 43–44.—Slonneger's graphical method of analyzing a dynamo-meter card is given. This may be summarized as follows : Given the motion of one end of a sucker-rod system, that is the motion of the polishing rod, and the instantaneous loadings, and what follows instantaneous stretch of the rods, at different points of the polished-rod motion, the motion of the other end of the rods—that is, the plunger stroke—can be quite accurately determined. Graphic solution is particularly adapted for this method, since with given curve of the polished-rod motion the stretch of rods has only to be added or subtracted in order to arrive at the curve of the relative plunger motion. To accomplish this the dynamometer card is placed in such a way that the loads are read horizontally and the polished-rod positions vertically, with up-stroke upwards. To the right of the card a semi-circle is drawn with diameter equal to the polished-rod stroke and to the same scale as the dynamometer card. For all practical purposes projection of any point of the card on the semi-circle represents corresponding position of the crank. From the semi-circle the polished-rod motion curve is plotted with crank positions as abscissæ and polished-rod positions as oridnates. To be able to determine graphically the stretch of rods for any desired point of the polished-rod motion curve, the rod-stretch line is laid out. The static weight of sucker-rods is taken as zero stretch. The stretch of rods due to their own weight is laid out, below the base line (negative stretch), on the zero line of the card. This stretch may be obtained from the formula :

$$e_r = \frac{L_2}{1,320,000}$$

where e_r = stretch of rods due to their own weight (in.), and L = length of sucker rods (ft.). The stretch for dynamic loading is calculated from

$$e_d = \frac{PL^2}{1,000,000\ W_r}$$

where e_d = stretch due to dynamic loading (in.) ; P = dynamic load (lb.) ; L = length of rod (ft.) ; and W_r = weight of rods.

An approximate method due to Kemler is also described with method of determining under- and over-travels. A. H. N.

1166. Patents on Production. A. Moeller, H. Tochtermann, and O. Trosken. U.S.P. 2,323,344, 6.7.43. Appl. 17.9.40.—Process of breaking petroleum emulsions and breaking agent.

E. D. Mattocks. U.S.P. 2,323,556, 6.7.43. Appl. 29.11.40. Method and apparatus for determining effective porosity.

J. E. Harmon. U.S.P. 2,323,713, 6.7.43. Appl. 14.7.41. Method of making screens in tubular forms.

J. D. Nixon. U.S.P. 2,323,838, 6.7.43. Appl. 1.4.40. Fluid-flow device for pressure regulation.

J. D. Nixon. U.S.P. 2,323,839, 6.7.43. Appl. 27.1.41. Fluid-flow-control device with pressure regulation.

A Boynton. U.S.P. 2,323,893, 13.7.43. Appl. 8.12.39. Stage-lift flow device using side valves.

R. E. Fulkerson. U.S.P. 2,323,989, 13.7.43. Appl. 4.11.40. Control-head packer for wells.

W. Brauer. U.S.P. 2,324,132, 13.7.43. Appl. 10.2.41. Automatic intermitting unit for a pressure fluid-lifting apparatus.

G. L. Parkhurst. U.S.P. 2,324,172, 13.7.43. Appl. 31.10.40. Processing well-fluids for effecting maximum recovery from a high-pressure petroleum reservoir.

T. A. Bertness, N. Johnston, and D. O. Newton. U.S.P. 2,324,254, 13.7.43. Appl. 11.3.41. Method of removing mud-barriers from oil-wells.

C. P. Walker and E. E. Simmons. U.S.P. 2,324,340, 13.7.43. Appl. 8.2.41. Detector for pressure wave translation systems.

W. Brauer. U.S.P. 2,324,355, 13.7.43. Appl. 2.6.41. Dual automatic intermitting unit for fluid-lifting apparatus disposed in wells.

M. De Groote and B. Keiser. U.S.P. 2,324,488, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,489, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,490, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,491, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,492, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,493, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,494, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

R. B. Fraser. U.S.P. 2,324,689, 20.7.43. Appl. 19.12.40. Valve for oil-well swabs.

H. C. Beene, H. Marks, and D. L. Mitchell. U.S.P. 2,324,814, 20.7.43. Appl. 3.9.40. Test device for oil-wells.

V. J. Beissinger. U.S.P. 2,325,218, 27.7.43. Appl. 11.8.41. Process for the gravel packing of wells.

R. G. Taylor, Jr., and D. B. Hooser. U.S.P. 2,325,556, 27.7.43. Appl. 22.3.41. Well-swab for use on a pipe in a casing.

R. L. Chenault. U.S.P. 2,325,661, 3.8.43. Appl. 10.12.42. Filter for inverted deep-well pump.

J. McAffee. U.S.P. 2,325,695, 3.8.43. Appl. 22.8.41. Fluid-meter.

E. F. Stover. U.S.P. 2,325,714, 3.8.43. Appl. 1.11.41. Flow-meter.

C. F. Schorn. U.S.P. 2,325,884, 3.8.43. Appl. 21.3.42. Flow-meter.

A. J. Zschokke. U.S.P. 2,326,114, 10.8.43. Appl. 8.12.41. Gun perforator.

E. W. Rearwin. U.S.P. 2,326,170, 10.8.43. Appl. 30.11.40. Well-pumping apparatus of the double-acting piston type.

L. L. McConnohie. U.S.P. 2,326,378, 10.8.43. Appl. 8.1.40. Submerged double-acting pump.

W. M. Mount. U.S.P. 2,326,384, 10.8.43. Appl. 14.10.41. Demulsifying and settling tank.

L. Spencer. U.S.P. 2,326,406, 10.8.43. Appl. 18.8.42. Gun perforator.

H. P. de Wit. U.S.P. 2,326,442, 10.8.43. Appl. 5.8.41. Gas-lift control for intermittent operation.

B. J. Festervan and N. F. Henderson. U.S.P. 2,326,528, 10.8.43. Appl. 11.6.40. Paraffin scraper.

B. L. Opsal. U.S.P. 2,326,556, 10.8.43. Appl. 22.8.40. Device for spooling Reda and like cable to pull tubings from wells.

G. Allen. U.S.P. 2,326,599, 10.8.43. Appl. 27.5.42. Process for breaking petroleum emulsions.

G. Allen. U.S.P. 2,326,602, 10.8.43. Appl. 27.5.42. Process for breaking petroleum emulsions.

A. L. Grisé. U.S.P. 2,326,637, 10.8.43. Appl. 14.11.42. Calibration means for piston meters.

J. C. Myers. U.S.P. 2,326,668, 10.8.43. Appl. 25.8.41. Device for controlling the transmission of power to pumps.

H. D. Kinney. U.S.P. 2,326,867, 17.8.43. Appl. 29.1.40. Valve structure for combined formation testing tools and pressure recorders.

H. Dew Thomas. U.S.P. 2,326,902, 17.8.43. Appl. 26.11.41. Pump.

P. H. Granger. U.S.P. 2,326,940, 17.8.43. Appl. 15.3.41. Oil-well tool in combination with well casing and tubing.

L. C. Chamberlain. U.S.P. 2,327,017, 17.8.43. Appl. 15.3.37. Treatment of wells producing mineral fluids.

O. W. Lyons and J. H. Adkinson. U.S.P. 2,327,051, 17.8.43. Appl. 27.7.40. Apparatus for treating wells with streams of fluid issuing from nozzles.

J. H. Wiggins. U.S.P. 2,327,083, 17.8.43. Appl. 2.1.41. Side-wall seal for floating tank roofs.

J. H. Wiggins. U.S.P. 2,327,084, 17.8.43. Appl. 15.3.41. Breather-type storage apparatus for gases and volatile liquids.

J. H. Wiggins. U.S.P. 2,327,085, 17.8.43. Appl. 27.1.42. Breather-type tank.

G. O. Kimmell. U.S.P. 2,327,111, 17.8.43. Appl. 27.7.40. Apparatus for removing samples from flowing streams such as exist in high-pressure oil or gas-well tubings.

L. Spencer. U.S.P. 2,327,141, 17.8.43. Appl. 23.9.42. Gun perforator.

A. H. N.

Gas.

1167.* Natural-Gas Pipe-Line Dehydration. H. N. Wade. *Pet. Engr*, March 1943, **14** (6), 184, April 1943, **14** (7), 100.—The articles bring up to date information given in a previous article by the writer (*Gas*, May 1940) on the same subject. Dehydration plants are divided into two general classifications: (*a*) those using a continuous circulation of a hygroscopic liquid for removing water from the gas, (*b*) those using solid moisture adsorbent materials, usually in granular form. General descriptions and flow-sheets of the two systems are provided. Operating reports recently collected are summarized and available cost data given. The largest plant still using calcium chloride solution went into operation in December 1937, treating gas at 500 lb./sq. in. on the outlet of an absorption plant and sulphur-removal unit using the soda-ash process. It processes 73 M. cu. ft. a day of gas containing a trace of H_2S (normally less than 0·5 grain per 100 cu. ft.), but no oxygen. Operation and maintenance costs at 21·8 c. per M. cu. ft. were stated to be increased by mechanical troubles and deterioration of solution in the dehydration unit apparently caused by accidental carry-over of soda-ash solution from sulphur-removal unit. Average dew-point depression accomplished is 20° F., giving adequate protection against hydrate formation except under temporary and unusual weather conditions. Of four plants using diethylene glycol solution consumptions of glycol in lb. per M. cu. ft. are :—

(1) Operating at 400-lb. pressure — 0·22.
(2) Slightly lower pressure — 0·501.
(3) At 300-lb. and gas temperature over 90° F. under heavy load — 0·811.
(4) At 500-lb. — 0·25.

Costs, including operation, maintenance, glycol make-up, and prorated fuel for the first two plants mentioned, are about 32 c. per M. cu. ft. Satisfactory operation of a combination dehydration and H_2S-removal plant, using a mixture monoethanolamine and diethylene glycol under Girdler patents, is mentioned. Experience shows that solution circulating pumps should be of the plunger type, not the packed-piston type. One operator reports the desirability of installing filters to keep the solution free of foreign matter. Three operators report no corrosion troubles, but the fourth experienced corrosion of the seamless steel tubes in the solution heat-exchanger and of admiralty bronze tubes in the still reboiler, both of which failed. The gas contained small amounts of mercaptans, but no detectable H_2S. The still base temperature was 320° F. and still pressure 10 lb. Overhead vapours from the still showed a positive test for presence of H_2S, and the product of corrosion from the heat exchanger consisted of ferrous oxide and iron sulphide. It was concluded that decomposition of mercaptans was responsible. Lowering the still temperature to 280° F. and pressure to 3 lb. resulted in production of a clear glycol solution and no detectable H_2S in the overhead still vapours.

Information available to the writer on solid-adsorbent-type plants is of only a general character, but indicates that the two forms of activated alumina now available for this purpose offer the most satisfactory performance that has been obtained by solid absorbents. Such systems are capable of a much greater degree of drying than possible with the hygroscopic liquid-type plants.

