Vol. 30. No. 242. February 1944.

STANDARDIZATION COMMITTEE.

REPORTS OF SUB-COMMITTEES.

Reports of the various Sub-Committees are published in this issue of the *Journal* in order to give members an account of the work done during the past year 1942–1943. Much of this work has resulted in modifications and additions to "Standard Methods for Testing Petroleum," but, in addition, all the various Sub-Committees and their Panels had under consideration other modifications and methods of test. This has involved in some instances co-operative work in many laboratories. Such work will result in improvements which may be incorporated in the next and following issues of "Standard Methods."

It is the desire of the Standardization Committee in these annual reports to keep members informed not only of the work done, but also of the trend of future work; it will welcome offers of co-operation which may make future editions of "Standard Methods" of increasing usefulness both to the petroleum industry and to users of petroleum products.

REPORT OF SUB-COMMITTEE NO. 1—MEASUREMENT AND SAMPLING.

1. Origin of Committee, its Scope and Present Composition.

The Committee, which was originally known as the "Measurement of Oil in Bulk Committee," was formed early in 1931. Mr. J. Kewley had for some time been convinced that the lack of standardization in methods appertaining to the commercial measurement of bulk quantities of liquid petroleum products was something to be deplored, and he persuaded the Institute to set up a section of its Standardization Committee with "the standardization and unification of methods and equipment used in the measurement of bulk petroleum products" as its terms of reference.

The Committee was reorganized three years ago, when, in addition to an extended personnel, its work was divided among a series of Panels. The present Committee and the seven associated Panels are constituted as follows:—

Sub-Committee I.

H. Hyams (*Chairman*) (Asiatic Petroleum Co., Ltd.).
P. Docksey (Anglo-Iranian Oil Co., Ltd.).
E. B. Evans (Anglo-American Oil Co., Ltd.).
T. L. Evans (Shell Refining and Marketing Co., Ltd.).
F. H. Garner (Birmingham University).
A. W. Higson (Petroleum Board).
M. H. Hoffert (Anglo-Iranian Oil Co., Ltd.).
W. F. Jelffs (B. & R. Redwood, Ltd.).
P. Kerr (Asiatic Petroleum Co., Ltd.).
J. Kewley.
A. Osborn (Esso European Laboratories).
E. Stokoe (Shell Refining and Marketing Co., Ltd.).
G. D. Thacker (Shell Refining and Marketing Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
F. Tipler (Petroleum Board).

Panel I.—Calibration of Tanks.

F. Tipler (*Chairman*) (Petroleum Board).
A. W. Higson (Petroleum Board).
W. F. Jelffs (B. and R. Redwood, Ltd.).
P. Kerr (Asiatic Petroleum Co., Ltd.).
E. Stokoe (Shell Refining and Marketing Co., Ltd.).

Panel II.—Measurement of Oil Depths.

E. Stokoe (*Chairman*) (Shell Refining and Marketing Co., Ltd.).
P. Docksey (Anglo-Iranian Oil Co., Ltd.).
G. W. W. Ford (Stemco, Ltd.).
A. W. Higson (Petroleum Board).
M. H. Hoffert (Anglo-Iranian Oil Co., Ltd.).
A. Osborn (Esso European Laboratories).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
F. Tipler (Petroleum Board).

Panel III.—Sampling.

W. F. Jelffs (*Chairman*) (B. and R. Redwood, Ltd.).
J. E. Byles (Board of Customs and Excise).
E. B. Evans (Anglo-American Oil Co., Ltd.).
G. W. Lepper (Ministry of Fuel and Power).
J. Mason (Ministry of Aircraft Production).
F. H. Newington (Admiralty).
A. Osborn (Esso European Laboratories).
G. D. Thacker (Shell Refining and Marketing Co., Ltd.).

Panel IV.—Temperature Measurement.

G. D. Thacker (*Chairman*) (Shell Refining and Marketing Co., Ltd.).
P. Docksey (Anglo-Iranian Oil Co., Ltd.).
T. L. Evans (Shell Refining and Marketing Co., Ltd.).
E. Stokoe (Shell Refining and Marketing Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Panel V.—Gravity Measurement.

E. B. Evans (*Chairman*) (Anglo-American Oil Co., Ltd.).
T. L. Evans (Shell Refining and Marketing Co., Ltd.).
A. Osborn (Esso European Laboratories).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Panel VI.—Units of Measurement, Calculations and Tables.

P. Kerr (*Chairman*) (Asiatic Petroleum Co., Ltd.).
E. B. Evans (Anglo-American Oil Co., Ltd.).
M. H. Hoffert (Anglo-Iranian Oil Co., Ltd.).

Panel VII.—Oil Measurement Apparatus.

W. F. Jelffs (*Chairman*) (B. and R. Redwood, Ltd.).
T. L. Evans (Shell Refining and Marketing Co., Ltd.).
G. W. W. Ford (Stemco, Ltd.).
A. W. Higson (Petroleum Board).
E. Stokoe (Shell Refining and Marketing Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

2. Work already Published.

(a) *Weights and Measures.*—The Committee first devoted its attention to the clearing up of the misunderstandings that existed in the industry because of the absence of authoritative conversion ratios for the various units of weight, volume, and capacity in the metric, Imperial (British), and American (U.S.A.) systems. The Institute's publication "Measurement of Oil in Bulk, Part I—Standard Weights and Measures," published in 1932, was the result. The table of Inter-Relation of Units and the recommended Contracted Ratios contained in the booklet are now widely recognized because of their up-to-date legal and scientific basis. The A.P.I. paid the Committee the compliment of accepting these tables on behalf of the American oil industry.

(b) *First World Petroleum Congress.*—The Committee took a very active part in this London Congress, held in 1933. It accepted responsibility for the collection and presentation of a series of papers on oil measurement, which formed a section of the deliberations of the Congress. Three members of the Committee presented the following papers :—

> " The Measurement of Oil by Volume," by J. McConnell Sanders.
>
> " The Calibration of Receptacles used for the Storage, Transport and Distribution of Petroleum and its Products," by W. F. Jelffs.
>
> " Hydrometers and Hydrometry," by Verney Stott.

(c) *Measurement of Oil by Volume.*—The interest aroused by Mr. McConnell Sanders' paper on this subject at the First World Petroleum Congress led to the decision by the Institute to hold a special meeting for the further ventilation of views. Accordingly, on 28th June, 1934, Mr. McConnell Sanders presented another paper on behalf of the Oil Measurement Committee, entitled " On the Advantages Secured by Expressing Quantities of Liquid Petroleum in Terms of Volume or Capacity rather than of Weight." [1] This paper strongly urged the exclusive use of measurement of oil by volume in commercial transactions, but in spite of overwhelming support and the unanimous decision of the meeting to work for the international standardization of volume measurement, no marked progress towards this ideal appears to have been made since 1934.

(d) *Coefficients of Expansion.*—In 1936 the Committee began a study of the tables and methods which were in use in the industry for the correction of volumetric quantities and specific gravity for temperature change. In 1937 it was decided to collect data on this subject from as many sources as possible. The collation of the material sent in was a considerable task; the outbreak of hostilities retarded progress, but in 1941 the results were produced in the *Journal* in the form of a report entitled " Expansion of Crude Petroleum, Petroleum Products and Allied Substances." [2] The conclusions were interesting. They showed that the results of the investigational work which had been carried out by the American Bureau of Standards in 1912–1915, on the oils then available, were still widely applicable in 1941. Thus, the volume and gravity correction tables contained in the Bureau's Circular C.410, whilst having certain limitations, could be recommended for general adoption. Certain materials would have to receive special treatment, but, in general, there was no justification for new and extended investigational work with the object of preparing a new set of tables.

(e) *Second World Petroleum Congress.*—The participation of the Committee in the Paris Congress of 1937 took the form of two papers, one on " Standard Weights and Measures " presented by Mr. Hyams on behalf of the Committee, and the other in Mr. Hyams' own name on " Volume

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[1] *J. Inst. Petrol. Tech.*, 1934, **20** (129), 665–688.

[2] *J. Inst. Petrol.*, 1941, **27** (215), 402–417.

Correction Tables in the Commercial Measurement of Liquid Petroleum Products." The first paper emphasized the need for the publication and the international use of authoritative tables of conversion ratios in the petroleum industry, and gave extracts from and comments on the I.P. booklet on Weights and Measures. The second paper summarized and commented on the work which had been published on this subject, and concluded that Table 2 of U.S. Bureau of Standards Circular C.410 was " worthy of universal acceptance because of its authoritative nature and the need for standardization "; and that " there is a need for tables, both in the Imperial and in the metric system, corresponding to Table 2 of U.S. Bureau of Standards Circular C.410."

(f) *Specific Gravity and Sampling.*—Of the methods of test covered by I.P. " Standard Methods," Sub-Committee I is responsible for Specific Gravity and Sampling. The Specific Gravity method was very largely rewritten and extended in the 1942 edition; the form in which the method now appears will, it is hoped, make it possible for the recommended procedure for the specific gravity determination of any product to be easily consulted and applied. In the next edition of " Standard Methods " the alterations to this method have been relatively minor; a method for specific gravity determination of liquefied petroleum gases has been included, and specifications for hydrometers have been substantially altered.

The Sampling Method, both in the I.P. and A.S.T.M. Standard Methods, has remained unchanged for some 10 years. Sub-Committee I decided on a complete revision both of material and set-up. The results will appear in the next edition of I.P. " Standard Methods," and are submitted as simplified and modernized procedures for the sampling of all types of petroleum products from every normal type of container.

(g) *60° F. as Standard Reference Temperature.*—Action which was contemplated by the I.S.A. (International Federation of National Standardizing Bodies) just prior to the outbreak of the war made it necessary for the Institute to define its attitude both on the question of the standard method of reporting the specific gravity of a petroleum product and on the standard temperature to which volumes of bulk products should, when necessary, be corrected. The I.S.A. apparently favoured density in terms of grammes per ml. at 20° C., and 20° C. also as the standard reference temperature for oil volumes. Sub-Committee I in a note entitled *Standard Temperature for Specific Gravity Determination and Volume Correction*[3] made it clear on behalf of the Institute that specific gravity 60° F./60° F. was the specific gravity basis recommended by the I.P.; and that 60° F. was the temperature favoured and laid down by the Institute both for reporting specific gravity results as well as for correcting volumes of liquid petroleum products. In these matters the Sub-Committee made it clear that the Institute was perfectly in step with the A.P.I. and the A.S.T.M.

3. Co-operation with the A.S.T.M.

Exchanges of views in 1938 between the chairmen of the I.P. Measurement and Sampling Committee and A.S.T.M. Committee XV on Sampling

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[3] *J. Inst. Petrol.*, 1943, **29** (235), 190–191.

and Gaging indicated that there was a common feeling that the subject of oil measurement was of sufficient importance to warrant steps being taken for a complete interchange of information with the object of securing uniformity in method and procedure. Close co-operation between the two Committees has been maintained ever since, in spite of war-time difficulties. Both Committees have a series of closely similar Panels which are charged with the detailed work.

Full exchange of draft proposals, in their earliest stages, takes place between the two Committees. There is agreement on the desirability of joint production of A.S.T.M./I.P. methods and views, wherever this is possible. A document on " Principles " relating to oil measurement has been produced by our Committee, and it is hoped that it will, before very long, be the first of the joint publications by the two organizations. We have also prepared a statement and a series of tables for the conversion of metric tons (*in vacuo*) to long tons and short tons (*in air*). The correct conversion of the one type of weight to the other has created difficulties in the computation of bulk petroleum products, and a joint pronouncement with our American friends is being sought. Further, difficulties in the preparation of a standard method for calibration of oil-storage tanks, and in the correlation of weight and volume tables (under preparation by our Panel VI), with tables published by Bureau of Standards, are being fully discussed with the American standardizing bodies.

In every respect, therefore, the co-operation with our American friends in the sphere of standardization work on oil measurement can be regarded as being very active.

4. WORK CONTEMPLATED.

The work of the Panels proceeds as speedily as war-time conditions permit. The intention is that the results produced by all the Panels shall eventually be dovetailed into one comprehensive work on oil measurement, the function of the Committee then being to keep the work up-to-date. Obviously, however, one Panel may progress faster than the others, so that its work will be available for publication earlier. Sampling has already been dealt with, but will have to be specially applied, and in greater detail, to quantity measurement. Tank calibration is receiving very active attention, and, when initial difficulties have been overcome, should result in an official publication on this subject—possibly a sister booklet to the one on Weights and Measures. Panel VI on Tables is engaged on the task of preparing a set of tables as follows :—

(*a*) A table of volume correction factors based on Table 2 of U.S. Bureau of Standards Circular C.410 but entered against specific gravity 60° F./60° F. instead of against ° A.P.I. at 60° F.

(*b*) Tables giving weight per unit volume and volume per unit weight, similar to Table 4 of Circular C.410 but entered against specific gravity 60° F./60° F. and giving

(i) Lbs. per Imperial gallon.
(ii) Long tons per Imperial gallon.
(iii) Imperial gallons per long ton.

These tables will possibly be published individually as they become available, but the programme undertaken by the Sub-Committee will, it is hoped, result in the production of a book of tables, authoritative in nature and widely applicable in the industry in connection with the quantitative measurement of bulk oil.

REPORT OF SUB-COMMITTEE NO. 2—CRUDE OIL.

The Sub-Committee on Crude Oil consists of the following :—

Sub-Committee 2.

G. H. Coxon (*Chairman*) (Anglo-Iranian Oil Co., Ltd.)
B. C. Allibone (Burmah Oil Co., Ltd.).
E. J. Boorman (Government Laboratory).
C. Dalley (Trinidad Petroleum Development Co., Ltd.).
A. G. Forbes (Agwi Petroleum Corporation, Ltd.).
G. W. Lepper (Ministry of Fuel and Power).
R. I. Lewis (Asiatic Petroleum Co., Ltd.).
H. E. L. Pracey (Asiatic Petroleum Co., Ltd.).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Before embarking on the evolution of a crude-oil evaluation the Sub-Committee made a survey of existing methods, and also contacted the corresponding Committee of the A.S.T.M. in the United States, who intimated that they are not at the moment contemplating the issue of any crude-oil assay.

In the earlier consideration of the crude-oil evaluation method the Committee considered that the information desired fell best under two headings : (1) a short sorting inspection and (2) a detailed evaluation. As now proposed the first inspection uses existing apparatus and test methods with few modifications, and is considered to be sufficient to allow comparison to be made between, for instance, successive cargoes of crude-oil receipts, or between a crude sample as offered for sale and the actual cargo receipt. The second, more detailed, evaluation requires specialized apparatus and technique, but in the consideration of this evaluation the Committee has tried to balance the scope of the evaluation with obtaining sufficient information to give such details as are generally required by the average operating refinery.

With the diversity of refining processes now in use, it is impossible to cater in a single analysis for all permutations and combinations of refinery operations. Likewise, since no two refineries require exactly the same straight cuts from crude, some arbitrary choice of cutting points has to be made. In order to cover this point, the distillation methods as specified make provision for a temperature/percentage distillate record to be taken, from which it is possible to produce distillation curves, thus allowing computation of the yield of any desired cut to be made.

As regards the stipulation of the tests to be carried out on the chosen fractions, the Committee consider that the range of tests given cover the main requirements for any purpose to which such cuts can be put.

No method for estimation of wax in the heavy distillate has as yet been included. The Sub-Committee still have this point under consideration, and four possible methods are being studied.