Five graphs presented with the articles provide the basic information required for the rough design of hygroscopic-solution-type plants, based on actual operating experience. References to similar data bearing on solid adsorbent plant and other appropriate literature references are provided. R. A. E.

Cracking.

1168. Patents on Cracking. H. Dreyfus. E.P. 554,831, 21.7.43. Appl. 18.12.41. A method of cracking hydrocarbons is described in which the hydrocarbons are passed down a cracking chamber in the form of a self-supporting helical stream. The hydrocarbon may be sprayed or atomized into the chamber by means of nozzles or jets arranged tangentially near the top of the wall of a cylindrical cracking chamber so that the spray or mist of hydrocarbon oil and the vapour arising from its volatilization adopts a helical path as it travels down the cracking chamber.

The Distillers Co., Ltd. E.P. 555,588, 30.8.43. Appl. 27.2.42. Process for the removal by selective oxidation of acetylene, together with any co-present hydrogen, from a gaseous mixture containing it in admixture with another hydrocarbon, or hydrocarbons, with or without hydrogen. The gaseous mixture is passed over an agent consisting of copper oxide maintained at a temperature between 275° and 450° C.

J. H. Hirsch. U.S.P. 2,316,334, 13.4.43. Appl. 25.3.41. In a conversion process of hydrocarbons, vapours evolved in a coking operation are subjected to dephlegmation with crude-oil residual stock. Dephlegmated vapours are fractionated to form a reflux condensate, which is then passed to a heating coil and heated to cracking temperature. The resultant mixture of reflux condensate and unvaporized residual stock are passed to a flash dephlegmatizing zone, where the mixture is stripped. The stripped mixture is combined with heated products from the heating coil, and the admixed products are coked. Vapours evolved from the coking zone are passed to the dephlegmatizing zone, and vapours from the flash dephlegmatizing zone are fractionated to form a reflux condensate. This is directed to a cracking zone, and the resultant cracked products are separated into vapours and liquid residue. Separated vapours are passed to the dephlegmatizing zone. The liquid residue is flashed and also passed to the dephlegmatizing zone.

D. G. Brandt. U.S.P. 2,316,931, 20.4.43. Appl. 14.5.40. A continuous process is described for converting corrosive petroleum oils by the use of lime in which the direct heating of the lime with the oil by firing is avoided. H. B. M.

Hydrogenation.

1169. Patents on Hydrogenation. Shell Development Co. E.P. 553,705, 2.6.43. Appl. 12.9.41. A process is described for the catalytic conversion of organic materials in the vapour phase at high temperatures in the presence of ferrous metals. It has special reference to the treatment of hydrocarbon vapours with dehydrogenation catalysts, particularly those comprising an oxide of chromium, molybdenum, tungsten, vanadium, or manganese, which are normally substantially free from iron and are subject to poisoning by iron. Contamination of the catalyst by iron is eliminated by maintaining in the feed to the conversion zone 0·0006–0·015% by weight of sulphur in the form of elemental sulphur or in the form of a reducible sulphur compound.

W. J. Mattox. U.S.P. 2,316,271, 13.4.43. Appl. 12.8.40. In a process for the dehydrogenation of hydrocarbons having 6–12 carbon atoms to the molecule, vapours of the hydrocarbons are combined with hydrogen and the mixture is subjected to contact with a metal oxide dehydrogenating catalyst under the following conditions:

Temperature, 450–650° C.; liquid hourly space velocity, 0·1–20 volumes per volume of catalyst; and mass velocity, at least 5 milligrams per square centimeter per second.
H. B. M.

Polymerization and Alkylation.

1170. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 553,334, 18.5.43. Appl. 10.7.40. An adaptation is described of the two-stage alkylation process in which a mixture containing the mono-olefins to be reacted is first contacted with sulphuric acid and the extract of mono-olefins so formed is reacted with *iso*paraffins to produce the desired product. The sulphuric acid and the mixture containing mono-olefins are fed to the extraction zone in the ratio of between 0·4 and 1·25 mols. of acid per mol. of mono-olefins, and the resultant extract is used for the alkylation.

Shell Development Co. E.P. 553,749, 3.6.43. Appl. 1.12.41. In a process for the production of hydrocarbons by reacting an alkylatable hydrocarbon with an alkylating agent in the presence of an organic sulphur acid catalyst, at least one of the reactants is treated with a substantially hydrocarbon insoluble strong carboxylic acid prior to contact with the catalyst. The effective life of the alkylation catalyst is thus increased.

Texaco Development Corp. E.P. 554,096, 21.6.43. Appl. 2.7.41. In a process for effecting conversion of hydrocarbons—*i.e.*, isomerization, alkylation, polymerization, and cracking—a special type of catalyst is used. It is a mixed halide having the approximate empirical formula $MeH_x^1H_y^2$, where Me signifies a polyvalent metal selected from Groups 2, 3, 4, 5, 6, and 8 of the Periodic Table; H^1 and H^2 are different halogen atoms and x and y have values sufficient to satisfy the valency of the metal.

A. L. Mond. E.P. 554,240, 25.6.43. Appl. 24.12.41. Process for synthesizing hydrocarbons which comprises reacting an *iso*paraffin with an olefin under alkylating conditions and in the presence of an alkylating catalyst in the liquid phase. The active ingredient of the catalyst is essentially hydrogen fluoride.

Shell Development Co. E.P. 554,825, 21.7.43. Appl. 8.9.41. Production of an alkylated hydrocarbon or an alkylated halogenated hydrocarbon from a saturated hydrocarbon or a halogenation product thereof which has a hydrogen atom attached to a tertiary carbon atom. The tertiary atom-containing compound is reacted with an organic halide having a halogenated aliphatic carbon atom, in the presence of a free acid alkylation catalyst. The process is applicable to the manufacture of other branched-chain products from *iso*butane, *iso*pentane, 2-methyl-pentane, 2 : 3-dimethylbutane, 2 : 2 : 5-trimethylhexane, 3-ethyl-pentane, *cyclo*hexane, and the like.

Shell Development Co. E.P. 556,099, 20.9.43. Appl. 20.5.42. In the isomerization of saturated hydrocarbons the vapours, together with a hydrogen halide promotor, are passed through one of a number of isomerization zones containing a supported catalyst of the Friedel–Crafts type. A decreasing gradient of hydrogen halide promotor concentration is maintained in the isomerization zone or zones, and an increasing gradient of space velocity in the direction of flow. This is achieved by introducing additional portions of the hydrocarbon to be isomerized into the stream of the reaction mixture at a number of points along its length. H. B. M.

Refining and Refinery Plant.

1171. Thermal Efficiency in Topping Plants. W. L. Nelson. *Oil Gas J.*, 28.1.43, **41** (38), 180.—The thermal efficiency of a topping plant is dependent mainly on the temperature attained in the exchangers, the temperature at which flue gases enter the stack, and the per cent excess air used at the still burners.

These three variables have been related by means of an efficiency equation and by equations showing amount of heat required per hour.

An example of a heat efficiency equation for a 10,000-brl. plant operating on Midcontinent crude is given and the heat required in B.Th.U./hour is shown.

In deriving an equation to calculate the heat required to operate a simple topping plant, the stack loss from the pipe-still is of particular importance. This item is a function of the slack temperature and per cent excess air used in burning the fuel, and an equation relating these factors is given.

These equations serve as a useful guide in keeping a periodic check on operation.
D. L. S.

1172. Operating Multidraw Fractionating Towers. W. L. Nelson. *Oil Gas J.*, 1.4.43, **41** (47), 31.—Although multidraw fractionating towers are common equipment in petroleum refineries, there is some confusion among plant operators regarding their method of operation. Batch-distillation and flash-vaporization curves of a typical Midcontinent crude oil are presented and used in conjunction with a diagram of a tower with steam strippers to illustrate seven rules or principles of operation which are listed and discussed. These are :—

> (1) Only the amount vaporized can be withdrawn above feed-plate. In raising the feed-plate temperature to increase vaporization, care must be taken not to overload the tower.
>
> (2) Top temperature regulates the amount of gasoline. It does not directly regulate the degree of fractionation, which is dependent on the number of trays between the top and kerosine draw-plate.
>
> (3) Opening the side-draw valve increases the yield of that product. The increase is due mainly to increase in E.P. and, to a minor extent, inclusion of some low-boiling material. At the same time it is necessary to close other side-draw valve(s) by a nearly corresponding amount (see Rule (1)).
>
> (4) Closing side-draw valve decreases product.
>
> (5) Changing top temperatures alters (3) and (4). This may be used, for example, in adjusting gravity or flash-point of the kerosine removed when the kerosine side-draw valve setting is altered. Kerosine yield will be increased or decreased according to whether the temperature is lowered or raised.
>
> (6) The number of trays between products regulates fractionation. Thus withdrawing a given product from another tray without changing setting of side-draw valve will affect F.B.Pt. without materially altering the yield of product. Should the I.B.Pt. be also lowered, partial correction can be obtained by the use of additional steam in the stripper.
>
> (7) Steam regulates the I.B.Pt. Attempts to use large amounts of steam for increasing the boiling range of a side-draw product are not usually successful. The proper method is to open the control valve and close by a like amount the control valve of a lower side-draw.

In connection with these rules, it is emphasized that the nature of the crude processed has an overriding effect on the composition of products, that change in the manner of withdrawing a product will result in changes in products withdrawn lower in the tower which will not be completely reflected in less than several hours.

Finally, it is stressed that high-boiling products are not necessarily withdrawn at low trays in the tower and, conversely, low-boiling products may be withdrawn low in the tower. The effects of changes in the point of withdrawal on the degree of fractionation of the various products are discussed. R. A. E.

1173.* The Solvent Extraction of Lubricating Oils. H. ter Meulen. *J. Inst. Petrol.*, September 1943, **29** (237), 237–252.—It is explained that the solvent extraction of lubricating oils is much more complicated than the study of kerosine extraction, and that the simple triangular representation is not sufficient to explain the phenomena fully. Approximate compositions of various oils are examined as a preliminary study of their solvent extraction. Experiments are reported and their results discussed. The influence of light/heavy selectivity of solvents is fully explained. This characteristic property of all solvents is the reason for the impossibility of extracting S.R. residues immediately with a single solvent to a suitable raffinate. The residues represent the ultimate case of a very wide cut, as the heaviest components, such as asphalt and resins, are present. A single solvent does not have such a low light/heavy selectivity that all asphalt is removed from the raffinate into the extract layer. Therefore single-solvent extraction processes are applicable only to distillate fractions. The only process capable of processing a S.R. residue is the Duo-Sol process, using a mixture of phenol-cresols as the aromatic solvent and propane as the paraffinic solvent. These two solvents are only slightly miscible, and produce two layers. The solubility of asphaltenes in propane is practically negligible, and therefore all the asphaltenes are precipitated from the raffinate layer into the extract layer. The conclusion may be drawn that it would also be possible to remove the asphaltenes from a S.R. residue by propane precipitation and then solvent extracting the remaining asphalt-free lubricating oil with a single solvent. This was carefully investigated, but it appeared that besides the asphaltenes other very heavy components were present (resins) which could not be extracted. These resins were not precipitated sufficiently by propane alone, but the combination propane-phenol removed all the heavy components into the extract (phenol layer). The paper is followed by a discussion. A. H. N.

1174. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 553,100, 7.5.43. Appl. 3.11.41. In a process for desulphurizing, stabilizing, and fractionating a hydrocarbon distillate, the original material is introduced into the top of a plate-tower, the bottom of which is maintained at a temperature sufficient to vaporize the most volatile hydrocarbon constituents and to boil out the hydrogen sulphide. Vaporized constituents and hydrogen sulphide are removed from the top of the tower, and the liquid is withdrawn from the bottom and passed into a second plate-tower, the bottom of which is maintained at a substantially higher temperature than that obtaining in the first tower. A substantial portion of the liquid is thus vaporized. Vapours are removed and cooled to condense at least a portion of them. The liquid is removed from the bottom of the tower, and condensed vapours and liquid are passed in indirect heat-exchange relationship with the hot liquid from the first tower. Finally, the condensate and liquid from the second tower are cooled. The process has particular reference to cracked naphtha, which may contain relatively large quantities of hydrogen sulphide and small amounts of light hydrocarbons which are too volatile for the purpose for which the naphtha is to be used.

L. M. Henderson and G. W. Ayers. U.S.P. 2,315,054, 20.4.43. Appl. 6.4.40. During the process of removing mercaptans from petroleum oils the latter are contacted with an aqueous alkali metal hydroxide reagent containing reaction products prepared in the following way. Light petroleum distillates containing organic acidic constituents, including naphthenic acids, phenols, and thiophenols, are contacted with an aqueous sodium hydroxide solution under suitable conditions to react sodium hydroxide with organic acidic constituents. Afterwards the aqueous sodium hydroxide solution is steam-stripped of hydrolyzable constituents and the stripped solution is concentrated to approximately 15% of reaction products.

W. T. Hancock. U.S.P. 2,316,954, 20.4.43. Appl. 9.6.39. During a refining process, petroleum hydrocarbons are heated, passed through a body of adsorptive material, and impregnated with a salt of the group consisting of zinc chloride and aluminium chloride. The adsorptive material is re-charged with the salt while the material is in the treating zone, by discontinuing the flow of hydrocarbons through the zone. A quantity of the salt is vaporized in a heating zone and the vapours are passed into the material. The vapours are condensed directly on the surface and within the pores of the material to promote uniformity of salt condensation throughout the body. Afterwards the hydrocarbons are again passed through the material.

W. L. Benedict. U.S.P. 2,317,600, 27.4.43. Appl. 30.3.40. Low-boiling petroleum distillates containing mercaptans are sweetened by electrolyzing a solution of an alkali-metal carbonate to form an alkali-metal hydroxide solution and an alkali-metal bicarbonate solution, and treating the distillate with the hydroxide solution. In this way mercaptans are transferred from the petroleum distillate to the hydroxide solution. The treated distillate is separated from the hydroxide solution and recovered as a product of the process. The mercaptan-containing solution is mixed with the bicarbonate solution to liberate mercaptans and form alkali-metal carbonate solution. The mercaptans are removed and the alkali-metal carbonate solution is passed back to the electrolyzing stage of the process.

F. A. L. Holloway and D. O. Wilkes. U.S.P. 2,317,770, 27.4.43. Appl. 12.7.41. To remove mercaptans from petroleum oils, they are introduced into one end of an absorption zone. A substantially sulphur-free solvent is passed into the other end and a partly regenerated solvent is introduced into the zone at an intermediate point. The feed-oil is countercurrently contacted with the solvent and then removed from the treating zone. Spent solvent is removed from the other end of the zone and regenerated in a regeneration zone in such a way that a portion of regenerated steam from an intermediate part of the zone is removed. This stream is recycled to an intermediate point of the absorption zone. A substantially sulphur-free solvent is removed from the regeneration zone and recycled to the absorption zone. H. B. M.

Fire Prevention.

1175. Fires Caused by Bacteria. Anon. *Oil Gas J.*, 10.6.43, **42** (5), 40.—A communication received in connection with an article on "Methods of Combating Fires in Oil-storage Tanks" (*J. Inst. Pet.*, 1943, Abs. 580) directs attention to the rôle played by anaerobic bacteria. *Spirillum desulfuricans* belongs to this genus, and is capable of reducing sulphates to H_2S, and requires the following conditions :—

(1) Water with total absence of air (oxygen).
(2) Total absence of light.
(3) Presence of assimilable organic compounds.
(4) Presence of sulphate(s).

As the sulphate-reducing spirilla are present in practically every soil, their introduction into a tank is more or less a certainty. The first three conditions for existence of the bacteria are satisfied in most tanks, since any oxygen in solution in the water on entering the tank is quickly absorbed by the steel shell and by aerobic bacteria in the water and sludge. Where the fourth condition is also satisfied, bacterial action may be expected. In crude-oil tanks, for example, since oil-well waters invariably contain sulphates, conditions for existence of the bacteria are assured. Laboratory experiments have shown that in the corrosion of iron through the medium of sulphate-reducing bacteria, the ratio of total corroded iron to iron in the iron sulphide varies from 2·4/1 to 3·4/1. A suggested mechanism indicates a theoretical ratio of 4/1, and the difference ascribed to increase in hydrogen sulphide formation due to the necessity for oxidizing the hydrogen from the organic foods as well as the cathodic hydrogen. The formation of pyrophoric iron sulphide and the incidence of excessive corrosion appear to be preventable by ensuring conditions unfavourable to the existence of anaerobic bacteria—for example, changing the water in tank bottoms once a fortnight. This was found sufficient in the U.S. Navy for fire-lines on warships with which trouble was experienced on account of excessive corrosion.
R. A. E.

Chemistry and Physics of Hydrocarbons.

1176. A Spectrophotometric Method for the Analysis of Multi-Component Mixtures and Its Infra-Red Application. R. R. Brattain, R. S. Rasmussen, and A. M. Cravath. *J. appl. Phys.*, August 1943, **14** (8), 418–428. For monochromatic radiation the optical density of a mixture equals the sum of the optical densities of the components, or

$$D = d_1 + d_2 + \ldots + d_n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the optical density d_n of an individual component can be expressed by

$$d_n = \epsilon_n x_n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This is the familiar Beer's law, where x_n is the mole fraction and ϵ_n the extinction coefficient (of the nth component) which is a constant for all values of x_n but varies with wave-length. Substitution of Eq. (2) in Eq. (1) gives for the optical density of D of a mixture at one wave-length.

$$D = \epsilon_1 x_1 + \epsilon_2 x_2 + \ldots + \epsilon_n x_n \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If the experimental conditions under which optical density is measured are such that both the above conditions hold, a mixture can be analyzed by the following steps : (1) Determination of the ϵ_n values of each pure component at n different wave-lengths. (2) Measurement of the optical densities of the mixture at these wave-lengths. (3) Solution of the n simultaneous linear equations (one for each wavelength) of the type (3) for the mole fractions x.

As no spectrograph works with strictly monochromatic radiation, the accuracy of analysis is limited by the deviation from Beer's law. It has been found possible to improve this accuracy by a method based on the assumption that: The optical density of a mixture equals the sum of the optical densities of the components even though the optical density of an individual component is not expressible as the product of a constant and the concentration. The apparatus is calibrated as follows: (1) The curve presenting the optical density plotted against mole fraction is determined for each of the n pure components at each of n selected spectral positions. In the general case these curves are not straight lines, so that the extinction coefficient ϵ_n of Eq. (2) is not a constant as x_n changes. (2) Using the data of step 1, values of the extinction coefficients are chosen so that the difference terms of step 4 below are reasonably small and the n simultaneous linear equations of the type (3) are solved considering these chosen values to be constants. This gives the mole fraction of each component as a linear function of the optical densities of the mixture measured at the n selected spectral positions:

$$x_j = \gamma_j^{(1)} D^{(1)} + \ldots + \gamma_j^{(n)} D^{(n)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where the subscript refers to the component, the superscript to the spectral position, and $\gamma_j^{(n)}$ are numerical constants. (3) The theoretical curve of optical density plotted against mole fraction for each of the components at each spectral position is calculated from Eq. (2) using the extinction coefficients chosen in step (2). (4) The differences between the optical densities calculated in step 3, and the experimental optical densities of step 1 are plotted against mole fraction for each component at each spectral position. The results of the calibration steps 1, 3, and 4 can be used in analyzing for the same component in different mixtures while calibration step 2 has to be done for each particular mixture, but only once for all samples of this mixture.

The analysis is then performed as follows: (1) The optical densities of the sample are determined at each of the selected spectral positions. (2) Eqs. (4) are solved arithmetically for the mole fractions, using the experimentally determined optical densities D of step 1. These mole fractions are only approximate, since the true extinction coefficients were not used in solving for Eqs. (4). (3) The experimental optical density at each spectral position is now corrected to a new value by adding to it the sum of the differences between the true and assumed optical densities for each component at this spectral position. These differences are obtained from the curves of calibration step 4, using the mole fractions from analysis step 2. These correct optical densities are the values which would have been experimentally determined at each spectral position if the optical density of each conponent were given by the theoretical curves of calibration step 3. (4) Eqs. (4) are again solved arithmetically for the mole fractions using the values of optical density D determined in step 3. Steps 3 and 4 are repeated until the values of the mole fractions are constant. For the samples so far analyzed one or two corrections have been sufficient.

The application of the method to infra-red absorption of vapour samples is described in detail. The results of tests using a six-component C_4 hydrocarbon mixture are given. The method is especially useful for the rapid routine analysis of large numbers of samples containing the same components, and therefore is well suited for plant-control purposes.
A. H. N.

1177. Patents on Chemistry and Physics of Hydrocarbons. Standard Oil Development Co. E.P. 553,920, 10.6.43. Appl. 30.12.41.—In the isomerization of straight-chain paraffins to the corresponding branched-chain isomers, it has been found that previously unused aluminium halide has a different degree of catalytic activity from the same aluminium halide after having been used as catalyst in a different isomerization reaction. The process described is designed to utilize more effectively the inherent variation in catalytic activity for isomerization of the various aluminium halides in the presence of the conventional promotors.

Standard Oil Development Co. E.P. 554,315, 29.6.43. Appl. 27.1.42. In order to increase and modify to some extent the activity of aluminium halide catalysts, varying proportions of one or more of either the same or corresponding halides of other metals may be mixed with them. By modifying the catalyst composition to compensate for the inherent reactive tendencies of any particular feed-stock, it is possible for the ordinary plant operator to exercise a lower degree of care and yet obtain the final desired product. H. B. M.