Since an evaluation such as described must eventually be tied in with actual refinery operations, it is considered that the method will have to be used in a comparative rather than in an absolute manner. For instance, a refiner can carry out the specified evaluation method on a crude which he normally runs in the refinery, and of which he has exact estimates of the yields of desired products obtainable. If then he desires to run a different crude on which the results of the proposed evaluation are available, it should be possible for him to make a good estimate of the yields and qualities of the products which he can obtain on this second crude.

Turning to the actual methods which have been evolved for the detailed evaluation, the Committee feel that the apparatus used to evaluate fractions up to 350° C. boiling point at atmospheric pressure are comparable in fractionating efficiency to modern refinery plant, and also that it is sufficiently robust and well designed to meet with general favour. In considering the apparatus to be used for the separation of the heavier fractions of the crude oil, however, the Committee did give serious consideration to the specification of a single flash pipestill method which would reduce the crude to a short residue without the dangers of possible cracking such as occur in batch distillation. Also, it is considered that by the introduction of a continuous distillation method it will be possible to run the crude oil to a shorter residue than the present method will allow. The difficulties of standardizing such an apparatus and technique were such that it was not thought possible to produce a suitable method for publication in the 1944 " Standard Methods," and that, for the time being at least, a batch distillation would have to be specified.

Lastly, the question as to whether chemical and/or physical treatments should be stipulated for the various distillate fractions was considered, but here again it was felt that, as the distillation fractions specified were not chosen to represent any particular product, there could be no point in stipulating the treatments to which such fractions should be subjected.

REPORT OF SUB-COMMITTEE NO. 3—LIQUEFIED PETROLEUM GASES, GASOLINE, KEROSINE, AND LIGHT DISTILLATES.

At the end of 1942 the various Sub-Committees of the Institute of Petroleum Standardization Committee were re-constituted in order to bring and keep up to date the " Standard Methods for Testing Petroleum and its Products " issued by the Institute.

Sub-Committee No. 3 as then appointed consisted of nineteen members, and was charged with the responsibility of revising, and, if necessary, adding to, the standard test methods for Liquefied Petroleum Gases, Gasoline, Kerosine, and Light Distillates.

The present composition of the Sub-Committee and its panels is as follows :—

SUB-COMMITTEE 3.

E. B. Evans (*Chairman*) (Anglo-American Oil Co., Ltd.).
F. S. Aumonier (Government Laboratory).
L. J. Bellamy (Ministry of Supply).
E. R. H. Davies (alternate J. W. Armstrong) (Imperial Chemical Industries, Ltd.).
A. E. Dunstan (Anglo-Iranian Oil Co., Ltd.).

F. H. Garner (University of Birmingham).
T. K. Hanson (alternate R. Sefton) (Trinidad Leaseholds, Ltd.).
S. R. Hills (Asiatic Petroleum Co., Ltd.).
W. H. Hoffert (National Benzole Co., Ltd.).
C. D. Lawrence (alternate E. N. Dodd) (Admiralty).
J. Mason (Ministry of Aircraft Production).
G. R. Nixon (Burmah Oil Co., Ltd.).
A. Osborn (Esso European Laboratories).
D. S. Paul (War Office).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
T. M. Taylor (Shell Refining and Marketing Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
S. A. W. Thompson (alternate J. M. A. Court) (Ministry of Aircraft Production).
W. A. Woodrow (Anglo-American Oil Co., Ltd.).

Burning Test Panel.

S. R. Hills (*Chairman*) (Asiatic Petroleum Co., Ltd.)
D. J. Lewis (Anglo-Iranian Oil Co., Ltd.).
G. R. Nixon (Burmah Oil Co., Ltd.).
A. Osborn (Esso European Laboratories).
D. S. Paul (War Office).
W. A. Woodrow (Anglo-American Oil Co., Ltd.).

Colour Panel.

W. A. Woodrow (*Chairman*) (Anglo-American Oil Co., Ltd.).
E. R. H. Davies (alternate J. W. Armstrong) (Imperial Chemical Industries, Ltd.).
E. N. Dodd (Admiralty).
G. S. Fawcett (The Tintometer, Ltd.).
S. R. Hills (Asiatic Petroleum Co., Ltd.).
W. H. Hoffert (National Benzole Co., Ltd.).
A. R. Javes (Anglo-Iranian Oil Co., Ltd.).
G. R. Nixon (Burmah Oil Co., Ltd.).
A. Osborn (Esso European Laboratories).
R. Sefton (Trinidad Leaseholds, Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Gum Stability Panel.

W. H. Hoffert (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
E. R. H. Davies (Imperial Chemical Industries, Ltd.).
S. R. Hills (Asiatic Petroleum Co., Ltd.).
J. Mason (Ministry of Aircraft Production).
G. R. Nixon (Burmah Oil Co., Ltd.).
A. Osborn (Esso European Laboratories).
R. Sefton (Trinidad Leaseholds, Ltd.).
T. M. Taylor (Shell Refining and Marketing Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
W. A. Woodrow (Anglo-American Oil Co., Ltd.).

Sulphur Panel.

W. H. Thomas (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
J. W. Armstrong (Imperial Chemical Industries, Ltd.).
G. Claxton (National Benzole Co., Ltd.).
A. R. Javes (Anglo-Iranian Oil Co., Ltd.).
R. Sefton (Trinidad Leaseholds, Ltd.).
T. M. Taylor (Shell Refining and Marketing Co., Ltd.).
W. A. Woodrow (Anglo-American Oil Co., Ltd.).

Liquefied Gases Panel.

W. H. Thomas (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
J. W. Armstrong (Imperial Chemical Industries, Ltd.).
N. Aston (Agwi Petroleum Corporation, Ltd.).
J. H. D. Hooper (Anglo-Iranian Oil Co., Ltd.).
N. E. Jones (Trimpell, Ltd.).

From January to July 1943 Sub-Committee No. 3 has met on five occasions. A number of test methods have been dealt with by the full

Sub-Committee, but it has been found convenient to appoint a number of Panels to consider certain tests. This has been the case either when a considerable amount of experimental work has been necessary, or when the tests have been of a very specialized character. The work of the various Panels has been greatly helped by the co-option of ten additional members having specialized knowledge of the subjects under discussion.

The Panels, five in number, and the subjects with which they are concerned are as follows :—

BURNING TEST PANEL.

The present methods for evaluation of the burning properties of kerosines were revised in 1940. It has been felt, however, that some improvement could be made in the method of char estimation, and considerable work has been carried out on this subject. This work is still in progress, and no change can be recommended for the moment, but it is hoped that a better method than the present hand-scraping procedure for char removal will be available before very long.

COLOUR PANEL.

This Panel is concerned with the measurement of colour, chiefly of the light petroleum products. The two methods now standardized, using the Lovibond Tintometer and the Saybolt Chromometer, have been examined, in co-operative work by a number of laboratories, for reproducibility of results. A correlation between the results of measurements by the two instruments has been worked out. This provides a conversion between I.P.-Lovibond numbers and Saybolt colour shades. Such a conversion can, of course, be only approximate and appreciable divergencies from the curve may sometimes occur, particularly with the darker-coloured products. This is a consequence of the methods involving comparison of the colours of products with those of arbitrary colour glasses, which cannot in all cases match precisely the tint of the sample being examined. It is felt, however, that a curve of this type should be useful for general purposes, and details have been published in the *Journal* of the Institute (*J. Inst. Petrol.*, Dec. 1943, **29** (240), 353).

Another problem which is engaging the attention of the Colour Panel is that of colour measurement in terms of International (I.C.I. or C.I.E.) Units.

GUM STABILITY PANEL.

The estimation of gum and similar residues in motor fuels, kerosines, tractor fuels, etc., has been the subject of a great deal of work, and a large number of methods are in use in different countries, both for the estimation of existent gum, and also for measuring the stability of motor fuels to storage and oxidising conditions.

Some modifications to " Standard Methods " have been proposed. The glass flask for Gum (Potential) in Motor Fuel (I.P. 39/42 (T)) appears no longer to be used, and will disappear from future editions of " Standard Methods." Some form of bomb-oxidation method is generally favoured for potential gum estimation, and also as a means of determining the stability of leaded fuels. Method I.P. 40/42 (T) was identical with the current A.S.T.M. Method (D.525–42T) for oxidation stability. It has been found, however, that some difficulty arises with the interpretation of the "break-point" as specified by the A.S.T.M. All fuels do not show the required rate of pressure drop. It is accordingly proposed to specify the break-point as "that point at which the pressure has fallen exactly 2-lbs./sq. in. below its maximum steady value." For most fuels the result would agree with the result by the A.S.T.M. method within experimental error; and, moreover, the definition is capable of application to all fuels which show a susceptibility to oxidation.

A.S.T.M. Method D.381–42 describes the estimation of gum in gasoline by evaporation in a current of hot air. This very useful method, with slight modification, can be applied to the estimation of gum and other residues in kerosines and tractor fuels. A slightly modified method of this type is being proposed for inclusion in "Standard Methods."

Sulphur Panel.

Among the tests considered by this Panel, are the well-known Doctor Test, the estimation of mercaptans, the estimation of corrosion by sulphur compounds, and the estimation of total sulphur in all classes of product from liquefied gases to kerosines.

The Panel is one of those most recently formed by Sub-Committee No. 3, but it has already given consideration to a number of problems, and, it is hoped, will shortly be in a position to make definite recommendations.

The qualitative description of copper strips in the usual corrosion tests, and the correlation of the appearance of the strips with the corrosive properties of fuels have always been a matter of some difficulty, and the Panel is investigating a proposed method to overcome the difficulty. Another subject under examination is the quantitative estimation of mercaptans by an electrometric titration method. A description of the method proposed has been published by two members of the Sub-Committee in *J. Inst. Petrol.*, Nov. 1943, **29** (239), 323.

Moderate amounts of sulphur compounds in unleaded motor fuels are of no great importance. In aviation fuels and leaded fuels, however, even very small amounts of sulphur may be very harmful and it is in consequence necessary to have means of estimating with accuracy these low proportions of sulphur (0·01% and less) as well as the larger amounts (0·1% or so). This problem also is receiving attention.

Liquefied Gases Panel.

The Standardization Committee has not previously concerned itself with the analysis of hydrocarbon gases and liquefied gases. The subject is of obvious importance in refinery control, and also in connection with the marketing of liquefied gases, such as propane and butane for domestic and industrial purposes.

A recently formed Panel of Sub-Committee No. 3 is concerned with analytical methods of this kind. Considerable progress has already been made in the examination of available methods, and it is hoped that before long "Standard Methods" may contain details of recommended methods for this type of work.

OTHER METHODS CONSIDERED BY SUB-COMMITTEE.

A number of other methods have also been considered by the Sub-Committee, and minor revisions or extensions made to some of the existing methods—*e.g.*, Aniline Point (I.P. 2/42), Aromatic Content (I.P. 3/42), Cold Test (I.P. 16/42), Flash Point by Abel Method (I.P. 33/42).

The method for Vapour Pressure (I.P. 69/42) has been further modified to make it suitable for use with motor fuels containing alcohol or other water-soluble constituents which would separate with the amount of water left in the bomb after purging by the usual procedure.

A method for Water Tolerance of Motor Fuels containing water-soluble constituents, such as alcohols or ketones, has been standardized. Methods for this determination have been in use for a number of years, and it was felt that a recommended procedure should be included in "Standard Methods."

A related problem is that of the tendency of fuel filters to choke at low temperatures, due to separation of ice particles from aviation fuels which have a slight solubility for water at normal temperatures. A method for evaluating this tendency has been discussed and a paper by a member of the Sub-Committee describing the method has been published in the *J. Inst. Petrol.*, Nov. 1943, 29 (239), 329.

The foregoing notes are intended to give a brief summary of the work carried out by Sub-Committee No. 3 since January 1943, together with an indication of the lines on which further work is proceeding. The whole range of tests on the products concerned will be kept constantly under review, and from time to time tests of wide application, after careful examination in detail, will be recommended for inclusion in "Standard Methods."

REPORT OF SUB-COMMITTEE NO. 4—GAS, DIESEL AND FUEL OIL.

The personnel of Sub-Committee No. 4 and its three panels are as follows :—

SUB-COMMITTEE 4.

A. R. Stark (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
W. E. J. Broom (Esso European Laboratories).
G. H. Brown (Admiralty).
J. S. Jackson (Asiatic Petroleum Co., Ltd.).
F. H. Jones (War Office).
C. D. Lawrence (Admiralty).
J. Parrish (Shell Refining and Marketing Co., Ltd.).
S. R. Pethrick (Royal Aircraft Establishment).
G. H. Smith (Scottish Oils, Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
A. T. Wilford (London Passenger Transport Board).
W. Woodrow (Anglo-American Oil Co., Ltd.).

Diesel Index-Cetane Number Correlation Panel.

J. Parrish (*Chairman*) (Shell Refining and Marketing Co., Ltd.).
W. E. J. Broom (Esso European Laboratories).
G. H. Smith (Scottish Oils, Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
A. T. Wilford (London Passenger Transport Board).

Asphaltenes in Crude Oil Panel.

J. Parrish (*Chairman*) (Shell Refining and Marketing Co., Ltd.).
B. C. Allibone (Burmah Oil Co., Ltd.).
L. O. Maskell (Silvertown Lubricants, Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
W. Woodrow (Anglo-American Oil Co., Ltd.).

Stability of Fuel Oils Panel.

W. E. J. Broom (*Chairman*) (Esso European Laboratories).
J. Parrish (Shell Refining and Marketing Co., Ltd.).
R. G. Sefton (Trinidad Leaseholds, Ltd.).
G. H. Smith (Scottish Oils, Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
A. T. Wilford (London Passenger Transport Board).

Only one new test, " The Low Temperature Filtration Test of Gas Oils, etc.", I.P. 85/44, has been proposed for the 1944 edition of " Standard Methods."

DIESEL INDEX-CETANE NUMBER CORRELATION PANEL.

The wording of the introduction of Diesel Index I.P. 21/42 was considered to be unsatisfactory and the Sub-Committee felt that much more than a mere clarification of the scope of the test was required, since, to be really useful, the diesel index should be directly correlatable with actual determined cetane number. On the samples of marketed high-speed diesel fuels examined it was found that the I.P. diesel index in extreme cases differed from the determined cetane number by as much as 9 cetane numbers.

A survey was therefore made of the existing methods for determination of ignition quality of diesel fuels, but no recommendation could be made of an alternative method, since the correlation with cetane number was in no case completely satisfactory. The panel was therefore reluctantly compelled to limit itself, as far as the 1944 Edition of " Standard Methods " was concerned, to making an alteration to the text of the existing method, pointing out that direct correlation between diesel index and cetane number is not to be expected. Work on this subject has not, however, been completely dropped, but is continuing. Should it be found that a correlation such as the above is not possible, then the Committee will publish the results of their investigation in full in the *Journal.*

ASPHALTENES IN CRUDE OIL PANEL.

It was pointed out by Sub-Committee No. 2 that there were certain waxy and asphaltic crude residues, in which the asphaltenes as determined by the existing method I.P. 6/42 were much in excess of the true value, due to the fact that high-melting-point waxes remained included with the precipitated asphaltenes. A case was reported in which approximately 90 per cent. of the precipitate was wax of setting point 195° F., which was only very slightly soluble in ethyl alcohol.

A panel was therefore appointed to consider this point, the approach to a solution being sought in the first place by the use of solvents alternative to ethyl alcohol, retaining the other conditions of the test exactly as laid down. The following solvents were tried: amyl alcohol, butyl alcohol, *iso*propyl alcohol, *cyclo*hexanol, butanone, methyl ethyl ketone, *cyclo*hexanone, and I.P. spirit. In all cases washing was to be carried out by the refluxing procedure.