Analysis and Testing.

1178.* A Modification of the C.F.R. Bouncing Pin Spring-Tension Balance and Instructions for Use. P. Draper. *J. Inst. Petrol.*, September 1943, **29** (237), 253–257.—The spring-tension balance designed in the Shell Laboratories, and described in the *J. Inst. Petrol.*, Vol. 28, p. 209, had proved so successful, particularly in enabling repeatable octane ratings to be obtained in the range of 90–120 O.N., that the Institute of Petroleum requested the C.F.R. Committee in America to co-operate by designing a less costly apparatus. This has been done very successfully by the Ethyl Gasoline Corporation Yonkers' Laboratory, and the instrument, which is described in this report, has certain advantages over the original model. All necessary details on the construction and use of the balance are given. A. H. N.

1179.* Emergent-Stem Correction Nomograph. J. G. Kane and H. A. Schuette. *Petroleum*, October 1943, **6** (10), 155.—A nomograph is presented for calculation of emergent-stem correction. A. H. N.

Motor Fuels.

1180. Patents on Motor Fuels. Standard Oil Development Co. E.P. 554,095, 21.6.43. Appl. 31.7.40. The object of this invention is to produce a finished stabilized motor fuel in a single unitary process without having to acid or clay treat. The fuel is prepared by applying to a hydrocarbon oil boiling in the gasoline range two consecutive reactions. Firstly, dehydrogenation and aromatization processes are carried out in the presence of hydrogen, but only so long as there is a net production of free hydrogen. Then hydrogenation is carried out in the presence of the free hydrogen produced in the first reaction.

International Catalytic Oil Processes Corp. E.P. 554,653, 14.7.43. Appl. 2.7.41. Aviation fuel of high anti-knock characteristics is prepared by subjecting a light naphtha fraction and a heavy naphtha fraction to separate and independent reforming treatment, in the presence of hydrogen. The reforming treatments are carried out in the presence of a catalytic material capable of improving the anti-knock characteristics of each fraction. Products resulting from reforming of the light naphtha are separated into a low-boiling and a higher-boiling fraction. A fraction having an end-point of 300° F. obtained from reforming the heavy naphtha is combined with a reformed light naphtha fraction boiling between 230° and 300° F.

Standard Oil Development Co. E.P. 554,796, 20.7.43. Appl. 18.12.41. The object of this invention is to confer upon hydrocarbon motor fuels high immunity to explosion and inflammability under a wide variety of service conditions, with the least possible detraction from the volatility and anti-knock qualities of the fuel. To achieve this, 0·5–5% by volume of a non-inflammable aliphatic organic halide boiling below 142° F. is blended with a hydrocarbon fraction boiling substantially within the gasoline boiling range.

V. Biske. E.P. 554,872, 22.7.43. Appl. 24.2.42. A process is described for preparing fuels for use in internal-combustion engines using ultrasonic sound vibrations, *i.e.*, sound-waves having a frequency in excess of 20 kHz and preferably in the range of 100–1000 kHz. By means of these vibrations it is possible to disperse water throughout and form a stable mixture with a hydrocarbon fuel with which it would otherwise be immiscible.

Shell Development Co. E.P. 555,046, 30.7.43. Appl. 18.3.42 In the production of aromatic hydrocarbons from aliphatic hydrocarbons having 6–12 carbon atoms, the original hydrocarbons are treated under cyclizing conditions with a catalyst containing a cyclizing compound of a metal selected from the left-hand columns of

Groups IV to VI of the Periodic Table, supported upon a stabilizing carrier of relatively low catalytic activity. The catalyst is promoted by the presence on it of platinum and/or palladium.

Standard Oil Development Co. E.P. 555,288, 16.8.43. Appl. 2.1.42. Process for the isomerization of mono-olefins in which straight-chain mono-olefins or olefins containing not more than one side-chain attached to any one carbon atom are converted into branched-chain olefins having the same number of carbon atoms but a greater number of side-chains than the original olefins. The olefin feed is contacted at a temperature between 400° and 1200° F. with a catalyst consisting of boron oxide carried on alumina or silica, for a period of from 0·05 to 60 seconds.

E. C. Lee and J. E. Ahlberg. U.S.P. 2,316,260, 13.4.43. Appl. 29.4.39. Hydrocarbon oils heavier than gasoline are converted by subjecting them at a temperature between 850° and 1100° F. to the action of a synthetic catalyst substantially devoid of alumina and alkali metal ions and consisting of a calcined mixture of a precipitated silica hydrogel and a precipitated hydrous oxide of tin.

A. R. Goldsby. U.S.P. 2,317,142, 20.4.43. Appl. 27.4.39. An improved method is described for the production of aviation spirit of high anti-knock rating by alkylating *iso*butane with a low-boiling olefin in the presence of an alkylation catalyst.

E. B. Hjerpe and W. A. Gruse. U.S.P. 2,317,603, 27.4.43. Appl. 25.3.36. In the manufacture of gasoline-like hydrocarbons of high anti-knock value from normally gaseous hydrocarbons by a polymerizing process, a fraction is used which consists predominantly of saturated and unsaturated hydrocarbons having four carbon atoms per molecule and having relatively small amounts of hydrocarbons having three carbon atoms per molecule. It is substantially free from refractory hydrocarbons such as methane, ethane, and ethylene.

A. P. Hewlett and G. E. Phillips. U.S.P. 2,317,766, 27.4.43. Appl. 3.1.40. Motor fuels of high anti-knock value are obtained by contacting petroleum feed-oils with bauxite at a temperature between 800° and 850° F. The feed-oils are characterized by having an acid heat above 150 and a clear octane number below 70. H. B. M.

Lubricants and Lubrication.

1181. Tall Oil in Lubricants. Anon. *Chem. Tr. J.*, 28.5.43, **112**, 504.—A new emulsified lubricating or cutting oil made chiefly from tall oil has been developed by one of Sweden's largest manufacturers of motor vehicles and machine tools. Tests extending over six months in the operation of various types of machine tools have given successful results. D. L. S.

1182. Radiosulphur Tracer Study of Sulphurized Lubrication Addition Agents. G. L. Clark, S. G. Gallo, and B. H. Lincoln. *J. appl. Phys.*, August 1943, **14** (8), 428.—Radioactive tracer techniques have been used to ascertain the concentration of sulphurized addition agent in lubricating-oil blends on metallic surfaces, the active element being radiosulphur prepared with the cyclotron and introduced into the olefin molecules. Film formation seems to be quite general, having been tested on seven different types of commercial metallic bearings as well as on glass. The film is transparent and very thin. In extreme cases it imparts a faint opalescence to the bright surface. The organic molecules may form a loose molecular compound with the metal or a polymerized film, sufficiently adherent, however, to resist the solvent action of benzene and carbon disulphide. The rate of film formation has been established at 88° C. (190° F.) and at room temperature for a typical bearing composition. It has been found that the rate at room temperature though several times slower than at 88° C. is still quite appreciable and favourable from the standpoint of engine protection. The mechanism of oxidation inhibition, and thus retardation of corrosion and sludging, with this addition agent seems to embrace both alteration of surface character of catalyzing metals and bulk or liquid phase inhibition in the oil. The adherent organic film is probably involved in " oiliness " (film strengthening and prevention of complete oil drainage from motor bearings and walls by anchoring through polar molecules), since engine tests have shown that the oiliness of straight mineral oil is appreciably improved by addition of sulphurized olefins. A. H. N.

1183. Temperature Relations in Journal-Bearing Systems. M. Muskat and F. Morgan. *J. appl. Mech.*, September 1943, **10** (3), A131–A138.—The basic principle underlying the method of investigation which has been followed in the present paper was outlined in a discussion of the paper presented by Hersey at the symposium. This consisted essentially in the proposal that film or bearing-surface temperatures be inferred from measurements of the friction torque acting either on the journal or bearing. The practicality of this proposal lies in the observation that the theoretical calculations of friction conditions in journal-bearing systems, for constant-lubricant viscosity, have reached a stage where the values of the friction torque can be accurately computed for a wide range of operating conditions and physical dimensions of the journal-bearing system. Hence by comparing such calculated friction torques with those actually measured, it should be possible to determine the effective equivalent constant-film viscosity corresponding to the operating conditions imposed on the journal-bearing system. Combining the film viscosities computed in this way with the viscosity–temperature characteristic of the lubricant used, the equivalent average film temperature can thus be reaily determined. This has been the principle of the present method of investigation. In its actual application, advantage was taken of the great simplification associated with the thick-film operation of the journal bearing—*i.e.*, by experimenting at high speeds and low loads where the simple Petroff formula should accurately predict the frictional behaviour.

In the course of these experiments, the transient history of the film or bearing temperature was observed and recorded, from the beginning of operation of the journal bearing until thermal equilibrium had been approximately approached. It was found possible to correlate the rate of asymptotic approach to equilibrium to the actual equilibrium conditions. It was also possible to correlate the latter with the operating parameters of the system. In addition to the experimental measurements, theoretical considerations are presented pertaining to the temperature distribution with the lubricant film, and also the problem of calculating effective film temperatures in journal-bearing systems provided with sufficiently great rates of lubricant flow as to materially influence the thermal-equilibrium conditions.

The need for more experimental work is emphasized. A. H. N.

1184.* Development and Application of Lubricating Greases. Part 2. M. W. Webber. *Petroleum*, October 1943, **6** (10), 148–149.—Very brief paragraphs describe the tests generally conducted on greases. These include drop and melting points, consistency and viscosity, stability tests of different types, and performance tests. Application of greases by screw-cups, automatic cups, ordinary and pressure guns is also briefly discussed. A. H. N.

1185. Patents on Lubricants and Lubrication. J. G. Fife. E.P. 553,234, 13.5.43. Appl. 8.9.41. A mineral lubricating oil suitable for use in internal-combustion engines has dissolved in it 0·25–5% of a sulphonate salt and one or both of the following: 1–10% of a sulphurized ester and 0·20–2% of an anti-oxidant selected from the group consisting of aromatic amine and hydroxy anti-oxidants. The sulphonate salt must be oil-soluble, free from free acid, and it must combine a hydrocarbon sulphonic acid with a polyvalent metal which forms an oxide that is not readily converted into other oxides under lubricating conditions.

Shell Development Co. E.P. 553,562, 27.5.43. Appl. 21.7.41. A mineral oil or a compounded oil containing more than 20% of mineral oil is used for the lubrication of textile fibres. The oil compositions may be prepared by the addition to mineral oils of a partial ester or esters of a polyhydric alcohol, such as glycol, glycerol, with a fatty acid containing more than 8 carbon atoms in the molecule. In use, the mineral-oil compositions have been found to have scouring properties equal or superior to those of fatty oils, such as olive oil, and are readily removed from textile fibres.

Socony-Vacuum Oil Co. E.P. 555,053, 3.8.43. Appl. 23.4.41. Preparation of a mineral-oil composition consisting of a viscous mineral-oil fraction and a small proportion of an oil-miscible metal-organic compound. The compound has at least two aryl nuclei, each substituted with a wax group and with a metal or metallo-group, interconnected by at least one atom of an element selected from the group consisting of sulphur, selenium, and tellurium.

Standard Oil Development Co. E.P. 555,081, 4.8.43. Appl. 2.9.40. Addition agents for lubricating oils are prepared by condensing a mono or polycyclic aromatic hydrocarbon, or a halogeno derivative thereof, with a polyhalide of a low-molecular-weight hydrocarbon, and with a monohalide of a low-molecular-weight saturated hydrocarbon, or a low-molecular-weight olefin, in the presence of a condensing agent. Examples of aromatic hydrocarbons and derivatives used are benzene, naphthalene, anthracene, and phenanthrene.

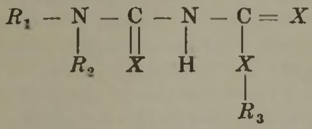
U. B. Bray and C. E. Swift. U.S.P. 2,316,395, 13.4.43. Appl. 19.2.35. Lubricating oil is produced from an oil which contains wax by mingling with the original material a liquid having a selective solvent action as between paraffinic and non-paraffinic fractions of the oil, also a relatively less selective solvent. In this way are formed an extract phase of selective solvent and non-paraffinic fractions, and a raffinate phase of the two solvents and paraffinic fractions, including wax. The raffinate phase is cooled and the wax is afterwards removed from it. H. B. M.

Sin-Iti Irigai. U.S.P. 2,316,587, 13.4.43. Appl. 4.1.41. A petroleum hydrocarbon oil is stabilized against oxidation by the addition of 0·01–1·0% by weight of diphenyl piperazine.

F. E. Armfield. U.S.P. 2,316,852, 20.4.43. Appl. 30.8.41. The catalytic oxidation of a lubricating or electrical oil caused by sludge containing a catalyst of the group consisting of copper, iron, chromium, lead, and their compounds, is inhibited in the following way. A small amount each of a phosphatide and a metal deactivator are added to the oil. The metal deactivator is selected from the class consisting of the reaction products of a primary amine and a β-carbonyl compound.

O. M. Reiff, F. P. Otto, J. J. Giammaria, and E. A. Oberright. U.S.P. 2,316,889, 20.4.43. Appl. 20.1.40. A mineral-oil lubricant has added to it a small proportion of an alkyl-substituted aromatic-aliphatic carboxylic acid in which a carbon atom of the aromatic nucleus is directly attached to a carbon atom of the aliphatic group, and in which the alkyl substituent is attached to the aromatic nucleus, and is derived from an aliphatic hydrocarbon material having at least 23 carbon atoms.

P. R. van Ess and E. R. White. U.S.P. 2,316,903, 20.4.43. Appl. 26.12.41. To improve a mineral lubricating oil a small amount of an allophanate is dissolved therein. The addition agent has the general formula :



$$\begin{array}{ccccccccc} R_1 & - & N & - & C & - & N & - & C = X \\ & & | & & \| & & | & & | \\ & & R_2 & & X & & H & & X \\ & & & & & & & & | \\ & & & & & & & & R_3 \end{array}$$

R_1 and R_2 are radicals selected from the group consisting of hydrogen and hydrocarbon radicals, R_3 is a radical having at least 6 carbon atoms selected from the group consisting of aliphatic, alicyclic, aromatic, and mixed cyclic and chain radicals. X is a radical selected from the group consisting of oxygen and sulphur.

A. W. Burwell and J. A. Camelford. U.S.P. 2,317,666, 27.4.43. Appl. 8.5.40. A lubricating composition is prepared from a mineral oil and an oil-soluble mixture of a number of different thio-alkyl compounds produced by reacting with phosphorus hepta-sulphide, a mixture of oxygenated, saturated aliphatic hydrocarbons, including alcohols, ketones, and carboxylic acid compounds, derived from a petroleum hydrocarbon mixture by partial oxidation.

P. K. Frolich and A. H. Gleason. U.S.P. 2,317,751, 27.4.43. Appl. 26.9.41. A lubricant is prepared from a viscous hydrocarbon oil and a small amount of a high-molecular-weight condensation polymer of an organic diamine and a dibasic organic acid. The polymer has a branched long-chain structure of interlinked recurring units, each of which contains at least 8 carbon atoms in branched side-chain hydrocarbon groups. The polymer further has a total hydrogen and carbon content of 80%.

Asphalt and Bitumen.

1186. Patents on Asphalt and Bitumen. E. Vannan. E.P. 554,950, 27.7.43. Appl. 27.2.42. Light-weight asphalt aggregates can be prepared by a heat process and without damaging the constituents by agitating the ingredients in a mixer to which heat is applied by circulating a hot fluid through a jacket surrounding the mixer. Any suitable fluid capable of achieving the requisite temperature may be used—*e.g.*, heavy lubricating oil introduced into the jacket through a thermostatically controlled supply. The following is an example of the type of mix which can be so prepared: Wood flour 16%, pitch 64%, grit 20%, by weight.

E. H. Nichols. U.S.P. 2,316,357, 13.4.43. Appl. 9.8.43. To retard deterioration of a bituminous coating mixture, consisting of asphalt and a filler of finely powdered slate, a retarding agent is distributed throughout the composition in the following way. The retarding agent is first heated, and then the slate particles are coated with it. The asphalt is heated, and thus rendered sufficiently fluid to mix thoroughly with the coated slate particles. H. B. M.

L. L. Lovell, D. C. Isted, and R. L. Ortynsky. U.S.P. 2,317,150, 20.4.43. Appl. 12.5.41. During the process of manufacturing asphalts by oxidizing a precipitated asphalt and blending with a flux, air is used as the sole oxidizing agent, and a blown asphalt is produced having an asphaltene content of 45–65%. The original asphalt has an asphaltene content under 20% and a resin content over 40%, and is obtained from a crude-oil short residue having a viscosity over 300 S.S.W. at 210° F. The blown asphalt is blended with a flux having a high dispersing power for asphaltenes.

J. M. Johnson and E. C. Brown. U.S.P. 2,317,959, 27.4.43. Appl. 1.3.41. A bituminous composition is prepared from an asphaltic material, a water-insoluble soap, and an amide of a higher fatty acid constituting an emulsifier adapted, when in contact with the insoluble soap and water, to cause emulsions of the water-in-oil type. The composition is characterized by thoroughness of contact and lasting adherence to stony aggregate incorporated in a wet condition.

Special Products.

1187. Relation of Composition to the Efficiency of Foliage- or Summer-Type Petroleum Fractions. P. J. Chapman, G. W. Pearce, and A. W. Avens. *J. Econ. Ent.*, April 1943, **36** (2), 241.—Emulsions from a range of petroleum oils varying in chemical composition and with viscosities of 54/80 secs. S.U. at 100° F. have been tested during three seasons to determine their ovicidal efficiency on codling moth, oriental fruit moth, and the eye-spotted bud moth. Using standard spraying equipment, egg-bearing leaves of apple and quince trees were sprayed out-of-doors and then transported to a greenhouse to enable the percentage survivors to be determined. Quantity of oil deposit was determined by extraction with petroleum ether of discs punched from the leaves. The oils were classified chemically by unsulphonated residue, density, aniline point, refractive index, specific refraction, and specific dispersion tests. There was no consistent difference found in the effect of any one spray on the three types of eggs. Determinations of the minimum dosage to give 95% kill of the eggs revealed that there was a wide difference between standard summer oils of similar unsulphonated residue content, but that toxicity was closely in line with paraffinicity. Thus aromatic hydrocarbons are regarded purely as diluents (as far as the above eggs are concerned), while paraffin hydrocarbons are more toxic than naphthenic. A highly refined white oil is thus more effective than a less refined oil. Viscosity appears to be of little significance, as far as the above range is concerned, it being a function of molecular weight and chemical composition. The molecular weight is regarded as of much less importance than the chemical composition. Further work on this aspect of the problem will be reported later. C. L. G.

1188. An Outline of the Relationship Between Asphaltic Bitumens, Petroleum Resins, and Aromatic Petroleum Residues. R. H. H. Morley. *J. Oil and Colour Chem. Assocn.*, April 1943, **26**, 55.—Following a brief indication of the classification of crude oils and of normal refining operations for the production of lubricating oils and asphalts, the origin and general characteristics of petroleum resins and aromatic petroleum residues are discussed. Petroleum resins, or light bitumens, are brown-coloured bitumens, substantially free from asphaltenes, derived from special crude oils—*e.g.*, Miri—or from high-molecular-weight aromatic petroleum residues, or from black asphaltic bitumen by removal of asphaltenes and concentration of the brown residue remaining. Aromatic petroleum residues are the viscous, high-molecular-weight extracts removed from heavy lubricating oil by solvents such as furfural, phenol sulphur dioxide, etc., owing to their low viscosity index, poor resistance to oxidation, and tendency to form gums. The last-mentioned characteristic leads to their use as drying oils in the paint industry. Drying time tests on a typical A.P.R. using varying percentages of cobalt, manganese, and combinations of these driers indicate the advantage of combining these two driers; 1% of cobalt is required to produce a drying time of 12 hrs., while up to 2% manganese has no effect on the drying time (150 hrs.). On the other hand, a combination of 0·4% cobalt and 0·2% manganese gives a 12-hr. drying time. Asphaltic bitumen may be of the steam-refined type, the blown type, or a third brittle type obtained by distillation of cracking residues. The blowing of A.P.R.'s yields blown-type bitumens. It is concluded that the materials constituting aromatic petroleum residues, petroleum resins, and asphaltic bitumens are in general all present in the heavy residual oil obtained after the initial distillation of crude petroleum oils, particularly when these are of the same asphaltic types. Further, in general, A.P.R.'s such as are used as binders in the paint industry, and black asphaltic bitumens both contain brown petroleum resins, because by physical methods it is possible to derive such resins from each. Black bitumens, however, also contain asphaltenes—polymerized or condensed non-volatile cycle hydrocarbons. The Pfeiffer and van Doormal theory of the constitution of bitumen is outlined, and analyses by Thurston and Knowles of the composition of a Mexican asphaltic bitumen given. C. L. G.