Correlation of results between the three participating laboratories was not satisfactory, and there was surprisingly little difference in the order of results obtained by the various solvents. It was felt that since the results obtained by each laboratory were self-consistent, there was a possibility that standardization would have to be taken back a farther step to include the I.P. precipitation spirit.

As regards the small differences obtained between the wax solvents, there is always the possibility that these differences are by no means straightforward, since in some cases asphaltenes may be dissolved out along with the waxes present. In order to elucidate this point, an examination is now to be made of the materials which have been dissolved out by the solvents.

It is anticipated that several months' work lies in front of this panel before a solution to the problem will be obtained.

Stability of Fuel Oils Panel.

When No. 4 Sub-Committee was reconstituted, the Main Standardization Committee requested that work should be undertaken to evolve a method of determination of stability of furnace oils.

After consideration, the Sub-Committee came to the conclusion that this problem could most properly be considered as consisting of three parts :

(*a*) Stability during storage.
(*b*) Dilution stability such as would occur on blending either two furnace oils or cutting back a furnace oil with a distillate oil.
(*c*) Stability to preheat treatment immediately before use.

The three methods of test which had found most general acceptance among those available to the Sub-Committee were chosen for investigation.

In case (*a*) tests which used a dilution method were ruled out completely because of the possibility of either precipitation or resolution of constituents of the material under investigation. Storage at a temperature of 100° F. was chosen in the first case, and precipitated material was measured by the " Hot Filtration Test," which consists of filtering the undiluted sample from the storage test through a steam jacketed filter funnel of the Gooch type under a pressure of approximately 10 inches of mercury. This work is proceeding satisfactorily.

In case (*b*) the method chosen is a modification of the Oliensis spot test, in which the sample under examination is agitated with mixtures of xylene and a paraffinic solvent, the percentage of xylene being progressively increased until the sample shows no nuclear ring on being spotted on filter paper.

Up to the present this method has not been quite satisfactorily worked out, and minor modifications to procedure are under investigation. The indications at present are that the basic method is sound enough to warrant further investigation.

In case (*c*) the method chosen was the Heater Test evolved by the American Naval Boiler and Turbine Laboratory, which consists in circulating the sample, heated to a temperature equivalent to a specified viscosity and observing the quantity and nature of the deposit formed on the heater tube. This test has been shown to give consistent and repeatable results but the Sub-Committee feels that it cannot recommend its adoption at present, since the classification adopted by the U.S. authorities is unduly restrictive for normal commercial usage. An attempt will be made to evolve a new and more generally acceptable classification based on commercial experience.

It is interesting to note in this connection that on blending two fuels of equal degree of stability as measured by this test a less stable fuel may result. This finding is in agreement with practical experience in some cases.

The Sub-Committee has felt itself so limited in opportunity to perform experimental work due to prevailing conditions that it decided not to embark on further projects until those mentioned above were drawing to a conclusion. It has in mind, however, that there are necessities for several new tests and improvements to existing ones. Among the former the Committee has in mind, when time permits, work on the emulsifying tendencies of marine furnace oils, and the determinations of aniline and cloud points of oils which are too opaque to permit of the present standard methods to be used.

REPORT OF SUB-COMMITTEE NO. 5—ENGINE TESTS.

The personnel of this Sub-Committee and of its panels is as follows :—

SUB-COMMITTEE 5.

F. H. Garner (*Chairman*) (University of Birmingham).
C. H. Barton (Asiatic Petroleum Co., Ltd.).
E. L. Bass (Ministry of Aircraft Production).
E. A. Evans (C. C. Wakefield & Co., Ltd.).
E. B. Evans (Anglo-American Oil Co., Ltd.).
E. Giffen (Institution of Automobile Engineers).
L. J. le Mesurier (Admiralty).
J. A. Oriel (Asiatic Petroleum Co., Ltd.).
D. S. Paul (War Office).
K. E. W. Ridler (Ministry of Aircraft Production).
R. Stansfield (Anglo-Iranian Oil Co., Ltd.).
A. T. Wilford (London Passenger Transport Board).
C. G. Williams (Thornton Aero Engine Research Laboratories).
C. S. Windebank (Anglo-American Oil Co., Ltd.).
J. G. Withers (Anglo-Iranian Oil Co., Ltd.).

Knock Rating of Aviation Fuel Panel.

K. E. W. Ridler (*Chairman*) (Ministry of Aircraft Production).
E. R. H. Davies (Imperial Chemical Industries, Ltd.).
P. Draper (Asiatic Petroleum Co., Ltd.).
T. K. Hanson (Trinidad Leaseholds, Ltd.).
J. Mason (Ministry of Aircraft Production).
C. H. Sprake (Esso European Laboratories).
R. Stansfield (Anglo-Iranian Oil Co., Ltd.).
S. A. W. Thompson (Royal Aircraft Establishment).
C. G. Williams (Thornton Aero Engine Research Laboratory).

Knock Rating of Motor Fuel Panel.

R. Stansfield (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
B. C. Allibone (Burmah Oil Co., Ltd.).
N. L. Anfilogoff (Texas Oil Co., Ltd.).
L. W. Barnard (National Benzole Co., Ltd.).
C. H. Barton (Asiatic Petroleum Co., Ltd.).
P. Draper (Asiatic Petroleum Co., Ltd.).
H. Fossett (British Ethyl Corporation).
E. Giffen (Institution of Automobile Engineers).
T. K. Hanson (Trinidad Leaseholds, Ltd.).
J. H. Pitchford (Ricardo & Co., Ltd.).
C. Sprake (Esso European Laboratories).

Ignition Quality of Diesel Fuel.

R. Stansfield (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
K. T. Arter (Esso European Laboratories).
S. J. Davies (King's College. London).
C. B. Dicksee (British Standards Institution).
P. Draper (Asiatic Petroleum Co., Ltd.).
E. Giffen (Institution of Automobile Engineers).
L. J. le Mesurier (Admiralty).
D. S. Paul (War Office).
A. T. Wilford (London Passenger Transport Board).
J. G. Withers (Anglo-Iranian Oil Co., Ltd.).

Mechanical Tests of Lubricants Panel.

C. G. Williams (*Chairman*) (Thornton Aero Engine Research Laboratory).
K. T. Arter (Esso European Laboratories).
C. H. Barton (Asiatic Petroleum Co., Ltd.).
D. Clayton (Ministry of Supply).
E. A. Evans (C. C. Wakefield & Co., Ltd.).
E. Giffen (Institution of Automobile Engineers).
L. J. le Mesurier (Admiralty).
A. R. Ogston (International Aviation Association).
D. S. Paul (War Office).
J. H. Pitchford (Ricardo & Co., Ltd.).
V. H. Rumble (Anglo-Iranian Oil Co., Ltd.)
G. H. Simmons (C. C. Wakefield & Co., Ltd.).
R. Stansfield (Anglo-Iranian Oil Co., Ltd.).
S. A. W. Thompson (Royal Aircraft Establishment).
H. L. West (Esso European Laboratories).
A. T. Wilford (London Passenger Transport Board).

AVIATION FUEL PANEL.

The Aviation Fuel Panel is maintaining a close collaboration with the work being done in the U.S.A. on various methods of rating aviation fuels.

A note has been published in the *Journal* referring to the calibration of C.F.R. reference fuels F.4 and C.12 with the addition of 4 mls. T.E.L. per Imperial Gallon, both by the motor method and the 17° motor method.

MOTOR FUEL PANEL.

The Motor Fuel Panel has not been very active during the past year, but has made a slight modification in the method of test I.P. 44/42 (T). This modification involves the removal of the throttle plate in the carburetter of the C.F.R. engine in order to bring the I.P. method into line with the A.S.T.M. (D-2) method. A similar modification has been accepted by the Aviation Fuel Panel for method I.P. 42/42 (T).

Ignition Quality of Diesel Fuel Panel.

The Ignition Quality of Diesel Fuel Panel has investigated the relation between cetane numbers of a number of diesel fuels, both by the I.P. method 41/42 (T) and the corresponding A.S.T.M. method D.613/41T, which uses the C.F.R. Diesel Fuel Testing Unit. It was found that the correlation was satisfactory, bearing in mind the reproducibility specified in the I.P. method. A modification of the wording has been made in I.P. 41/42 (T) to call attention to this agreement in ratings by the two methods.

Mechanical Tests of Lubricants Panel.

The various methods of test for special E.P. lubricants have been discussed, including the use of the S.A.E. machine, the Four Ball machine, the Cornell machine with the modified method of test used by the Ford Motor Company, and the Almen method. A report has been prepared by Mr. H. L. West on the testing of E.P. lubricants which will be presented at a meeting of the Institute early in 1944, and it is felt that the discussion of this paper should be helpful as an indication of the necessity for such tests and of the type of tests desirable.

The A.S.T.M. adopted the 35-hour Chevrolet test as a proposed method of test for oxidation characteristics of heavy-duty crankcase oil in 1942, and the Panel has considered both this and other tests on the Caterpillar engines, in view of the adoption of such engine test methods in the specification for crankcase oils used in the Services. Mr. C. H. Barton is preparing a paper on these methods of test which will be presented at a meeting of the Institute.

Tests on Turbine oil, such as the U.S. Navy work factor test, have also been discussed in view of their use in some specifications. No decision has, however, yet been reached by the Panel on the adoption of additional methods of test to those included in " Standard Methods " of Test for 1942.

REPORT OF SUB-COMMITTEE NO. 6—LUBRICANTS.

The Sub-Committee obtained the assistance of four panels which were styled the Miscellaneous Tests Panel, the Oxidation Panel, the Viscosity Panel and the Grease Panel.

The members of the Sub-Committee and Panels are as follows :—

Sub-Committee 6.

E. A. Evans (*Chairman*) (C. C. Wakefield & Co., Ltd.).
N. L. Anfilogoff (Texas Oil Co., Ltd.).
S. C. Atkinson (Ministry of Supply).
S. J. M. Auld (Vacuum Oil Co., Ltd.).
C. H. Barton (Asiatic Petroleum Co., Ltd.).
W. E. J. Broom (Esso European Laboratories).
D. Clayton (Ministry of Supply).
C. D. Lawrence (Admiralty).
L. O. Maskell (Silvertown Lubricants, Ltd.).
J. Mason (Ministry of Aircraft Production).
D. S. Paul (alternate H. F. Jones) (War Office).
E. R. Pethrick (Royal Aircraft Establishment).
E. R. Redgrove (Snowdon, Sons & Co., Ltd.).

K. E. W. Ridler (Ministry of Aircraft Production).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
R. D. Streeton (Anglo-American Oil Co., Ltd.).
J. L. Taylor (Petroleum Board).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Grease Panel.

E. A. Evans (*Chairman*) (C. C. Wakefield & Co., Ltd.).
S. C. Atkinson (Ministry of Supply).
J. A. Bell (Shell Refining and Marketing Co., Ltd.).
H. W. Chetwin (Chetwin, Newark & Co., Ltd.).
D. Clayton (alternate Dr. M. Thompson) (Ministry of Supply).
E. G. Ellis (Vacuum Oil Co., Ltd.).
F. J. S. Hall (Horton Manufacturing Co., Ltd.).
J. Hill (London and North Eastern Railway).
C. D. Lawrence (Admiralty).
L. O. Maskell (Silvertown Lubricants).
W. Pethrick (Royal Aircraft Establishment).
M. W. Webber (Hill and Jackson, Ltd.).
H. L. West (Esso European Laboratories).

Grease Panel Working Group.

H. W. Chetwin (*Chairman*) (Chetwin, Newark & Co., Ltd.).
S. C. Atkinson (alternates L. J. Bellamy and H. Hollis) (Ministry of Supply).
J. A. Bell (Shell Refining and Marketing Co., Ltd.).
E. G. Ellis (Vacuum Oil Co., Ltd.).
F. J. S. Hall (Horton Manufacturing Co., Ltd.).
G. H. J. Simmons (C. C. Wakefield & Co., Ltd.).
H. L. West (Esso European Laboratories).

Viscosity Panel.

G. Barr (*Chairman*) (National Physical Laboratory).
N. L. Anfilogoff (Texas Oil Co., Ltd.).
W. E. J. Broom (Esso European Laboratories).
J. Cantor (Shell Refining and Marketing Co., Ltd.).
J. C. Cragg (C. C. Wakefield & Co., Ltd.).
E. B. Evans (Anglo-American Oil Co., Ltd.).
F. H. Garner (University of Birmingham).
J. L. Taylor (Petroleum Board).

Viscosity of Working Group.

G. Barr (*Chairman*) (National Physical Laboratory).
J. C. Cragg (C. C. Wakefield & Co., Ltd.).
E. G. Ellis (Vacuum Oil Co., Ltd.).
J. H. Joyce (Ministry of Aircraft Production).
M. M. Lapitzky (Shell Refining and Marketing Co., Ltd.).
A. H. Nissan (University of Birmingham).
L. Steiner.
R. D. Streeton (Anglo-American Oil Co., Ltd.).
H. L. West (Esso European Laboratories).

Oxidation Panel.

R. D. Streeton (*Chairman*) (Anglo-American Oil Co., Ltd.).
S. C. Atkinson (alternate H. Hollis) (Ministry of Supply).
D. Clayton (alternate Dr. M. Thompson and G. Kimmer) (Ministry of Supply).
E. G. Ellis (Vacuum Oil Co., Ltd.).
N. F. Hitchcock (C. C. Wakefield & Co., Ltd.).
D. M. Japes (Shell Refining & Marketing Co., Ltd.).
L. O. Maskell (Silvertown Lubricants, Ltd.).
J. Mason (alternate J. H. Joyce) (Ministry of Aircraft Production).
H. L. West (Esso European Laboratories).

Miscellaneous Tests Panel.

L. O. Maskell (*Chairman*) (Silvertown Lubricants).
N. L. Anfilogoff (Texas Oil Co., Ltd.).
S. C. Atkinson (alternate F. Bellamy) (Ministry of Supply).
J. C. Cragg (C. C. Wakefield & Co., Ltd.).

R. W. Dawe (co-opted) (Great Western Railway).
E. G. Ellis (Vacuum Oil Co., Ltd.).
C. D. Lawrence (alternates E. N. Dodd and D. Wyllie) (Admiralty).
J. Mason (alternate J. H. Joyce) (Ministry of Aircraft Production).
D. S. Paul (alternate H. F. Jones) (War Office).
W. Pohl (Shell Refining and Marketing Co., Ltd.).
R. D. Streeton (Anglo-American Oil Co., Ltd.).
J. L. Taylor (Petroleum Board).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
A. T. Wilford (London Passenger Transport Board).

The Miscellaneous Tests Panel was not able to give detailed consideration to all the matters which came within its terms of reference. Therefore, some tests have been re-adopted without reconsideration. The Viscosity Panel has been faced with the greatest difficulty, and until its Working Group has proceeded further with its present investigation it is not possible to give a carefully considered opinion upon the precision requirements introduced in the 1942 edition under the heading of " Kinematic Viscosity." The Grease Panel has considered greases which may simultaneously be both acid and alkaline. It is now giving consideration to stability.

Grease Panel.

The Grease Panel has given attention to the outstanding difficulty occasioned by the simultaneous presence of free alkali and free acid in grease. A definite procedure has now been introduced for the first time to meet this difficulty. The Panel has adopted B.S.I. Drop Point Apparatus, and, to meet the special demands of the Petroleum Industry, has recommended the use of a metal cup instead of glass. The glass cups are very difficult to make to the dimensions which are felt to be necessary.

A working group has been formed for this panel.