1189.* Thiokol—Rapidly Developed Commercial Synthetic Rubber. J. W. Crosby *Petrol. Engr*, June 1943, **14** (10), 96.—The superior resistance to oil, gasoline, and oxidation, and the impermeability to gases of Thiokol led in pre-war days to its use in fuel lines, for electrical insulation, press blankets, rollers and plates for the printing trade, paint spray-hose, washers, etc. It was also available in powder form for moulding, or in solution for impregnation of fabrics and paper. The present emergency has led to other uses—*e.g.*, emergency self-sealing tanks and impregnated cotton bags for transporting fuel, linings for underground cement storage reservoirs, etc. In powder form, insoluble in any known solvent, it is used for abrasive and water-resistant coatings to propeller shafts and shaft supports, submarine submersion tanks, etc. As a coating on felt it replaces sponge rubber cushioning and gaskets on army trucks, etc. The production of Thiokol from non-critical materials has also led to its use in tyres, particularly for recapping, Thiokol N recaps giving 8000–10,000 miles of service. In addition to the dried material obtained by coagulating the reaction products from sodium polysulphide and ethylene dichloride, an uncoagulated Thiokol latex is now available, being used for airplane gas-tank bladders, cement storage-tank linings. A special Thiokol (Vitrobond) is also used for the bonding of brick linings—*e.g.*, in pickling tanks for steel production. C. L. G.

1190.* Sulphur Products from the Aluminium Chloride Complex Obtained in Refining High-Sulphur Gasolines. I. I. Tsyganok and L. A. Yanyukova. *Petrol. Engr*, July 1943, **14** (11), 75. (Translation from *Vostochnaya Neft*, No. 9, 1940.)—The great possibilities inherent in the aluminium-chloride method of desulphurizing distillates has led to a study of the complex reaction products separated by the treatment, with a view to finding methods of utilizing them. Treatment of a gasoline, previously treated with caustic soda, with 3% of Al_2Cl_6 reduced the sulphur content from 0·35% to 0·04% and gave 1·44% of a fluid complex from which 0·54% of an organic substance containing 8·33% S and 0·325% Cl was recovered by decomposition with water. On distillation the latter product gave as residue a black viscous product with a dark red shade and a specific gravity over 1, which dries slowly to an even solid film soluble in gasoline. The sulphur compounds in the distillate (which amounted to 8·92% of the distillate) were distributed as follows: mercaptans 4·14%, disulphides 15·01%, sulphides 71·30%, and residual sulphur 9·55%. Increasing the amount of Al_2Cl_6 used gave high yields of complex and extracted organic matter (thus 9% gave 4·78% of complex and 1·00% of organic matter). The distillates were excellent solvents for rubber, and have possibilities for use in chemical industry as a raw material for the preparation of mercaptans or sulphides. C. L. G.

1191. Plastics Tested for Brake Cylinder Pistons. Anon. *Brit. Plastics,* August 1943, **15**, 144.—At a recent meeting of the S.A.E. in Detroit, J. F. Bachman gave a report on wheel cylinder pistons made from various materials, including plastics, as substitutes for aluminium. Lignin phenolic resins were found unsatisfactory owing to swelling and etching by the hydraulic-brake fluid. Of the phenolic materials tested, the telephone-receiver stock gave the best results, showing only very slight shrinkage in brake fluid, but the strength was not quite satisfactory with steel inserts. A composite piston with a Durez No. 1544 plastic skirt on a hardened steel head was very satisfactory for head strength, life, corrosion resistance, and inertness to brake fluids. It has distinct possibilities, but it is not yet known whether pistons of this type could be produced on the large scale. C. L. G.

1192. New Type Plastics Material. Anon. *Brit. Plastics,* August 1943, **15**, 181.—It is reported that the Dow Chemical Co., in co-operation with the Corning Glass Co., has developed a range of plastic materials (Silicones) differing from present types in having a melting point of about 500° F. They are compounds of silicon dioxide with methyl or ethyl groups, or with ethylene chloride or phenol. They may be used in liquid form, in which state their viscosity is independent of temperature. In view of their heat stability, they have great possibilities in electrical and high-frequency insulation, etc., though they are at present still in the experimental stage.

C. L. G.

1193. Sugar-Cane Wax. Anon. *Chem. Tr. J.*, 13.8.43, **113**, 158. (Abstract of article in April–June issue of *Bulletin of the Imperial Institute*).—Sugar-cane wax occurs in a thin layer on the stalks of the cane, to the extent of 0·1–0·5% of the total weight. It is recovered by solvent extraction of the mud-press cake, which contains up to 17% of crude wax, from the filtration of the expressed juice. Production in Natal commenced in 1916 and increased up till 1924, when 5000 tons were exported, but subsequently decreased, owing to competition, and was discontinued in 1930. The possibility of production in Louisiana has now been considered, a pilot plant being set up at Houma, La. It is hoped to produce 3000 t.p.a. of a product superior to the Natal wax, which was dark, sticky, and of an unpleasant odour. The suitability of different solvents is being investigated, no difference having been found between benzole, toluole, and 95–103° C. petroleum naphtha. Removal of fatty matter present (to the extent of 20–45%) is effected by a diffusion process using cold acetone. The extracted wax is hard and of a green colour, due primarily to chlorophyll, and is difficult to bleach. The fatty fraction contains a component melting at about 132° C., which is probably a mixture of phytosterols. The product should be useful as a substitute for carnauba wax, particularly if the colour can be improved. C. L. G.

1194. Preliminary Experiments on the Use of Oil-Soluble Copper Compounds as Fungicides. C. J. Hickman, R. W. Marsh, and E. H. Wilkinson. *Ann. appl. Biology,* August 1943, **30** (2), 179.—The usual method of improving the adhesion and penetration of fungicidal copper compounds is to mix a suspension in water of the compound with an oil emulsion. The possibility of using oil-soluble copper compounds in order to obtain improved contact has now been investigated. The copper compounds used were salts of the following acids: oleic, palmitic, stearic, linoleic, chaulmoogric, sulphoricinic, abietic, adipic, sebacic, benzoic, di-nitro-*o*-cresol, salicyclic, and 3 : 5-di*iso*propylsalicylic. The last-mentioned was the only one soluble (to the extent of 0·22% Cu) in the oils used (white oil, white spirit, cottonseed oil, turpentine, and pine oil). The others gave suspensions, some of which could be dispersed, or were insoluble in these oils. Laboratory phytocidal tests were carried out on the basic oils and on copper D.I.P.S. at 0·01% Cu in white oil and in water, only pine oil, white spirit, and turpentine causing damage. Field tests on onions with the white oil alone and with 0·01% Cu as D.I.P.S. confirmed these results, but 0·1% Cu as D.I.P.S. in white oil caused shrivelling of the leaves, the plants recovering after a month. Laboratory fungicidal tests showed that copper D.I.P.S. in white oil gave better results than in water, the latter results being on a par with those given by Bordeaux mixture of equivalent copper content. Field fungicidal tests on control of downy mildew on onions, however, showed no control with Cu D.I.P.S. This may have been due to the fact that spraying was carried out at the end of May, June, July, the mildew appearing shortly before the final application, when the effectiveness of the spray deposit had been lost by weathering, while there was considerable growth of new and hence unprotected foliage. Further trials will be made giving more frequent applications at the critical period. C. L. G.

1195. Patents on Special Products. Standard Oil Development Co. E.P. 553,297, 17.5.43. Appl. 30.10.40. A method is described for the production of β-olefins from α-olefins, in particular butene-2 from butene-1. At least one α-olefin is contacted with sulphuric acid of 50–80% concentration at a temperature between 100° and 220° F., for a period of 5–60 minutes, with vigorous agitation. At least one β-olefin is recovered from the reaction mixture.

Anglo-Iranian Oil Co. E.P. 553,599, 28.5.43. Appl. 2.10.40. A process is claimed for the production of branched-chain alkanes, such as *iso*butane or *iso*pentane, from the corresponding straight-chain alkane, such as *n*-butane or *n*-pentane, or for the production of such hydrocarbons from normal hydrocarbons of high molecular weight. An aluminium halide, generally aluminium chloride, is used as catalyst, and the process is carried out in liquid phase in either a continuous or discontinuous manner, at high temperatures and under super-atmospheric conditions. Loss of catalyst from the reaction chamber is avoided by employing a cyclic process as described in the patent.

Shell Development Co. E.P. 554,124, 22.6.43. Appl. 18.9.41. Process for the production of halogenated ethers by halogenating an unsaturated ether in which each of the two radicals directly linked to the ether oxygen atom contains an olefinic linkage between two carbon atoms, each of which is linked to at least one hydrogen atom and neither of which is directly linked to the oxygen atom. The halogenation is effected by reacting the unsaturated ether with a halogen under such conditions that a liquid phase is present in the reaction zone.

Standard Oil Development Co. E.P. 554,974, 28.7.43. Appl. 12.11.41. In a process for isomerizing paraffinic hydrocarbons at least one paraffinic hydrocarbon containing at least four carbon atoms per molecule is contacted at a high temperature with a catalyst composition consisting of a hydro-halide acid-treated clay, containing at least one metal from the group consisting of iron, cobalt, and nickel, in the presence of free hydrogen.

Remington Arms Co. E.P. 555,826, 9.9.43. Appl. 16.7.41. An improved bullet lubricant consists of a mixture of a solid lubricant and a small proportion of a microcrystalline petrolatum wax. The solid lubricant preferably consists of a mixture of petrolatum wax with one or more lower-melting substance—*e.g.*, various grades of paraffin scale, paraffin wax and petrolatum, ozokerite, oleostearine, and mixtures of solid fatty alcohols containing at least 14 carbon atoms in the molecule.

A. L. Mond. E.P. 555,861, 9.9.43. Appl. 20.3.42. In the production of branched-chain paraffin hydrocarbons from less branched aliphatic hydrocarbons, the latter are contacted in the presence of added hydrogen and a hydrogen halide with a composite of an active-olefin hydrogenating catalyst consisting of a reduced metal and a paraffin-isomerizing catalyst consisting of a metal halide, at a temperature between 50° and 300° C.

V. N. Ipatieff and H. Pines. U.S.P. 2,316,247, 13.4.43. Appl. 12.1.40. Process for the isomerization of paraffin hydrocarbons to produce substantial yields of more highly branched compounds. The original material, mixed with a hydrogen halide, is contacted with a granular composite of substantially anhydrous chlorides of aluminium and zirconium and a relatively inert adsorbent under isomerizing conditions of temperature and pressure.

V. N. Ipatieff and H. Pines. U.S.P. 2,316,248, 13.4.43. Appl. 12.1.40. Process as described in U.S.P. 2,316, 247, except that the paraffin hydrocarbons, in admixture with a hydrogen halide, are contacted with a granular composite of substantially anhydrous chlorides of aluminium and copper. H. B. M.

Detonation and Engines.

1196.* Effect of Friction in Air-Inlet and Exhaust Systems of Internal-Combustion Engines. Part 2. O. Adams. *Petrol. Engr*, August 1942, **13** (12), 92.—The flow of gases in ducts and pipes has been studied experimentally, and a number of equations have been deduced. These indicate that friction losses in duct systems are affected by the size, shape, surface roughness, and length of the pipe. The following laws have been found to govern such systems :

1. Frictional resistance varies approximately as the square of the velocity.
2. Frictional resistance varies directly with the area of contact between fluid and duct, and also with the density of the fluid.
3. The total frictional resistance is independent of its pressure against the wall of the duct.
4. The nature of the surface of the duct has a great influence. Smooth surfaces offer less resistance to flow than rough surfaces.
5. Obstructions such as baffles, filters, etc., and any fitting that changes the direction of flow will offer resistance to the flow of the fluid. D. L. S.