Viscosity Panel.

The Viscosity Panel has been faced with a great difficulty. It wishes to keep a parallel course with the A.S.T.M., but it realizes that the anticipated precision given in the 1942 edition will be very difficult to attain during the War period. It has therefore come to the conclusion that as the word " accuracy " is defined in Standard Methods, 0·3 per cent. means a departure of ±0·3 per cent. from the true value.

In the 1944 edition, a tolerance of ±0·3 per cent. will be allowed for the finished calibrated viscometer and a further ±0·3 per cent. tolerance permitted for the actual laboratory measurement on a sample of oil. This means a possible departure of ±0·6 per cent. from the *true value*. The object for this degree of accuracy is to meet the growing demand for a more accurate expression of viscosity index. When viscosity index is demanded, a much closer attention must be given to the measurement of viscosity. The Viscosity Panel has appointed a Working Group to investigate certain details which are, at the moment, somewhat obscure. The Panel has abandoned the use of 40 per cent. sucrose solution as a primary standard. For the time being it is intended to retain water and 60 per cent. sucrose solution as primary standards, but it realizes that the subject of primary standards needs careful consideration. In view of the present limitations, the only capillary viscometers which shall be permitted are the Suspended Level, Fenske and B.S.I.

OXIDATION PANEL.

The Oxidation Panel has reviewed the existing oxidation tests, and has given consideration to numerous other oxidation tests, including those detailed by the A.S.T.M.

The Sub-Committee is very grateful to its corresponding Committee of the A.S.T.M. whose co-operation augers well for the future.

The Oxidation Panel has made several adjustments in the tests which it has reviewed. Probably they will be considered to be minor adjustments. It is not unmindful of the difficulty of removing the solid from the flask in the Sludging Test, but before making any proposal it is seeking the co-operation of B.E.I.R.A. The necessary adjustment has been made in the dimensions of the apparatus used in the Ramsbottom Carbon Residue Test.

MISCELLANEOUS TESTS PANEL.

The Miscellaneous Tests Panel has given careful attention to Alkali Blue for use as the indicator for acidity estimation. By sensitizing this indicator it can be made to yield extremely satisfactory results and has a wider application than phenolphthalein.

Clearly it would not be good policy to abandon phenolphthalein after so many years of standardized service until there has been sufficient time for more experience with sensitized Alkali Blue. The Panel has realized that the expression "Preliminary Transient Sparking" in the di-electric strength test gives rise to some ambiguity. Consequently communication has been made with B.E.I.R.A., and it is now hoped that a satisfactory conclusion has been reached. Now that the A.S.T.M. has included the Ramsbottom Carbon Residue Test in its Standard Methods, the Panel feels that the Conradson Carbon Residue Test should be abandoned for Lubricating Oils. In fact, it recommends that the Ramsbottom Method should receive preferential consideration whenever a Carbon Residue Test is required.

Both the Miscellaneous Tests Panel and the Oxidation Panel have found it necessary to place safeguards on all tests which might be affected by the presence of chemical additions. This is a very necessary step to take now that chemical additives are being used on a commercial scale.

REPORT OF SUB-COMMITTEE NO. 7—ASPHALTIC BITUMEN.

The following Sub-Committee and Panels have been set up to deal with asphaltic bitumen methods :—

SUB-COMMITTEE 7.

J. S. Jackson (*Chairman*) (Asiatic Petroleum Co., Ltd.).
D. C. Broome (Limmer and Trinidad Lake Asphalt Co., Ltd.).
I. Cameron (British Bitumen Emulsions, Ltd.).
L. G. Gabriel (Colas Products, Ltd.).
C. F. Jackson (Shell Refining and Marketing Co., Ltd.).
A. W. Jarman (Petroleum Board).
H. S. Keep (alternate H. F. Gillbe) (Ministry of War Transport).
A. R. Lee (Road Research Laboratory).
A. Osborn (Esso European Laboratories).
P. E. Spielman.

A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
E. Vannan (Neuchatel Asphalte Co., Ltd.).
D. M. Wilson (D. Anderson & Son, Ltd.).
D. A. Yonge (Shell Refining and Marketing Co., Ltd.).

Bituminous Emulsions Panel.

I. Cameron (*Chairman*) (British Bitumen Emulsions, Ltd.).
L. G. Gabriel (Colas Products, Ltd.).
H. Gardner (Shell Refining and Marketing Co., Ltd.).
A. R. Lee (Road Research Laboratory).
A. Osborn (Esso European Laboratories).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).
D. M. Wilson (D. Anderson & Sons, Ltd.).

Soil Stabilization Panel.

L. G. Gabriel (*Chairman*) (Colas Products, Ltd.).
J. F. T. Blott (Shell Refining and Marketing Co., Ltd.).
I. Cameron (alternate A. E. Lawrence) (British Bitumen Emulsions, Ltd.).
R. Glossop (John Mowlem & Co., Ltd.).
H. S. Keep (alternate H. F. Gillbe) (Ministry of War Transport).
A. D. H. Markwick (alternates K. E. Clare and L. Maddison) (Road Research Laboratory).
A. Osborn (Esso European Laboratories).
R. K. Schofield (Agricultural Research Station, Rothamsted).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).

Apart from the normal consideration of existing methods, and the adoption of new asphaltic bitumen methods, two important decisions were taken by the main Standardization Committee. In the first place, it was decided that the next edition of "Standard Methods" should include descriptions of as many as possible of the methods available for the testing of bituminous emulsions. Secondly it was decided that this Committee should undertake a survey of the various methods already in use in connection with soil stabilization processes involving the use of petroleum products.

BITUMINOUS EMULSIONS PANEL.

This panel has already made good progress and the following emulsion methods will appear in the next edition of "Standard Methods":—

1. Water Content.
2. Residue on sieving.
3. Coagulation of Binder.
4. Stability in Bulk.

The Engler viscometer has also been adopted as the standard instrument for the determination of the viscosity of emulsions, but time will not permit of the preparation of a full description of this method for publication in the next edition. The whole of the above methods are broadly based on the existing methods published in B.S.S.434.

The panel will continue the consideration of the following methods which all call for further discussion or investigation :—

1. Coagulation at low temperature.
2. Lability Demulsification and Cement Testing.
3. Sedimentation.
4. Proportion of emulsifying agent.

5. Alkalinity.
6. Miscibility with water.
7. Freezing Test.
8. Particle size.

The B.S.–A.R.P. tests will also be considered with a view to selecting those of permanent value.

SOIL STABILIZATION PANEL.

Much good work has already been accomplished by this Panel. In the first place, existing schedules of test were reviewed and the corresponding tests set down for discussion, with the object of eliminating minor variations in operation where these exist. In this way it is hoped to arrive at standardized versions which can be used for future work on this very complex problem of soil stabilization, thus providing the maximum interchangeability of data between the various laboratories working in this field. The schedules of test considered included the following :—

1. Tests sponsored in almost identical form by the American Society for Testing Materials and the American Society of State Highway Officials.
2. Tests recommended by the International Society for Soil Science.
3. Tests which appeared in the general discussion at the Hague Road Congress in 1938.
4. Tests in use in the following laboratories :—
    a. Road Research, Harmondsworth.
    b. British Bitumen Emulsions, Ltd.
    c. Shell Refining and Marketing Co., Ltd.

The tests chosen for the first discussions were those on the performance of a stabilized mix. These have now been considered in detail, and in the near future it is hoped that they will be satisfactorily co-ordinated, and consideration will then be given to the ancillary tests necessary to classify the soils and other materials used in the processes under review.

In the discussions which have taken place it has become apparent that a simple smoothing out of detail variations between tests will not be possible, and certain tests which do not fit in completely with the scheme will have to be included because of their general interest. It is therefore considered necessary that the schedules of test which will ultimately be put forward by the panel shall be accompanied by a fairly extensive explanatory report setting out the reasons for the course taken in arranging the tests. It is thought that this explanatory report will be of great value in summarizing the position of soil stabilization from the aspect of the measurement of results obtained. In view of this fact, it is not deemed advisable to submit the tests already considered for inclusion in the next edition of "Standard Methods." The report of this panel will be published as a separate pamphlet giving a survey of soil stabilization methods. It is hoped in this way to ensure a wider discussion of these methods, and further experience of their use before actual standardization is attempted.

The British Standards Institution has also set up a committee to study the general question of soil stabilization. Contact has already been made with this committee and the closest co-operation can be confidently anticipated.

Descriptions of the following tests have already been prepared :—

1. The cone penetration resistance of a compacted stabilized soil.
2. Capillary water absorption test.
3. Compression test.
4. Rapid water absorption test by immersion.

As regards the normal work of the main sub-Committee, only two major changes have been recommended. The Fraass Breaking Point Test has been described, and will be included in the next edition. I.P. Method 8/42 Asphaltene (soft asphalt) is no longer in common use, and will therefore be withdrawn. The minor alterations to other standardization methods to bring them up-to-date will be dealt with in detail in " Standard Methods." As regards the future work of the Sub-Committee, a sulphonation test for the examination of tar bitumen mixtures is under investigation by a group of laboratories, which have already reported promising results. The possibility of evolving a satisfactory method for estimating the paraffin-wax content of asphaltic bitumen is also under consideration. The desirability of describing a method for the recovery of asphaltic bitumen from coated aggregates, etc., will also be considered.

The Sub-Committee will, at all times, welcome criticisms of existing methods and suggestions for improvements or new methods.

REPORT OF SUB-COMMITTEE 8—PETROLEUM WAXES.

The personnel of Sub-Committee 8 is as follows :—

SUB-COMMITTEE 8.

W. J. Wilson (*Chairman*) (Burmah Oil Co., Ltd.).
J. Cantor (Shell Refining and Marketing Co., Ltd.).
C. G. Gray (Asiatic Petroleum Co., Ltd.).
W. G. Leach (British Waxed Wrappings, Ltd.).
S. T. Minchin (Burmah Oil Co., Ltd.).
C. E. Mold (Price's Patent Candle Co., Ltd.).
W. B. Peutherer (alternate W. R. Guy) (Scottish Oils, Ltd.).
V. L. Shatwell (Chiswick Products, Ltd.).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
W. H. Thomas (alternate F. W. H. Mathers) (Anglo-Iranian Oil Co., Ltd.).
T. C. G. Thorpe (Petroleum Board).

Nomenclature Panel.

J. Cantor (*Chairman*) (Shell Refining and Marketing Co., Ltd.).
S. T. Minchin (Burmah Oil Co., Ltd.).
V. L. Shatwell (Chiswick Products, Ltd.).
T. C. G. Thorpe (Anglo-American Oil Co., Ltd.).

The scope of the work of this Sub-Committee is comparatively small, for although the petroleum waxes are products of considerable importance, accepted methods of test in connection with it are few. It is known, however, that certain test methods have been developed which have not yet been published, and the attention of the Sub-Committee will be directed to such methods as they become available.

During the past year the designation of the Sub-Committee has been changed from " Paraffin Wax " to " Petroleum Waxes." The broader title has become necessary because of the increasing commercial production and utilization of waxes which, while they are derived from petroleum, yet differ considerably from the product known as " Paraffin " or " Paraffin Wax."

" SETTING POINT " AND " CONGEALING POINT."

The " Setting Point " method of test is one which has, with occasional modifications, been a standard method for many years. The method was devised for paraffin waxes and scales only, but some time ago a modified procedure was incorporated in the text which was designed to make the method applicable also to other petroleum waxes. Actually the modification did not ensure a result being obtained from all types of petroleum waxes, and the Sub-Committee this year, in reconsidering the position, decided that the petroleum waxes other than paraffin wax require to be considered entirely separately from paraffin wax with regard to the determination of a temperature representing the change from the liquid to the solid phase, or vice versa. Certain existing standard methods, *e.g.*, A.S.T.M. D.127–30—Melting Point of Petrolatum and I.P. 31/42—Drop Point of Greases, Petrolatum and Asphaltic Bitumen, were possible bases for the formulation of the desired new standard method. Other proposals were considered, and ultimately, after some co-operative experimental work had been done, a new tentative standard method was adopted, termed the " Congealing Point " method. This simple method is an adaptation of a test which has had occasional use in a number of laboratories in the past.

COLOUR.

Some minor modifications have been made in the method (I.P. 17/42) for measurement of the colour of waxes. It is felt that the art of colour measurement, in relation to waxes and oils, requires further development, and further consideration will be given to this subject.

OIL CONTENT.

A method for determination of the oil content of wax (*i.e.*, that proportion of the product which exists in the liquid state at a specified temperature), reasonably simple and accurate, has long been the quest of many experimenters. While a few methods have been published and others have been employed in individual laboratories, none appears to have won general approval. It was inevitable that this subject should engage the attention of the Sub-Committee, especially as a newly published method had received the endorsement of A.S.T.M. The Sub-Committee did not feel able to recommend, at the present stage, the adoption of this or any other method. The subject continues under periodic review.

NOMENCLATURE PANEL.

In the course of discussions it became evident that the nomenclature of petroleum waxes and intermediate products was in a state of some confusion. The Sub-Committee was persuaded that an attempt ought to be made to deal with this difficult matter. A panel was constituted for this purpose, and its report was accepted by the Sub-Committee and has been published in the *Journal*.*

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* *J. Inst. Petrol.*, Dec. 1943, **29** (240), 361.

REPORT OF SUB-COMMITTEE NO. 9—DERIVED CHEMICALS.

Origin and Scope of Committee.

Towards the end of 1942 it was felt by the I.P. Standardization Committee that I.P. " Standard Methods " should include methods of analysing the various chemical products derived from petroleum now coming into widespread industrial use. A Committee was accordingly set up under the chairmanship of the writer, the decision as to the range of products to be covered being left to the Committee. The Committee and Panel membership was :—

Sub-Committee 9.

J. A. Oriel (*Chairman*) (Asiatic Petroleum Co., Ltd.).
L. J. Bellamy (Ministry of Supply).
E. J. Boorman (Government Laboratory).
W. E. J. Broom (Esso European Laboratories).
L. W. Chubb (Technical Products, Ltd.).
E. A. Coulson (Department of Scientific and Industrial Research).
C. L. Gilbert (Asiatic Petroleum Co., Ltd.).
E. M. W. Fawcett (Anglo-Iranian Oil Co., Ltd.).
D. Morten (Shell Refining and Marketing Co., Ltd.).
A. R. Stark (Anglo-Iranian Oil Co., Ltd.).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

Physical Tests Panel.

W. E. J. Broom (*Chairman*) (Esso European Laboratories).
E. J. Boorman (Government Laboratory).

Chemical Tests Panel.

W. H. Thomas (*Chairman*) (Anglo-Iranian Oil Co., Ltd.).
E. A. Coulson (Department of Scientific and Industrial Research).

Technological Tests Panel.

L. W. Chubb (*Chairman*) (Technical Products, Ltd.).
E. M. W. Fawcett (Anglo-Iranian Oil Co., Ltd.).

In view of the great variety of chemical products available from petroleum, some difficulty was found in defining the term " derived chemicals," but it was eventually agreed that the Committee should consider all marketed products produced from petroleum which were not intended to be used directly as fuel or lubricants, with the exception of petroleum products such as asphalt, special boiling-point spirits, and waxes. To begin with, only products marketed or produced in the U.K. were to be considered. A rough classification of products was suggested in terms of : (1) Pure Chemicals and (2) Other Materials. The former category was taken to include : (*a*) carbon and hydrocarbons, (*b*) oxygen-containing derivatives of hydrocarbons, (*c*) halogen- and nitrogen-containing derivatives of hydrocarbons and (*d*) sulphur-containing derivatives of hydrocarbons. The second category included : petroleum resins and extracts, petroleum acids, sulphonic acids, phenols, synthetic detergents, etc.

It was, however, finally decided to classify the tests under the headings : (*a*) Physical, (*b*) Chemical, and (*c*) Technological tests. Panels were then set up to consider the most suitable tests of each type, and as a result the following methods were standardized :—

(There are, of course, many tests applicable to these materials which are described for more general products. For example, it was not considered necessary to consider Specific Gravity, Boiling range, etc.)

(a) *Physical Tests.*—Mean molecular weight. Surface and Interfacial Tensions.

(b) *Chemical Tests.*—Naphthenic acids in soda neutralized oils, Iodine value, Peroxide value of ethers, Inorganic salts in petroleum detergents of the alkyl sulphate type, Alkalinity, Acetate content of solvents, Halogen content, Unsaponifiable matter in drying oils.

(c) *Technological Tests.*—Residual odour of lacquer solvents, Wetting power of wetting agents derived from petroleum, Drying time of Aromatic Petroleum Extracts.

Additions have also been made to the Union Colorimeter Test, to cover the testing of petroleum extracts, and to the distillation test, to cover the necessity for testing for peroxides before carrying out a distillation on ethers.

WORK IN HAND.

In addition to the above tests, an attempt has been made to standardize a suitable relative evaporation test for the examination of solvents to be used in the paint and lacquer industry. From contact with Paint Research Stations and industrial firms, it appears that no suitable well-recognized test is in existence. Those that are actually used are either simple rule-of-thumb tests or require complicated apparatus and are not suitable for routine work. As it is generally agreed that such a test is of value in assessing the behaviour of solvents, advice on the methods used in the U.S.A. was sought from the A.S.T.M., but so far the appropriate committee of that body is taking no steps to standardize a test, as they have not been asked to do so by their members. In the meantime a search is being made of the literature available on the subject, so that the significance of any method can be fully appreciated.

CONTACTS WITH OTHER COMMITTEES.

Contact is being maintained with the Methods Sub-Committee of the Extracts Pool Technical Panel, and a brief report on the progress of our work on this side has been sent to the Secretary of Committee D.2 of the A.S.T.M. Partly as a result of our contact with the A.S.T.M., the latter have decided to organize a new Committee which will deal with a limited selection of derived chemical products.

FUTURE WORK.

The Committee appreciates that only a relatively small start has been made with the methods which will eventually be required for the testing of these products, and will add to the number of methods as the need for them arises and suitable methods are worked out.

REPORT OF SUB-COMMITTEE NO. 10—APPARATUS.

The following Apparatus Sub-Committee has been set up to maintain uniformity throughout the various sub-committees in matters concerning apparatus and equipment.

Sub-Committee 10.

J. S. Jackson (*Chairman*) (Asiatic Petroleum Co., Ltd.).
J. E. C. Bailey (alternate I. C. P. Smith) (Scientific Instrument Manufacturers Association).
A. E. Calderara (British Lampblown Scientific Glassware Association).
J. C. Cragg (C. C. Wakefield & Co., Ltd.).
S. J. Davies (British Laboratory Ware Manufacturers Association).
J. A. Hall (National Physical Laboratory).
H. Hyams (Asiatic Petroleum Co., Ltd.).
M. M. Lapitzky (Shell Refining and Marketing Co., Ltd.).
J. Mason (Ministry of Aircraft Production).
A. Osborn (Esso European Laboratories).
W. H. Thomas (Anglo-Iranian Oil Co., Ltd.).

It will be seen that this Committee has been fortunate in securing the co-operation of the principal trade associations concerned, and there is every hope that all apparatus specified in "Standard Methods" will ultimately meet with the approval of both the user and the manufacturer. The present arrangement has the great advantage that the manufacturers have ample warning of impending changes, and are therefore in a favourable position to meet their customers' requirements without either inconvenience to the customer or loss to the supplier.

The Sub-Committee's first task was to reconsider the whole of the existing thermometer specifications. These have been extended to include a number of new thermometers, and a complete schedule of new war-time specifications has already been published in the *Journal*. In preparing this schedule special efforts were made to make the best possible use of the limited skilled labour and specialized materials available in war-time. It should be emphasized, however, that the effective co-operation of the manufacturers' representatives has ensured that the simplifications which have been effected have not resulted in any loss of accuracy or workmanship. In fact, it is confidently expected that the new thermometers will not only be easier to make, but actually more satisfactory in use, and the war-time schedule can obviously become the basis of normal peace-time production with the minimum amount of modification.

The hydrometer specifications have also been simplified very considerably, and a complete set of war-time specifications has been published.

Hydrometers constitute a special case presenting peculiar difficulties, and these war-time specifications call for some brief explanation. It was generally agreed that circumstances did not warrant any relaxation of the accuracy requirements. In fact, it was felt that greater accuracy was required and could reasonably be specified. On the other hand, the close dimensional requirements of the pre-war 1942 specifications have caused practical manufacturing difficulties, with resultant restriction of output. It was therefore decided, after due consideration of all the factors, to compromise between the previous I.P. practice of specifying closely all critical dimensions and the A.S.T.M. practice of concentrating upon the required accuracy. Thus, the war-time hydrometer specifications will specify only (1) accuracy, (2) overall length, and (3) length of scale, in addition, of course, to the usual general clauses. Bulb and stem dimensions, etc., are set out merely to indicate to the manufacturer the type of instruments required, and these dimensions will not be obligatory.

The reconsideration of the thermometer and hydrometer specifications has consumed much time, and so far it has not been possible to give detailed attention to more than a few of the general apparatus questions, but a number of outstanding difficulties have been dealt with. Thus, an improved specification for the Ramsbottom coking bulb and its metal sheath will appear in the new edition, whilst the use of a straight-necked Redwood viscosity flask is permitted as well as the fragile Kohlrausch type.

In connection with the penetration test, the A.S.T.M. needle has now been specified. This incidentally is in accordance with the desire of the Institute to co-operate as closely as possible with the A.S.T.M. Similarly, the B.S.I. specification for the Drop Point apparatus has been accepted. These changes will, of course, facilitate production, since only one specification will exist in each case, instead of two.

The Committee has made excellent progress, and it constitutes in a small way an interesting example of the useful results that can be obtained when supplier and user meet and really understand and appreciate each other's requirements and difficulties.

The future work of the Committee must depend largely on the activities of the other Committees, but a number of points have already accumulated, and doubtless, now that the Committee is actively operating, suppliers and users will bring forward their difficulties and suggestions.

PRACTICAL ALIGNMENT CHART FOR FLUID FLOW IN PIPE-LINES.*

By Percy Meyer.

Where a calculation employing simple multiplication or division is required, the advantage of an alignment chart over long-hand working or slide-rule reckoning is questionable. On the other hand, when an equation contains a variety of fractional powers then an alignment chart can be quicker, and to the extent that it avoids any ambiguity in the decimal point, it can be more accurate. The first feature of this alignment chart therefore is that the number of scales and the variety of units used have been kept to a minimum.

Fluid flow is a subject which from the fundamental viewpoint is best handled with self-consistent units giving dimensionless terms. However, in practice one deals in common engineering units, and the second feature of the chart is to avoid the need for interconversion of units.

A third feature is that the use of the chart assumes no prior knowledge of whether the flow is turbulent or streamline. Apart from pressure drop calculations, the chart is useful in ascertaining whether an orifice in the line will be outside the streamline flow region and thus give the usual metering accuracy associated with turbulent flow.

Regarding the units chosen, the use of " feet head of flowing fluid " is not very practicable for gases, and accordingly pounds per square inch have been used. Similarly the cubic foot is a satisfactory measure of volume for both liquids and gases and therefore preferable to the gallon. The viscosity of liquids, generally speaking, covers a much wider range of values than that of gases, and the majority of viscometers in use for liquid testing give a flow time which is directly convertible to the common unit of kinematic viscosity, the centistoke.

The established relationship for fluid flow in pipe-lines is :

$$Q = 34{\cdot}5\sqrt{\frac{D^5P}{GLF}}$$

where Q = cubic feet per hour flowing fluid.
D = actual pipe diameter in inches.
P = pressure drop, lb. per sq. in., between inlet and outlet.
G = specific gravity or density of flowing fluid (water 1·0).
L = length of pipe-line in feet.
F = the Fanning friction factor.

To ascertain the value of F, it is generally necessary to calculate the Reynolds number, which includes the effect of viscosity, and to look up a graphical correlation of F with the Reynolds number. In this alignment chart, the right-hand-side deals with the flow equation above, in terms of Q, D, and P/GLF. Passing through the reference axis and the viscosity

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scale gives the value of F for clean commercial pipe. Above the value $F = 0{\cdot}011$ the flow is streamline, and below this region it becomes turbulent, tending to approach the value of 0·005 and rarely falling below this. (Actually the reference axis is a scale of Q/D, algebraically equivalent to the product of linear flow velocity times pipe diameter: this, divided by the kinematic viscosity, gives the Reynolds number. These intermediate values do not enter into the final computation and hence the scales do not need these calibrations.)

For gas flow, the pressure drop may be large and the volume of gas may expand considerably under flow conditions. The formula generally used is of the type:

$$Q = \text{Constant} \sqrt{\frac{D^5(P_1^2 - P_2^2)}{GTLF}}$$

where Q is defined under standard conditions (60° F. and 14·7 lb. sq. in. for instance), G is the gas specific gravity or density standardized under the same conditions, P_1 and P_2 are the inlet and outlet pressures in lb. sq. in. absolute, and T is the absolute temperature.

However, $(P_1^2 - P_2^2)$ factorizes as $(P_1 - P_2)(P_1 + P_2)$, in which the first term represents pressure drop while the second term is twice the arithmetic average pressure. In deriving this equation the usual gas laws have been assumed whereby the flowing volume and flowing density of a gas depend upon the flowing pressure. By using Q and G in terms of arithmetic-average flowing volume and flowing density, and referring the flowing gas density to water as unity, the general fluid-flow equation as originally stated is precisely applicable to high-pressure gas flow, giving a result mathematically identical with that from the more elaborate equation using the $(P_1^2 - P_2^2)$ term.

Example 1.—What pressure is required to force 600 cu. ft. per hour of liquid through 500 feet of 2 inch pipe? The fluid is of 10 centistokes viscosity and 1·1 sp. gr. at flow temperature.

Answer: Drawing a straight line through the 600-cu.-ft. and 2-inch points, gives P/GLF as 9·1. Hence $P = 9{\cdot}1GLF$. This straight line is also drawn to intersect the reference axis. Proceeding from this point of intersection through the 10-centistoke point gives F as 0·0083.

$$\text{Hence } P = 9{\cdot}1 \times 1{\cdot}1 \times 500 \times 0{\cdot}0083.$$
$$= 42 \text{ lb. per sq. in}$$

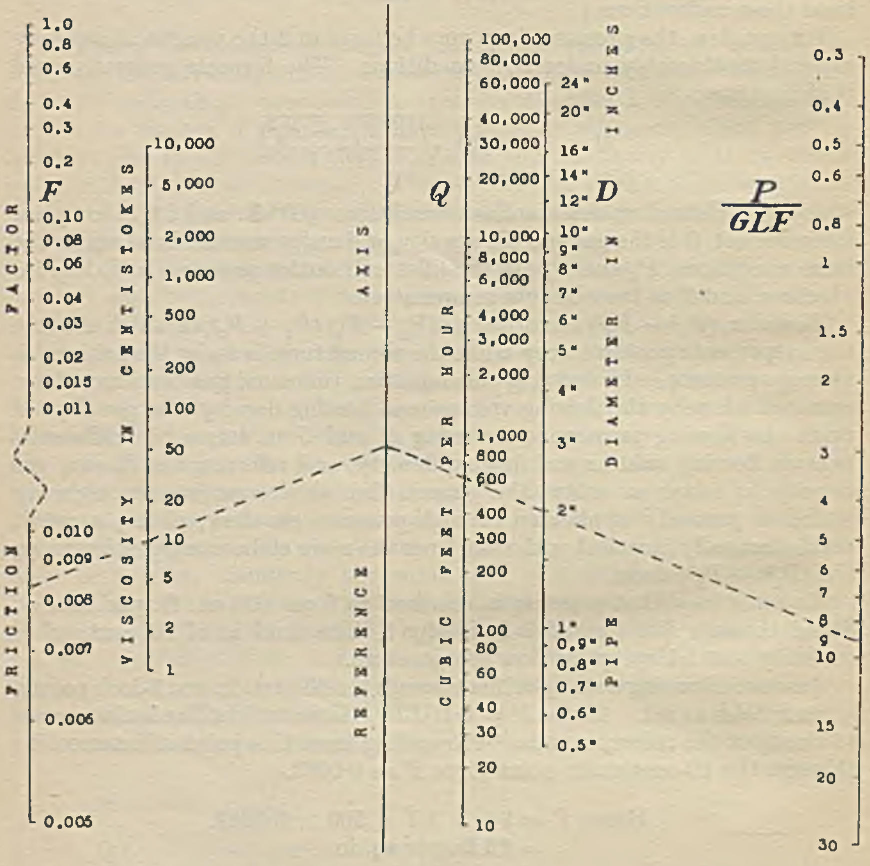
This is, of course, the dynamic pressure drop assuming a horizontal pipe-line; if the discharge level is above or below the inlet level, the usual static-head correction has to be applied.

Example 2.—The above line delivers into a 4-inch line in which it is proposed to install an orifice for measuring the quantity flowing. Will the meter give accurate measurement?

Answer: The F point falls between 0·010 and 0·011, that is, where the flow may be either turbulent or streamline. It would be better to put the orifice in the 2 inch line.

Example 3.—What diameter pipe-line is required to deliver 10,000 cu. ft. per hour (measured at 60° F. and 14·7 lb. per sq. in.) of nitrogen a distance of three miles? Assume average atmospheric temperature, and an available inlet pressure of 95 lb. per sq. in gauge, with discharge pressure to be above 5 lb. per sq. in. gauge.

Answer: The probability is that the smallest calculated diameter will include an odd fraction and will not be matched by a standard size. Therefore the nearest larger standard size would be used in practice. Hence the discharge pressure would be higher than the specified minimum 5 lb.: it would be (for trial) 25 lb. say; giving an *average* line pressure between 95 lb. inlet and 25 lb. outlet, of 60 lb. gauge or 75 lb. absolute, *i.e.*, five atmospheres.



269

Under this pressure the 10,000 cu. ft. per hour will average about 2,000 flowing cubic feet per hour. Aligning this point with a trial 4-inch diameter pipe, gives $P = 3{\cdot}2GLF$.

G for nitrogen under atmospheric temperature and pressure is about

0·0012 : under five atmospheres it will be about 0·006. Thus with L at 15,800 ft.

$$\begin{aligned} P &= 3{\cdot}2 \times 0{\cdot}006 \times 15{,}800 \times F \\ &= 300 \times F. \end{aligned}$$

Regarding the value of F, for rapid approximate work it is worth noting that gas flow in pipe-lines falls in most practical cases in the turbulent flow region, limiting F to the range 0·005–0·010; where a large error in the assumed viscosity makes a relatively small difference to F; also that the range of values for gas viscosity, except at extremes of temperature and pressure, is relatively small, *e.g.* :

	At 0° C.	At 300° C.
Hydrogen	0·008	0·014
Nitrogen	0·017	0·028
Oxygen	0·019	0·034
Mercury	—	0·054
	centipoises	

In practice, taking F at the upper value of 0·010 for turbulent flow in clean pipe will give a factor of safety. However, a check on flow conditions is desirable and is readily carried out.