BOOK REVIEW.

Beitrag zur Kenntnis der Schmieröle und Treibstoffe für Dieselmotoren (Part I). By H. Stäger and H. Künzler.

The study of the mechanism of alteration and deterioration of mineral oils in use is one which has commanded considerable attention in the past, and which still warrants the continued development of methods of examination and procedure.

The authors of the papers under review are aware of the comparative lack of knowledge regarding the mechanism of deterioration, and maintain that as general analytical data on mineral oil are insufficiently characterized, new methods of test should be sought. For example, a study of the development of turbidity in oils during use has been made, and for this purpose a modification of the Kauri–Butanol test, including electrical measurements embodying a photoelectric cell, has been employed.

The authors have studied turbidity development in paraffinic- and naphthenic-base oils and also the effect of temperature thereon.

A description is given of the effects produced by the two types of oil when small quantities were dropped on a heated aluminium bar. The results are compared with the build-up of deposit around the inlet ports of Diesel engines.

One of the most promising lines of research by the authors is the analysis of the products of alteration or deterioration by means of selective solution using alcohol, petroleum ether, benzol, and chloroform. Paraffinic, naphthenic, and mixed-base oils have been used in this series of experiments, and results reproduced in graphical form show the method to be promising.

The work is to be continued. (For a review of Part II, see *J. Inst. Petrol.*, Jan. 1943, **29** (229), 28A.) W. H. Thomas.

BOOKS RECEIVED.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. XXVII. 1942. Issued by the Society of Chemical Industry, 56, Victoria Street, London, S.W.1. Pp. 492. Indexes 493–545.

This collection of reports contains twenty-six papers, each a condensed record of the notable researches during 1942 in the particular industry under review. Of special interest to the Petroleum Industry is the chapter on "Mineral Oils" contributed by Mr. W. W. Goulston, who reviews the outstanding developments in each section of the industry—viz., petroleum substitutes, refinery plant, motor spirit, lubricating oils, fuel oil, asphaltic bitumen, cracking, isomerization and alkylation, special products, and analysis and testing.

Review of the Work of the Joint Research Committees, 1924–1943, of The Iron and Steel Institute and The British Iron and Steel Federation. Special Report No. 29. Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Pp. 167. Price 10*s*. (Members 5*s*.)

Electric Arc Welding Manual. Vol. I.—Equipment. Pp. 126. Murex Welding Processes, Ltd., Hertford Road, Waltham Cross, Herts.

This handbook has been prepared to give assistance to those not previously experienced in the type of equipment required for electrical welding. There are chapters on "The Electric Arc when used for Metallic Arc Welding," "Motor Generator Arc-Welding Sets," "Engine-Driven Arc-Welding Sets," "Multi-operator Arc-Welding Equipments," "Transformer Equipments," etc., etc.

Transactions of the Institute of Marine Engineers. Vol. 54. Session 1942–43. Pp. 197. Published by the Institute, London.

Thirteen papers read before the Institute during the 1942–43 Session are reproduced, including one on diesel installations, viz: "Operation of Diesel Machinery in Cross-Channel Vessels" (J. W. Coulthard).

Handbook of British Standards No. 1, 1943. Pp. 152. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 1*s*. 6*d*.

The Handbook includes the report of the work of the Institution during the period of eight months to 31st May, 1943. A numerical list of British Standards and a subject index to the list of British Standards are also given.

INSTITUTE NOTES.

December, 1943.

STANLOW BRANCH

The Committee of the Stanlow Branch has made tentative arrangements for the following meetings during the 1943–44 Session. Branch members will be notified direct, in advance, of the date, place and time of all meetings, and in this connection it is requested that any Member of the Institute resident in the Stanlow area should acquaint the Honorary Secretary of his wish to be registered as a member of the Stanlow Branch.

Provisional Syllabus.

Jan. 16, 1944.	Social event and Brains Trust.
Feb. 16, 1944.	Fuels for the C.I. Engine. Mr. F. L. Garton.
Mar. 14, 1944.	Synthetic detergents and wetting agents. Mr. A. N. Holmes
Apr. 12, 1944.	Petroleum and plastics. Dr. H. Barron.

The officers and members of committee for the forthcoming Session are :—

Chairman : J. S. Parker.
Members of Committee : V. Biske.
G. Davidson.
F. L. Garton.
J. Grant.
J. G. Hancock.

J. C. WOOD-MALLOCK,
Hon. Secretary and Treasurer.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, Para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, Paras. 9 and 10.

Transfer to Fellow.

Draper, Philip.

As Members

Dussek, Alan James.
Hudson, Cyril Henry.
Miles, James Douglas.
Tetlow, Norman.
Wallach, Herbert L.

As Associate Members.

Cowell, Leonard Herbert.
Holmes, Harold Richard.
Lindsay, James.
McCarthy, William C. F.
Maughan, Alexander C.
Ruffell, Henry A.

Transfer to Associate Member.

Ju, Ting Yih.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

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

The names of candidates' proposers and seconders are given in parentheses.

Campion, James Douglas, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone ; P. G. Higgs.*)
Gardiner, Michael Allan Rawson, Student, Birmingham University. (*F. H. Garner.*)
Glyde, Harold Stanley, Research Engineer, Ricardo & Co., Ltd. (*H. R. Ricardo ; C. H. Barton.*)
Hardy, Alfred Cecil, Naval Architect. (*S. J. M. Auld ; C. W. Wood.*)
Harland, William Stanley, Chemist, Royal Dutch Petroleum Co.(*A. McCulloch.*)
Harries, Gwynne Hughes, Research Chemist, Manchester Oil Refinery Ltd. (*E. J. Dunstan ; P. M. Griffiths.*)
Hebberd, Richard Stanley Hurcum, Student, Birmingham University. (*F. H. Garner.*)
Hutchinson, Fred, Analytical Chemist, Shell Refining & Marketing Co. (*G. Davidson ; J. Grant.*)
King, George, Senior Installation Supervisor, Petroleum Board. (*G. Davidson ; J. Grant.*)
Leighton, William Alan, Student, Birmingham University. (*F. H. Garner.*)
Loxley, Michael John, Student, Birmingham University. (*F. H. Garner.*)
Petty, Donald Stuart, Student, Birmingham University. (*F. H. Garner.*)
Polson, Hector Fraser, Senior Technical Adviser, Scottish Oils & Shell-Mex Ltd. (*A. E. Hope ; H. W. Clark.*)
Shearn, Ronald Bertram, Student, Birmingham University. (*F. H. Garner.*)
Smith, Jack Kitson, Student, Birmingham University. (*F. H. Garner.*)
Stout, Kenneth Rowland, Student, Birmingham University. (*F. H. Garner.*)
Tigg, Thomas Hugh, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone ; P. G. Higgs*).
Whiston, John Reginald Harvey, Professor of Chemistry and Metallurgy, Military College of Science. (*A. E. Dunstan ; D. A. Howes.*)

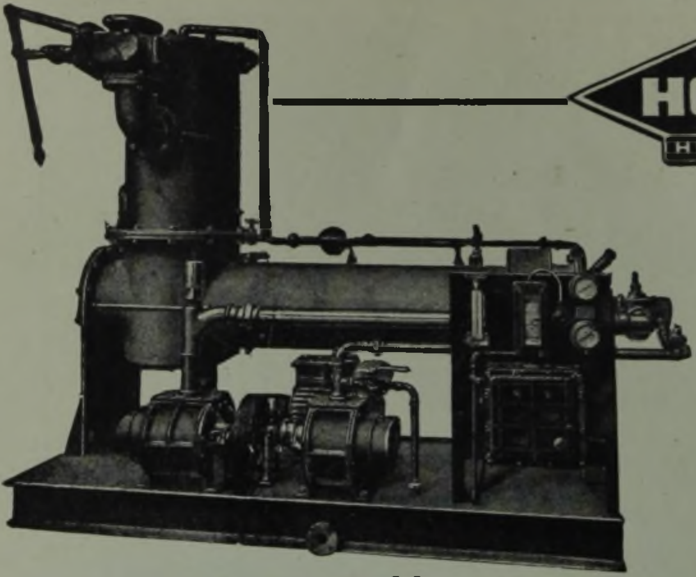
Applications for Transfer.

Cude, Arthur Leslie, Assistant Chemist. (*T. G. Hunter ; A. H. Nissan.*)
Kiernan, Herbert Stephen, Works Chemist and Production Manager. *J. E. M. Haslam ; E. A. Evans.*)
Moore, Philip Harold, Chemical Engineer. (*J. Barrett ; H. Moore.*)

BENEVOLENT FUND.

The attention of members is directed to the urgent need for building up reserves in the Benevolent Fund in support of the many cases that will undoubtedly arise at the termination of hostilities. Contributions may be sent to the Secretary of the Institute at 26, Portland Place, London, W.1.

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



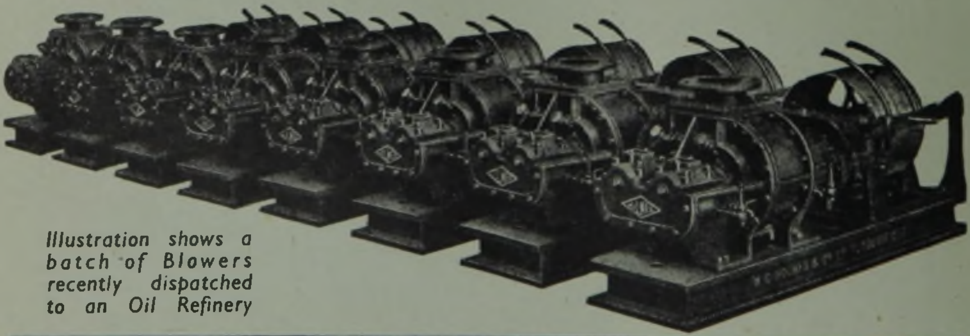
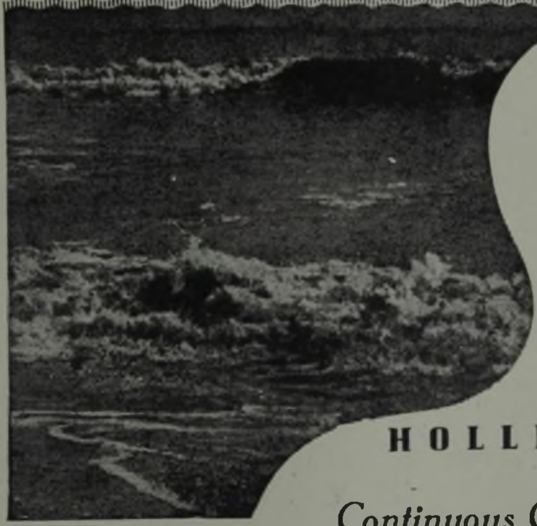