Taking the viscosity of nitrogen as 0·018 centipoises, dividing by the flowing density of 0·006 gives the kinematic viscosity as 3 centistokes. Hence F is about 0·0055 and

$$\begin{aligned} P &= 300 \times F \\ &= 300 \times 0{\cdot}0055 \\ &= 1{\cdot}65 \text{ lb. per sq. in.} \end{aligned}$$

The outlet pressure from the 4-inch line would be only 1·65 lb. below the inlet pressure : clearly this diameter is unnecessarily large.

Trying a 2-inch line : for 2,000 flowing cubic feet and a 2-inch line the value of P/GLF is off the scale; but as this value is 3·2 for a 4-inch and is dependent on the fifth power of the diameter it will be $(4/2)^5$ equals thirty-two times as great, *i.e.*, 32 times 3·2 or, say, 100 for a 2-inch line. F becomes about 0·005. Hence

$$\begin{aligned} P &= 100 \times 0{\cdot}006 \times 0{\cdot}005 \times 15{,}800 \\ &= 47 \text{ lb. per sq. in.} \end{aligned}$$

With an inlet pressure of 95 lb. per sq. in. gauge, a drop of 47 gives an outlet pressure of 48 lbs. per sq. in. gauge, which is somewhat higher than required.

Trying 1½-inch-diameter line : the ratio of diameters to the fifth power $(2{\cdot}0/1{\cdot}5)^5 = 4{\cdot}2$, indicates that the pressure drop will be of the order of 4 times the 47 lb. above, *i.e.*, much higher than the available 90 lb. (It will be observed that the pressure drop rises very steeply as the line gets smaller).

A 2-inch line is the nearest practicable diameter.

The usual allowance for bends, elbows, valves, etc., in the line can be included by adding the " equivalent length of pipe." A rough pipe surface, except in so far as it may reduce the effective pipe diameter, does not affect pressure drop in the viscous or streamline flow region, but it causes an increase in the turbulent flow region. Where this condition is expected, a factor of safety may be introduced by taking F at the lowest value for streamline flow and the highest value for turbulent flow—*i.e.*, at about 0·011, even if the flow is indicated to be turbulent. Additionally it is important that the actual effective pipe diameter be used, and not the nominal one; particularly is this true of small-bore pipes.

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 Production.

159.* The World's Oil in War-time. W. A. Sawdon. *Petrol. Engr*, October 1943. **15** (1), 65.—Because of the great productive capacity, the highly developed technique, and the ability to ship oil, the U.S.A. oil reserves have been drawn upon especially heavily in the present war. The reserves have been depleted, and the normal exploratory work which would have added to the reserves has been prevented. War developments in the past year have made available oil supplies in areas nearer to the battlefronts than U.S.A.

The total Allied oil production exceeds 6,000,000 brl./day; German-controlled Europe may yield 150,000 brl./day, and Japan's production, together with that of Burma and the East Indies, is probably 100,000 brl./day. Germany has a great synthetic oil industry, but the store of oil and its products laid up before the war may now be exhausted. Germany's oil supply is probably decreasing, both from natural causes and from military action. 70% of Germany's oil comes from Rumania, where the 1942 production is estimated to have been 34,000,000 brl., 4,000,000 brl. less than in 1941.

Shortage of material has restricted activities in fields throughout the world, hampering production seriously in some areas. Exploratory work has been curtailed.

Exclusive of Sakhalin, the Russian production in 1942 is estimated at 210,000,000 brl., compared with 238,150,000 brl. in 1941. Sakhalin may produce 4,000,000 brl./year, but it is not known where this oil goes now.

Some oil is being obtained from wells down structure from seeps in the southern part of the Gobi desert in China. The 1942 production in India is estimated to have been 2,500,000 brl., compared with 2,270,000 brl. in 1941. The Burma production in 1942 may have been 2,500,000 brl.—about one-third of the production in the preceding years. It is unlikely that the Japanese have been able to do much rehabilitation in Burma, but when Burma is freed rehabilitation should follow quickly.

The Near East fields should be important in supplying oil for attacks on the Axis. Bahrein has practically been drilled up in its present productive zones, but in 1942 there may have been slight production increases in Iraq, Iran, Saudi Arabia, and Egypt. The Iran production in 1943 is estimated at 73,000,000 brl., 5,000,000 brl. less than in 1939. Oil from Iran and from Iraq will be more readily available following the re-opening of the Mediterranean. Bahrein gave 6,800,000 brl. in 1941, and Saudi Arabia produces about 6,000,000 brl./year. In addition to Damman, there are other fields of great extent which have been little more than proved. In 1942 Egypt produced approximately 9,000,000 brl., more than 2,000,000 brl. above the average for the previous two years. The Near East has a large volume of refinery capacity.

The full productive capacity of Venezuela has not been used because of transport difficulties. During the first half of 1943 the Venezuelan output averaged 400,000–500,000 brl./day, but late in 1941 it was 700,000 brl./day. The potential production has risen since 1941. Greater refinery capacity will be needed on the mainland. Colombia's production also was curtailed by the war, and the 1942 production was about two-fifths of that in 1941. New production has been developed since curtailment began. The Ecuadoran production rose slightly in 1942 and exceeded 2,000,000 brl., and that of Peru rose to 13,600,000 brl. Prospecting is proceeding in Brazil, and Bolivia gives over 200,000 brl./day. Argentina produced 23,742,000 brl. in 1942, 8% more than in 1941. 70% of the oil came from Comodoro Rivadavia. The production of Trinidad in 1942 was estimated at 25,700,000 brl. G. D. H.

160.* Petroleum in Canada. F. K. Beach. *Petrol. Engr*, October 1943, **15** (1), 80.—The wells in the Norman Wells area are shallow, and after testing they are capped, but they seem to be capable of supplying the war needs of the Alaskan area. A pipe-line is being constructed from Norman Wells to Whitehorse, where a refinery is to be erected. The oil is said to be pumpable at very low temperatures.

Oil was discovered at Norman Wells twenty years ago, and there has been commercial production for ten years, 15,000–20,000 brl. having been obtained in four months' operation each year.

Turner Valley still gives 96% of Canada's oil output, but seems to have passed its peak. 28 producers were completed in 1942, compared with 43 in 1941. The Government has financed marginal wells. Gas allotments have been made for some of the older wells with poor gas–oil ratios, without any restriction on the manner of production, and this has reduced the average decline from 42% to 21%.

On the east side at the north end of Turner Valley, a second limestone occurrence seems to have been discovered recently below the fault-block from which the rest of the field produces. The oil is without water, and as low as −5300 ft., compared with an oil–water contact originally at −4500 ft. in the main fault-block. Minor extensions have been made at the northern and southern ends of the field in the past year.

Production was suspended in the Vermilion field from October 1942 to May 1943. There is only a limited outlet for the oil, but new prices made resumption of production profitable in May 1943. The Taber field is rather spotted. Oil comes from the Ellis and in one well from the Sunburst. One well has produced over 50,000 brl.

The oil discoveries at Princess and Tilley have not proved commercial, although Princess may prove a valuable gas reserve. Several wildcats have explored Lower Palæozoic horizons in the plains area, following geological and geophysical investigations. The Shell Norman well at Jumping Pound found the top of the Rundle at a depth of 11,588 ft.

The Canadian Government is providing $500,000 for investigation and further development of the Athabasca tar-sands. The Abasand plant was repaired, and produced 10,000 brl. of oil in 1942, but had produced none in 1943 up to the end of August. 60 ml. below McMurray a company has separated bitumen for paint-making, etc., and the hydrogenation of the bitumen is being considered.

The price of oil from Turner Valley was increased by 15 cents/brl. on 1st April, 1943, making the price of 41° oil $1·66/brl., with a rise of 2 cents per degree up to 64°. Neither exploitation nor wildcatting seems to have been checked by steel shortage. The stabilization of *iso*butane has been begun, and a polymer plant and an alkylation plant are now operating.

Several deep tests are under way in Saskatchewan, but no oil discoveries have been announced. Old wells have been reconditioned in Ontario, while a little stripper production is obtained in New Brunswick.

The demand for natural gas has risen. The Edmonton supply comes from Viking and Kinsella. The former field has 19 wells and the latter more than 11. A recent wildcat near Athabasca found gas at a depth of 1700 ft., with a large open flow and closed-in pressure of about 500 lb./in.^{2} A gas well has been completed near Pouce Coupe.

Tables present consumption, production, and drilling data. G. D. H.

161.* Colombia's Production Prospects. W. A. Sawdon. *Petrol. Engr*, October 1943, **15** (1), 96.—El Dificil is the eighth producing area to be opened in Colombia. This structure is about 70 ml. from the coast. El Dificil No. 1 is high on the structure and gave gas, while the second well was lower and flowed 34° A.P.I. oil from the limestone reservoir rock.

The producing zones are 6200–7200 ft. deep. El Dificil has led to an improvement in the estimates of the lower Magdalena Valley prospects, and an exploratory test is under way. There is also a test in the middle Magdalena Valley, north-west of Puerto Wilches.

The Casabe field has ten wells, producing from depths of 4000–5000 ft. The oil averages 24° A.P.I.

Lack of equipment and supplies has greatly hampered the Barco operations. In addition to the Petrolea and Rio de Oro fields, there is production at Tres Bocas and Socuavo. The Tres Bocas wells are 8500–9000 ft. deep, and those of Socuavo are about 4500 ft. deep. Both fields give oil of 31–34° A.P.I. gravity.

A small producer has been drilled near Puerto Wilches, and this is reported to be on the Casabe structure.

A test is to be drilled 40 ml. up the Sinu River. G. D. H.

162.* Drilling Activity in California at Peak. Anon. *Oil Wkly*, 25.10.43, **111** (8), 10.—In the first nine months of 1943 1048 wells were completed in California, compared with 486 in the same period of 1942. At the beginning of October 328 rigs were drilling, against 152 rigs at the beginning of October 1942.

Compared with completions in the first nine months of 1942, completions this year are down by 31·5% in Texas, 38% in Louisiana, 9·8% in Oklahoma, and 8·8% in Illinois. Relaxation of spacing regulations and a 25-cent increase in crude prices seem to be responsible for the spurt in California. G. D. H.

163.* Overlooked Shallow Sands May Hold Important Reserves. D. L. Carroll, *Oil Wkly*, 25.10.43, **111** (8), 14.—It is generally recognized that on numerous occasions shallow sands and good shows worthy of test have been drilled through. In some cases this is due to mudding-off, and in others is deliberate in heading for a lower, more prolific horizon. The last practice is excusable provided accurate logs are taken and filed.

In the Illinois Basin area especially much shallow Pennsylvanian production was ignored, first in seeking Mississippian production, and later in exploring Devonian and Trenton horizons. The Pennsylvanian horizons were important oil producers in the older fields. For five years no attempt was made to collect information on the Pennsylvanian beds penetrated in drilling to deeper horizons. This is a serious loss. Now wells are carefully examined from the surface downwards, several types of information (samples, drilling time and electric logs) being collected.

In producing fields with possible shallow pays, additional shallow wells should be carefully drilled to test the value of the pays. Old cased wells should be examined by the newer methods, which can log the potentialities of formations through casing and cement. G. D. H.

164.* Crude Production Hits Another High. Anon. *Oil Wkly*, 25.10.43, **111** (8), 52.—In the week ended 23rd October, 1943, the daily average production in U.S.A. was 4,419,466 brl., 6,245 brl. higher than in the previous week. In Illinois the daily output was 223,650 brl., an increase of 14,750 brl. There were also slight rises in New Mexico (3200 brl./day), Pennsylvania (1950 brl./day) and California (1350 brl./day), but in Kansas the daily output of 284,780 brl. was 14,200 brl. lower than in the previous week. G. D. H.

164a.* Vermilion Field Well Makes Unusual Flow. Anon. *Oil Wkly*, 25.10.43, **111** (8), 52.—Cannar 17 produced 350 brl. of oil in the first day, and is the biggest well in Canada outside Turner Valley. This well is flowing. Vermilata 2 flowed 60 brl./day at first, but is now pumping. G. D. H.

165.* Structural Geology and Oil Possibilities of the Big Horn Basin, Wyoming. W. T. Thom. *Oil Wkly*, 1.11.43, **111** (9), 26.—The oilfield uplifts of the Big Horn Basin generally show an elongated asymmetrical domed form, with numerous epi-anticlinal tension faults, a curving axial trace, and, if strongly uplifted, a steep fault nearly parallel with the long axis or a slight rupture and overthrusting of their steep limbs. Groups of adjacent oilfield structures show similarity in the axial trend, the direction of asymmetry, and relationship to the underlying crustal blocks. In the formation of a typical asymmetrical dome in the Big Horn Basin a crustal block some

10 ml. thick is bent into a trough by horizontal compression, so that the upper surface is shortened locally and relatively to the bottom surface. When the block is formed of sediments, the shortening in an 80-ml.-wide plate flexed about 70° will give rise to Appalachian-like folds and bedding-plane glidings. When the block is composed of massive basement rocks lacking bedding planes, the shortening of the upper surface will first induce slight local bulging of the basement surface and then faults facing the basin rim. This type of fault dips less and less steeply at depth, and hence the upper fault-blocks tilt more and more as flexing proceeds. The faults will be parallel to each other and to the basin border. Thin, less competent beds overlying the basement fault-blocks will tend to be draped over the upthrust block edges as asymmetrical anticlines until they rupture along the steep limb, first as a normal fault and later as a thrust fault.

In early pre-Cambrian time a fold system developed in the Big Horn Basin with an axial trend of N. 55° E. Towards the end of the orogeny granite batholiths were intruded with trends of N. 35° W. A series of profound basement rifts trending N. 75° W.–S. 75° E. developed in later pre-Cambrian time, and younger granites were intruded.

Shallow shelf-seas transgressed eastward across the region in the Palæozoic, covering the planed-off surface of the basement complex with thin, fairly uniform sheets of shallow-water sediments. There were recurrent down-warpings of the western part of the region. This "foreland-behaviour" continued to Lower Cretaceous time, giving 4500 ft. of shallow-water shales, sandstones, and limestones, and on top were laid 4000 ft. of upper Cretaceous beds, marine, and near-shore in facies. Following fairly strong post-Cretaceous compressional movements, 1000–5000 ft. of Paleocene coastal-plain deposits were laid down, after which the main period of mountain-building and thrust-faulting occurred, initiating the Eocene cycle of basin-filling. Broad regional uplift affected the eastern Rocky region at about the end of the Eocene, causing a rapid removal of part of the basin fill, and canyon-cutting in the basin border ranges. This activity recurred several times in the later Tertiary and Quaternary.

Further oil discoveries are to be expected in the Big Horn Basin from deeper drilling on many of the known structures, and from the geophysical discovery of hidden structures. Structural-palæogeographical studies will lead to the location of structural and stratigraphic oil-traps. Possible producing horizons are in the Mesozoic, Permian, Pennsylvanian, Mississippian, and possibly in the Ordovician and Cambro-Ordovician of the western part of the basin. G. D. H.

166. Elk Basin May Outrank Salt Creek as Largest Reserve in Rockies. N. Williams. *Oil Gas J.*, 4.11.43, **42**, (26) 12.—Tensleep production was opened in the Elk Basin in November 1942, and since then 16 wells have been completed to prove an area 4 ml. from north to south, and over 1 ml. from east to west. The daily output has risen to 14,000–15,000 brl./day. The proved area may take 150 wells, and a recoverable reserve of 350–375 million barrels is indicated.