Illustration shows a batch of Blowers recently dispatched to an Oil Refinery



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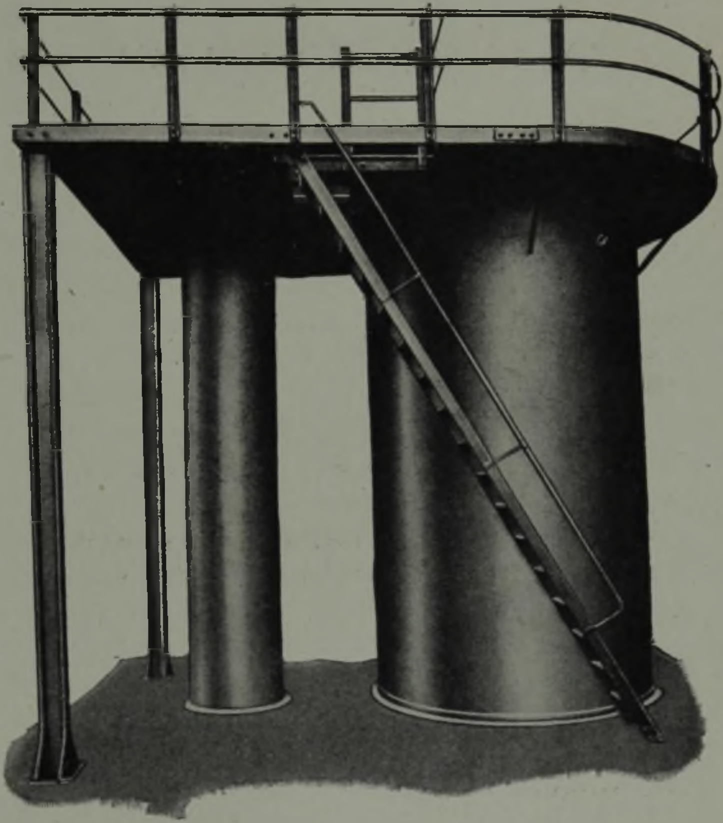
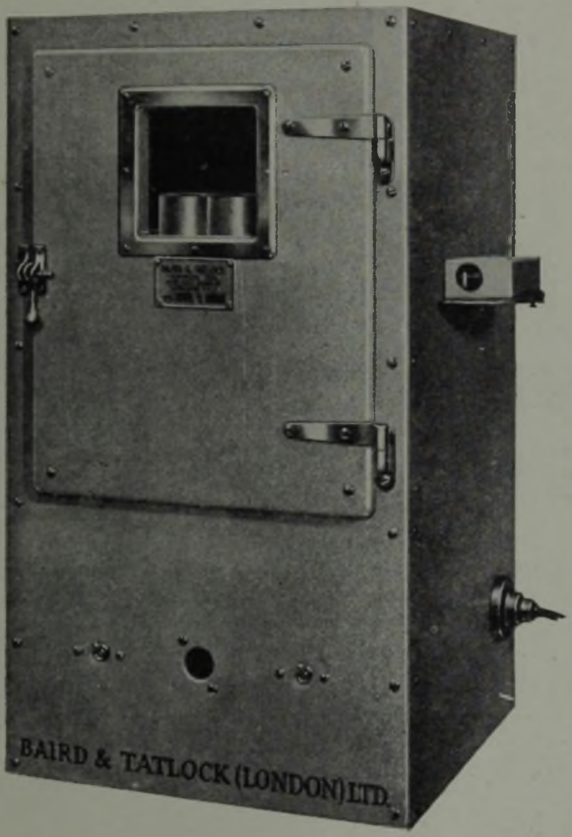


The B.T.L.

LOSS ON HEATING OVEN



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High and low temperature heating circuits with separate switches, and pilot light to indicate when oven is in operation.

Temperature control up to 315°C. ± 1°C. by means of a bimetallic regulator provided with graduated quadrant and pointer.

●

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●

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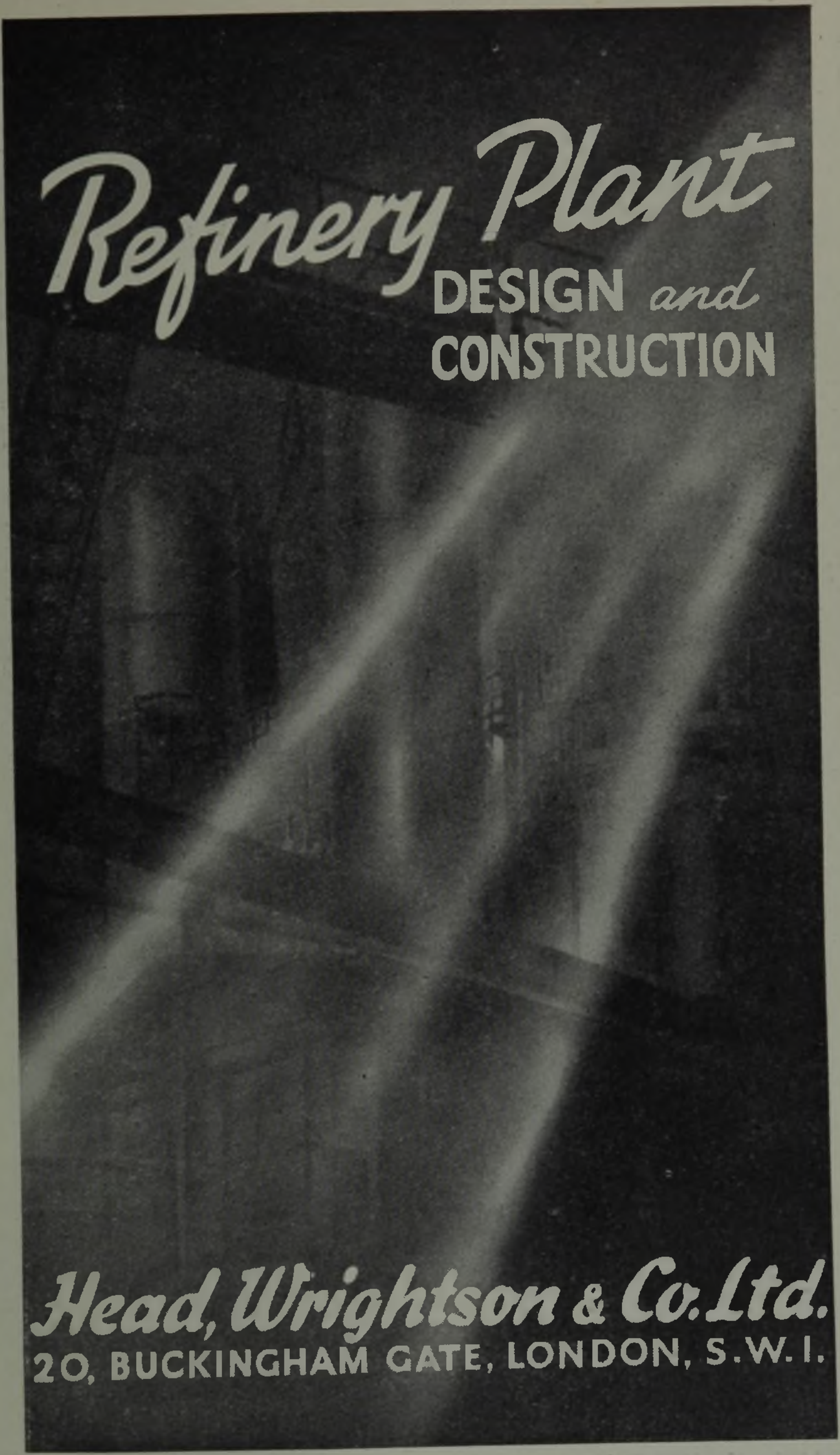
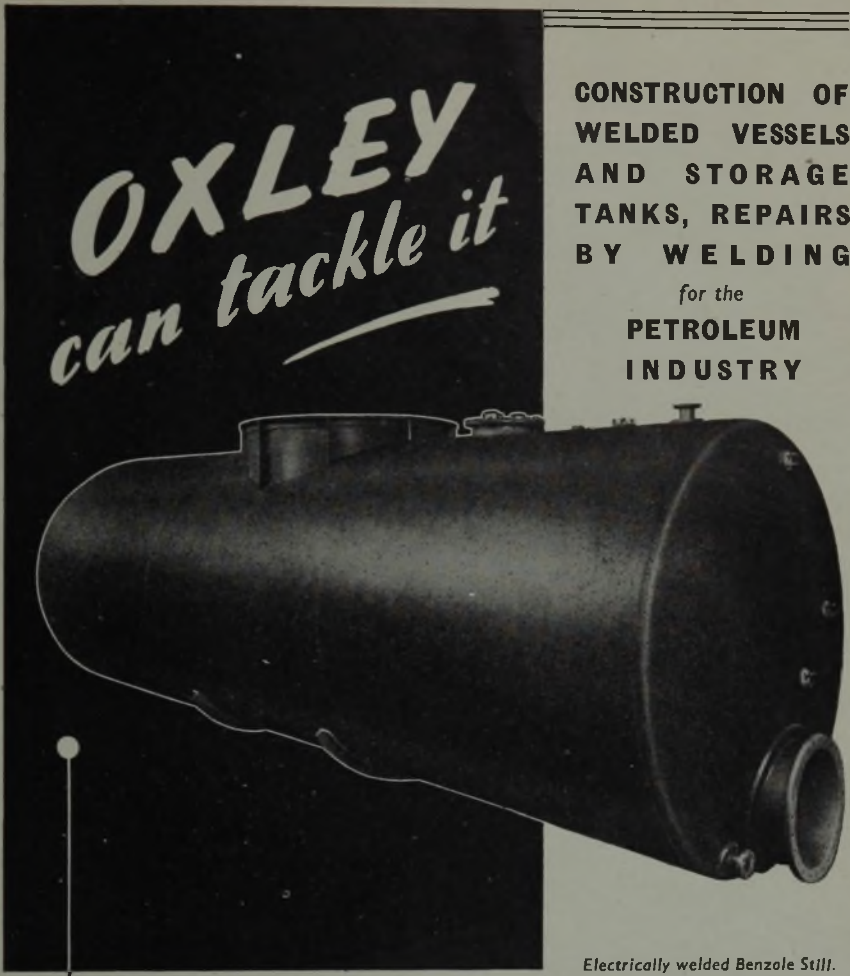
With acknowledgment to Messrs. Dunhill & Co. Ltd. for use of illustration showing a pipe, now in their possession, used by Sir Walter Raleigh.

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