Elk Basin is one of the many large structures on the margin of the Big Horn basin. The structure has given light oil and gas from the Frontier sands at 1350 ft., and gas from the Dakota at 2500 ft. The producing area in these shallow formations covers less than 1200 acres, and since 1915 the light-oil production has been under 12,000,000 brl. The Tensleep is at 4400–5300 ft. The closure may be 1600–1700 ft.

The topography and isolation of the field present difficulties in its development. Water is scarce. Steep dips and hard rocks create other difficulties, and frequent well surveys are necessary. Drilling costs are $8–$10/ft., and wells take 60–90 days to drill. There is frequent loss of circulation in some wells. The anhydrite section at the top of the Spearfish red beds below the Sundance causes deterioration of the drilling mud, and starch products are being used to combat this. Some wells have encountered sloughing shale.

Rotary rigs, generally fuelled by natural gas, are employed. The derricks are regular 136-ft. steel derricks, or jack-knife and collapsible types. Usually there is one mud-pump and a small shale shaker.

The Tensleep gas carries about 18% of H_2S. The working pressures of the wells range up to 1400 lb./sq. in.

So far pipe-line outlets are limited to a small line to local refineries. Permission is being sought to lay a trunk line from Elk Basin to Casper and Salt Creek, in order to connect with a main line to the east. G. D. H.

167.* Wildcats and Discoveries. Anon. *Oil Gas J.*, 4.11.43, **42** (26), 83.—In the week ended 30th November, 1943, 9 oil, 1 distillate and 2 gas-discovery wells were completed in U.S.A. The most important find may be the Cisco lime well in King County, North Texas, which gave 361 brl. of 33·1-gravity oil from a depth of 3702–3713 ft. A new pay was opened in a North Texas field. A 140-brl. well opened the Little Kentucky field of Jackson County on the lower Gulf Coast. A test is proceeding in the South Anahuac area of Chambers County, and it has given 3–5 brl./hr. One mile north of Alice, South-west Texas, a substantial gas-well was completed. A 342-brl. discovery well was brought in Fresno County, California, but it showed little gas. In the Elgin area, Comanche County, Oklahoma, a well pumped 22 brl. in 10 hours from a sand at 500–510 ft. There was a second small successful wildcat in Oklahoma. A 178-brl. Tuscaloosa discovery was made in Mississippi, and near the Mississippi–Louisiana boundary, in Adams County, a 179-brl. well was completed in the Wilcox at 5880–5884 ft., after plugging back from 10,383 ft.

2813 wildcats have so far been drilled in U.S.A. in 1943, and 324 oil discoveries have been made.

A table summarizes by States and districts, the wildcatting results in the week ended 30th October, and gives the cumulative data for 1943 to that date. G. D. H.

168.* Geology of Central Jackson County, Texas, Oil-Fields. J. Hornberger. *Oil Wkly*, 4.10.43, **111** (5), 18.—Fault, fold, terrace, stratigraphic trap, and combination types of oil-fields are known in central Jackson County, Texas. The West Ganado field is a closed structure against a down-to-the-south fault, while Sterling and Stewart have closure against an up-to-the north fault. Lolita, North Laward, and Maubro are anticlinal, and Ganado and Texana faulted anticlines. Harmon, Mayo, Mauritz, and West Mauritz are of the terrace type.

The marine shales of the Anahuac wedge form the cap-rock of the Greta stringer production, and a marine wedge below the Greta sand is likewise the cap-rock for deeper production. The interfingering of marine shale wedges between the sands of the Frio below the Greta influence oil accumulation, and lenticular sands below the Greta produce at West Ganado, Ganado, Texana, North Laward, Mayo, Harmon, Mauritz, and West Mauritz.

Cores with slight shows from some of the sands have yielded more oil than would be expected from the electrical logging results. Some electric logs did not show the porous bentonitic, sandy shale zones, saturated with oil, which produce at Harmon, Mayo, and Mauritz.

The main production at West Ganado is from the Greta sand at 4700 ft. Several wells produce from a multiple lenticular sand horizon at 5150–5300 ft. A few wells give gas from a blanket sand at 5400 ft., while a lenticular sand at 6000 ft. yields oil and gas in a few wells. One well has found oil in a sand at 6200 ft. The Stewart field produces from the Greta sand at 4970 ft., and deeper oil and gas-shows have been encountered. The Sterling field has a gas-well in the Greta sand at 4830 ft.

Greta production is found at 5100 ft. at Ganado, and there are deeper sands at 5500 ft., 6200 ft. (oil and gas), 6300 ft. (gas), 6400–6500 ft. (lenses giving oil and gas), 6600 ft., 5700 ft. (gas) and 5800 ft. (gas). The Harmon field produces from below the main Greta sand, a lenticular producing zone occurring at 5400 ft. The Mayo field produced first from the 5300-ft. level, below the Greta sand. There is a lenticular zone at 5400 ft., and a few wells on the flank give oil from a thin stringer in the upper part of the Greta sand at 5100 ft. Gas shows occur in some wells at 5600 ft. Lenticular sands at 5450 and 5500 ft. give the main production at West Mauritz, and there are oil-shows in cores from the upper part of the Greta sand, and in lenticular sands below 5500 ft. Several wells obtain gas from a sand at 5600 ft. The top of the Texana stringer yields oil and gas at 5050 ft. in the Texana field, while a multiple zone with gas and distillate produces in several wells at a depth of 5550–5600 ft. North Laward obtains its principal production from the Greta sand stringer at 5200 ft., while a lenticular sand-zone with oil and gas has been developed on the north flank at the structure at 5600 ft. The Maubro field gives oil from the Greta at 5200 ft. Lolita produces from the Greta stringers at 5300 ft., but mainly from a depth of 5900 ft. Gas-sands have been logged at 5700 and 5800 ft., and a few wells give oil from 6400 ft.

The principal production in Jackson County is between the −5400 and −5500-ft. contours. The regional dip from Ganado to Laward is just under 1000 ft. in 15 ml.

The flattening of the dip indicates a rather large structural feature, broken by numerous faults, and with several closed structures on it.

Two stratum contour maps, electrical logs, and a stratigraphic column are included.
G. D. H.

169.* California Situation Alarming, in View of Coming Pacific Offensive. D. Carroll. *Oil Wkly*, 8.11.43, **111** (10), 60.—When the war emphasis shifts to the Asiatic area, military supplies will be drawn more heavily from the west coast of U.S.A., and California will become extremely important for oil supplies. Since April, the west coast oil demand has exceeded the supply, and the deficiency, met by withdrawals from storage, is increasing steadily. A production of 820,000 brl./day is optimistically predicted for the end of 1944 in California. Up to the end of September this year only one major field had been found in California, in spite of the most strenuous wildcatting for many years. 94% of the 1943 wildcats have been dry (the figure is 85% for the whole of U.S.A.).

In 1944, 2500 new producers will be required merely to offset the declining production and abandonment of present wells. Large areas of Tertiary and Cretaceous beds of considerable thickness have not yet been tested by drilling, for neither surface geology nor geophysics has been able to show the existence and location of favourable structures. Core-drilling is an expensive exploratory method in virgin territory, and few companies can afford to undertake the programmes necessary to secure the information needed for scientific wildcatting. Hence only the wildest wildcatting or exceptional luck remain to locate the stratigraphic traps which seem likely to exist in the northern part of the San Joaquin valley, the Salinas Basin, and the Sacramento Valley. The Imperial Valley and several offshore areas also deserve careful testing.

The Californian reserves are estimated at 3,500,000,000 brl. At the current rate of production the reserves are being depleted at the rate of 10% per year.

The capacity of the Californian refineries is 200,000 brl./day greater than the current deliveries from all sources.

The Government-controlled prices do not encourage exploration and development, and thousands of Californian stripper wells demand more satisfactory conditions for reasonable operation.

A number of large new oil refineries in California are approaching completion, and four or five may be ready within 90 days. It is not clear whence the crude for these will be obtained without disrupting the present allocation of supplies. G. D. H.

170.* Canada's Wartime Oil Boom. J. Montagnes. *Oil Wkly*, 8.11.43, **111** (10), 74.—After war began Turner Valley's production was boosted by 27% to its highest practicable level, but by the end of 1942 its production rate had fallen slightly. Early in 1943 a Government company was created to assist in developing marginal oil on the west flank at Turner Valley, and it is now financing ten projects, most of which are already drilling.

The demand for aviation gasoline and other transport fuels has risen substantially in Canada.

In the summer of 1943 exploratory geological work for oil was carried out in British Columbia, south-west Ontario, Alberta, and the Sussex and Waterford areas of New Brunswick. The Pouce Coupe Entrance, Alexo, Saunders, and Athabasca areas were examined in Alberta, and the Fox Valley, Kindersley, and Radville areas in Saskatchewan.

In the first half of 1943 Canada produced 5,037,870 brl. of oil, 4,803,719 brl. coming from Turner Valley. The production outside Turner Valley was higher than in the corresponding period of 1942, whereas Turner Valley showed a fall. The Taber field had produced 107,600 brl. of oil up to the end of August 1943, most of it in 1943. Oil is also obtained from Red Coulee, Vermilion, Wainwright, Dina, Del Bonita, Lloydminster, Princess, and Tilley, Vermilion being the most important.

In 1942, 10 wildcats were drilled in the foothills region outside Turner Valley. The footage was 25,184 ft.

New Brunswick produced 13,713 brl. in the first half of 1943 (12,017 brl. in the first half of 1942); Ontario produced 66,737 brl. (73,865 brl. in the first half of 1942); the Norman area gave 89,929 brl. (9674 brl. in the first half of 1942).

Various tax reliefs and exemptions have been given to encourage oil exploration in Canada. G. D. H.

Drilling.

171.* Weighting Acid With Calcium Chloride Aids in Freeing Stuck Tools. H. F. Simons. *Oil Gas J.*, 23.9.43, **42** (20), 239.—When using hydrochloric acid to free tools stuck in a well being drilled it is necessary that the acid has approximately the same, or in many instances a greater, specific gravity than the drilling fluid. Calcium chloride may be used as a weighting agent in the acid to a maximum of 4 lb./gal. to produce a solution weighing 12 lb./gal. Use of this treatment to free a fish in a North Central Texas well is described. The weighting of the acid can be done in the field or at the acid depot. The dry calcium chloride in the desired amount is slowly added to the acid while the solution is agitated with compressed air. Amounts of calcium chloride to obtain the desired density with various concentrations of acid are shown.

In addition to being used with acid for freeing stuck drilling tools, the calcium chloride is used in a similar manner to free casing pumps frozen in the hole due to precipitation of calcium carbonate. The treatment is the same as that for freeing stuck cable tools, the mixture of acid and calcium chloride being placed on top of the casing pump with a dump bailer and allowed to settle down around the pump. A dilute acid in place of the customary 15% or stronger is used for this type of work. A. H. N.

172.* The Gyroscopic Clinograph. G. L. Kothny. *Oil Wkly*, 11.10.43, **111** (6), 25.—It is claimed that the gyroscopic instrument, besides being the only one to record inclination and direction of the inclination in a cased hole, fulfils the following conditions which should govern the design of every clinograph: (1) The design and construction of the instrument must be such as to produce true records with sustained accuracy. (2) Ability for self-checking (*i.e.*, if false records are produced, the instrument must provide means for recognizing them as such). (3) Making records automatically, thus eliminating the possibility of human errors. (4) Producing clear and easily interpretable records. (5) Speedy operation to reduce loss of rig time to a minimum. (6) Ample recording capacity to make possible two surveys, one on the in and one on the out run, thus providing a check of the accuracy of the survey. The elementary principles of gyroscopes are briefly outlined.

The gyroscopic clinograph consists of three units: the gyroscope, the camera, and the inclination unit, all of which are assembled inside a steel protective casing in the order named, the gyroscope being at the bottom. The gyroscope unit consists of a small, heavily weighted rotor, driven by a direct-current motor, which operates at approximately 10,000 revolutions/minute. Attached to the top of the vertical axis of the gyroscope is a pointer, pointing in the same direction as the axis of the gyroscope. This pointer is arranged above the gyroscope within a compass scale, inside which there is also a watch for the purpose of indicating the time at which each picture was taken, and a thermometer recording the temporture prevailing in the space surrounding the gyroscope. The camera unit uses a 16-mm. film and two lens barrels pointing in opposite directions, one towards the surface of the gyro and the other towards the inclination unit. The inclination unit consists of a box level gauge or a cross-hair pendulum. The three units are assembled inside a high-pressure steel case which has a maximum outside diameter of 5½ in. and is made up in three joints screwed together. The two lower joints carry the dry-cell batteries which form the power-plant for the operation of the gyroscope, the camera motor, and the illumination. The case is built to withstand hydrostatic pressures up to 8000 lb./sq. in.

The method of operation of the clinograph is given in some detail, together with interpretation of surveys and the method of checking for errors. The paper is well illustrated by photographs of the main parts of the instrument. A. H. N.

173.* How Operators Are Fitting Drilling Equipment and Practices to Conditions. M. L. Cashion. *Oil Gas J.*, 21.10.43, **42** (24), 67–69.—The paper deals with war-time conditions and attendant troubles in oil-field drilling. The lowering of specifications for oil-field materials has caused considerable difficulties, involving breakages and shutdown time. The experiences of one major company in this connection are related together with suggestions for the maintenance of pre-war equipment still in use. The author also discusses the man-power situation, and makes suggestions for the improvement of delivery of materials and a speeding-up of the drilling campaign.

The chief source of trouble appears to be due to using N.E. (National Emergency) steels and materials, instead of S.A.E. The author does not agree with the claim made by N.E. manufacturers that N.E. steels give the same service as S.A.E.

A. H. N.

174.* Lay-out for A.C. Drilling Rig. E. H. Lamberger. *Oil Gas J.*, 4.11.43, **42** (26), 48–49.—Power for a.c. oil-well drilling rigs is commonly supplied by a sub-station consisting of either one three-phase or three single-phase transformers. At the sub-station any convenient supply voltage, usually 2300 volts, is stepped down to 440 volts for use at the motor terminals. The sub-station also includes a primary disconnect switch, a primary breaker, and metering equipment. The sub-station may be furnished completely by the utility and power meters on the 440-volt side of the transformers; or the utility may meter the power at high voltage and make the sub-station the responsibility of the drilling company. In this case it is often found convenient to mount the sub-station permanently on a trailer for ease of moving and setting up at new location.

Specifications for a.c. drilling equipment for wells to different depths are presented in tabular form, together with a plan-view lay-out of a complete a.c. variable-voltage drilling rig.

A. H. N.

Production.

175.* The Rôle of Capillarity in Oil Production. G. L. Hassler, E. Brunner, and T. J. Deahl. *Petrol. Tech.*, September 1943, **6** (5), A.I.M.M.E. Tech. Pub. No. 1623.—A series of curves has been obtained showing the relationship between capillary pressure and liquid saturation, when the liquid content is being reduced, for a number of sandstone and limestone specimens. In one case the process was reversed and the absorption branch of the curve was examined. This differed in form, and depended on the saturation at which the absorption experiment was begun. For the depletion the following formula represented the data for a number of sandstones quite well :—

$$\pi\sqrt{k} = 2{\cdot}53\left(\frac{1-s}{s}\right)^{\left(0{\cdot}52\frac{1-s}{s}-0{\cdot}25\right)}.$$

k = permeability in millidarcys; s = saturation, expressed as a fraction; π = capillary pressure in atmospheres for air and water.

As the saturation is reduced, gas penetrates into smaller and smaller pores, and more deeply into the angles at grain contacts, until the curve seems to become asymptotic to the pressure axis.

Three-phase capillary pressure measurements have also been made under suction for gas, oil, and water, and the data are presented on a ternary diagram.

The capillary pressure is not uniquely a function of the saturation, but depends also on the previous history of the system. This is due to the complex geometry of the pore system, which permits equilibrium with different liquid distributions and different capillary pressures. True equilibrium is possible when both phases are continuous throughout the porous medium, but distributions are possible in which globules of the non-wetting fluid become isolated, and they give rise to further capillary hysteresis (" trap " hysteresis). Trapped globules may not be in equilibrium.

The displacement pressure is that shown between two immiscible liquids in contact within a porous material; it is directed towards the non-wetting fluid, and is the static pressure that can be developed by the meniscus in the largest available interstice.

Observation of the capillary pressure–saturation relationship for air–water and air–kerosene systems in a single specimen in succession did not give a constant ratio of the capillary pressures at all saturations. The greatest deviation from the expected ratio occurred at low saturations, and may be due to the menisci touching the finer, powdery grains, and places near the points of contact of the large grains.

The silicates can be arranged in a hardness series that corresponds with their wettability. In a rock the mineral nature may vary with the particle size.

The critical saturation is the quantity of oil that a rock can hold without escape of gas, but hysteresis permits the existence of the critical distribution of liquid at several saturations, depending on the previous history of the system. At the critical saturation even an infinitesimal pressure difference will cause steady gas-flow, at a rate proportional to the pressure difference.

Gas flows easily through rocks (probably as separate globules) at saturations above the critical whenever the threshold pressure is exceeded, and no threshold pressure greater than the displacement pressure can be observed in a rock, however long the specimen or however great the assumed drainage radius. The capillary pressure is everywhere the same in a rock in equilibrium.

The liquid saturation at the outflow face of a sand cannot be less than the critical saturation when liquid and gas are flowing, but it cannot be greater than the critical saturation at any finite distance from the boundary. The presence of a finer-pored medium at the sand outlet permits the production of a considerable amount of the liquid from the coarser sand with very little loss in formation pressure for certain pressures, and at a lower gas–oil ratio for higher pressures than when there is no finer-pored medium.

The rôle of capillary forces in oil accumulation, and in the equilibrium vertical distribution of the fluids in a virgin field, is discussed. G. D. H.

176.* Types of Sucker-Rod Pumps. J. Zaba. *Oil Gas J.*, 23.9.43, 42 (20), 242.—A descriptive classification of pumps is given. All pumps are first classified as : (1) tubing pumps, (2) rod pumps, and (3) casing pumps. To the tubing pumps group belong all pumps with the working barrel an integral part of the tubing. The barrel is installed on the bottom of the tubing string, and is run into the well on the string, with plunger assembly lowered into the barrel on rods. This type of pump is characterized by simplicity of construction, has the advantage of making possible use of larger-diameter plunger for given size of tubing, but requires pulling of tubing in order to service the barrel. Tubing pumps are then re-classified from the viewpoints of (1) type of working barrel used, (2) standing valve arrangement, and (3) type of plunger used. Each sub-class is briefly discussed.

To the rod-pump group belong the pumps, frequently referred to as inert pumps, in which the plunger assembly and the barrel form a unit, assembled on the surface and lowered into the well on rods, as a unit. The rod pumps have the obvious advantage of reducing the time needed for servicing any of the parts of the pump. Another advantage is the fact that the highly machined working parts are protected during process of installation, since the pump is lowered into the tubing as a unit. For a given size of tubing, however, the plunger diameter of a rod-pump is smaller than that of a tubing pump. Under heavy sand conditions, settling of sand between barrel and tubing may be a cause of considerable difficulties. This group of pumps is again subdivided into the two classes : (1) inverted and (2) stationary inserted pumps.

A casing pump is run into the well on sucker rods. Packer, on top or bottom of the barrel, provides the fluid pack-off between barrel and casing at any desired point of setting. The problem of support needed for expansion of the packer may be solved by one of several possible methods : either by special anchoring device, or by setting on liner, or by extending the gas and mud anchor to the bottom of the well. No tubing is used. As most generally used, the casing pump is a large-volume pump.

A. H. N.

177.* Bottom-Hole Choke Reduces Gas–Oil Ratio in K.M.A. Wells. H. F. Simons. *Oil Gas J.*, 30.9.43, 42 (21), 39.—The regulations governing the gas–oil ratios and allowables in the K.M.A. fields are discussed, together with detailed considerations of the reasons for the use of bottom-hole chokes. The action of a bottom-hole choke when installed to control the gas–oil ratio is twofold : (1) a fluid-seal is established by raising the fluid-level in the well, so that the gas cannot come out of the formation and by-pass the oil, a process which is called breaking through ; and (2) it permits the oil to be produced continuously as it enters the well-bore. Gas coming into the well-bore aerates the column of fluid and helps to lift it to the surface. Practically a constant fluid level and bottom-hole pressure are maintained in the well. Productivity index of the well is the basis for the design of the choke. The choke is run in the tubing on a single-strand wire measuring line with small jars and a setting tool. When the choke has arrived at the setting point, the wire line is manipulated and the slips grip the interior of the tubing and hold it in place. To pull the choke from the well it is only necessary to run in with a special socket, drive down to release the slips, and pick up to retract them. The choke used at K.M.A. is of the positive type, and it is necessary to change beans when it is desired to alter the orifice size.

Typical data on improvements in gas–oil ratios by using chokes are presented. The use of chokes to restrict water production is briefly discussed. Success of bottom-hole chokes in maintaining flowing conditions in a well in the face of increasing gas and water production largely depends on the reservoir characteristics. Both gas and water move more readily through the producing formation than does oil; consequently the objective is to restrict as much as possible the movement of the former two, while enhancing the possibilities of the oil getting into the well-bore. Where the gas–oil contact is well defined, it is possible to establish a fluid-seal so that any gas entering the well must first pass through oil or force oil ahead of it. If the oil and gas are not segregated in the formation, or if there are alternate streaks producing gas and oil, the establishment of a fluid-seal is difficult, and flow benefits must come primarily from aeration of the fluid column and the maintenance of a constant bottom-hole pressure. The control of water is due to a maintenance of bottom-hole pressure and the constant removal of water as it enters the well. A. H. N.

178.* Counterbalancing—Purpose and Principles. J. Zaba. *Oil Gas J.*, 30.9.43, **42** (21), 56.—The need for counterbalance is briefly discussed. Differentiation is made between actual and effective counterbalance—*i.e.*, the actual load of the weights and the counterbalancing result which the weights exert. Taking into consideration a unit installation with a beam counterbalance, the effective counterbalance depends on the point the weights are placed on the beam. For instance, if the weights are placed between pitman bearing and samson post, the effective counterbalance is less than the actual counterbalance. The ratio of decrease will depend on the ratio of arms of leverage from the pitman bearing to the samson post and from the centre of gravity of the weights to the samson post. If the weights are placed on the extension of the beam, beyond the pitman bearing, the effective counterbalance is, of course, larger than the actual counterbalance. In case of rotary counterbalance, the ratio between actual and effective counterbalance depends on the radius of gyration of the centre of gravity of the weights.

In case of a beam counterbalance, the effective counterbalance depends also on speed of operation. For constant speed of operation the effective counterbalance of a rotary counterbalance is independent of the operating speed. In case of a beam counterbalance, however, changes in speed affect the rate of acceleration and deceleration of the mass of weights, which results in change of effective counterbalance. These changes can be expressed by formula : $C_e = C + C_a$. Where C_e = effective counterbalance (lb.), C = actual counterbalance (lb.), g = accleration of gravity (32 ft./sec.^{2}), a = vertical acceleration (ft./sec.^{2}). An ideal effective counterbalance should equal the load consisting of weight of rods plus half of the weight of fluid. An example is worked out for illustration. The effect of counterbalance on torque is discussed. To calculate the torque, a formula was used : $T = (W - C_e)R \sin O$, where T = torque (in.-lb.), W = well load (lb.), C_e = effective counterbalance (lb.), R = crank radius (half of stroke) (in.), O = angle between instantaneous crank position and position of crank at bottom of stroke. This formula, which is approximate, assumes uniform motion of the crank and vertical load at the wrist-pin.

It is indicated that these simple formulae neglect very many important factors. These are to be discussed in further instalments of this series of papers on pumping. A. H. N.

179.* The Explosive Cord. Anon. *Oil Wkly*, 4.10.43, **111** (5), 14.—The explosive cord has been used successfully in removing mud, rust, scale, wax, and other foreign matter from holes and slots of perforated liner or casing and the opening through screen pipe. It has also been used to loosen pipe that could not be pulled under safe strain. The cord is run into the well on the end of a conductor cable, to which it is joined by a special water-proof, firing-head connection. It is positioned opposite the perforations or screen to be cleaned, and is kept straight through its length by a sinker bar attached to its bottom end. The cord may be at the bottom of the well or at any one or more places up the hole where perforations are to be cleaned. Under most conditions two or more lengths of cord fastened together in parallel are used opposite the section of pipe to be cleaned, and when there are more than one of these sections, a single length of cord joins the multiple strands used opposite the perforated sections. The single cord will have no effect on the blank casing connecting the sections to be cleaned. Perforations at two or more places can thus be cleaned at the same time, but it is not economical to clean more than one zone per run if the zones are more than 100 ft. apart.

The size of the pipe, the condition of the well, and the tightness of the formation against the pipe determine the number of cords to use. The majority of the jobs have probably been done with two cords. Regardless of other conditions, only one cord is recommended in zones likely to give sand trouble. In one job recently performed to loosen screen pipe, four cords were used, and examination of the screen after it was pulled out showed that no serious damage had been done to it. Only the wire wrapping had been slightly bulged opposite the perforations in the liner. The cord is like a slow-burning fuse, and can be used whether there is fluid in the hole or not; but it is best used under fluid. Certain details about its operation are given. A. H. N.

180.* Correct Spacing Increases Gas-Lift Efficiency. H. F. Simons. *Oil Gas J.*, 7.10.43, **42** (22), 78.—The paper deals with the spacing of a conductor pipe in relation to the standing valve of an accumulation chamber of an intermittent gas-lift system. The system uses a packer, accumulation chamber, a conductor pipe, a bottom-hole operating valve, and a standing valve. In setting the packer, the tubing is turned to release the slips, and then lowered to expand the packer. This produces a telescoping effect as far as the relation of the conductor pipe to the accumulation chamber and standing valve is concerned. If the travel of the packer in setting is 18-in., then the conductor pipe approaches the standing valve that much. If sufficient allowance has not been made for this travel, the conductor pipe will sit down on the standing valve, and the system will not function. If the spacing is too great, the system will work, but the accumulation chamber will not be exhausted each time gas is admitted, and sand and debris will collect on top of the standing valve. For this reason the bottom of the conductor pipe should be approximately 6 in. from the standing valve mentioned above, which means that when the equipment is assembled on the floor for running in the hole, the conductor pipe should be about 24 in. from the standing valve. If a packer requiring more or less travel to expand is used, the spacing must be adjusted accordingly. A. H. N.

181.* First Triple-Zone Completion in Texas Successfully Made in Lake Creek Field. E. H. Short, Jr. *Oil Gas J.*, 21.10.43, **42** (24), 76.—The procedure is described after briefly discussing the three zones, *A*, *B*, and *D*, which are to be produced simultaneously. After the usual tests, the operational steps involved were as follows: (1) A 7⅝-in. dual-completion packer with junk pusher at lower end was installed in the casing above zone *D*. (2) A 5-in. × 7⅝-in. packer with circulation port above was installed a short distance below zone *A*. This horizon was then washed in with water through circulating port in the wash-joint. Gas was then injected down the 5-in. casing, and the water flowed up through the annular space between the 7⅝-in. and 5-in. casing. Wash-joint port was then closed in the 5-in. and the upper sand allowed to clear itself. (3) The 2½-in. tubing was set in the 7⅝-in. packer on bottom with the tubing side-door port open. A swab was run down to the choke (choke will not permit swab to go lower) and the tubing swabbed in order to bring in zones *B* and *D*. Side-door choke closed to separate middle and lower formations. Each zone was thoroughly tested before the next zone was brought in.

This triple-completion represents a substantial saving. A. H. N.

182.* Water-Injection Programme Benefiting East Texas. R. W. Byram. *Oil Wkly*, 25.10.43, **111** (8), 16.—The effects of salt-water injection on maintaining pressure and increasing production in East Texas are given. Since January 1943 the daily average production of oil has risen from a low value of 324,627 brl. in February to 382,605 brl. in September, an increase of 57,978 brl. daily, or 17·9%. During this same period the daily average production of water rose from 340,524 brl. in February to 356,985 brl. in September, a gain of 16,461 brl., or only 4·8%. During the nine months, despite the fact that production constantly rose (with the exception of the short month of February), the total decline in pressure was only 5·11 lb., an average of 0·5677 lb./month. Total production for the period was 95,214,585 brl., and 18,632,991 brl. of oil were produced for each pound of pressure lost. The average decline/million brl. of oil produced was 0·0537 lb./sq. in.

In order to prevent the production of salt water as far as possible, the Texas railroad commission has instituted two plans. Under one plan it is possible to pay for injection in part by " bonus oil." This provides for the production from some other lease of 1 brl. of oil for each 50 brl. of salt water produced from leases with large amounts of water and put into some of the salt-water-injection systems. A maximum of 8 brl. of oil may be produced for the credit of any particular well. However, as a companion to this programme, the Commission has, in effect, another order which forbids the production of more than 5 brl. of water for every brl. of oil produced, unless the excess water is turned into some disposal system for injection. This order, the first of its kind issued, was sustained in a decision handed down in the Third Court of Civil Appeals at Austin on 6th October, 1943. The net result of this programme is to encourage, through the bonus payments, injection of water through the various private and public services offered. The ratio order prevents production of large volumes of water by those operators who feel that the bonus is insufficient.

The paper contains a great number of production and other data. A. H. N.

183.* Effect of Temperature and Vapour Pressure of Oil Upon Volumetric Pumping Efficiency. G. M. Stearns. *Oil Wkly*, 25.10.43, **111** (8), 24–29. *Paper Presented before American Petroleum Institute.*—The article given in the *Oil Weekly* is an abstract of a progress report entitled " On Experimental Investigation of Volumetric Efficiency of Sucker-Rod Pumps." Tests conducted with an experimental well hook-up, that simulates actual conditions as nearly as possible, have been made which show a slightly decreasing volumetric efficiency of a pumping well as the temperature of the oil is increased. This trend, indicated by the plotted results shown, is believed to be the result of the lower viscosity of the oil at the higher temperatures, thus causing increased slippage of the fluid past the plunger. Apart from this factor, investigation was conducted into a possible change in plunger fit (resulting from a difference in coefficients of thermal expansion of the stainless-steel plunger and cast-iron liners) affecting efficiency ; also whether or not the increased vapour pressure at the higher temperatures caused lower efficiency. Judging from the data obtained in Series A and B, there was no evidence that the third factor mentioned above had an appreciable effect, since decreased volumetric efficiency due to higher vapour pressure should be evidenced by compression of gas between the valves at the beginning of the downstroke. No such indication could be found from a study of indicator diagrams taken during the tests of these two series.

As to the effect of differential expansion of the plunger and liners, it is believed that this would cause a closer fit of the plunger at the higher temperature, since the coefficient of thermal expansion for stainless steel is in general higher than that for cast iron. So such expansion would partly annul the effect of additional leakage due to reduced viscosity of the oil. It should be pointed out, however, that no data have been obtained regarding the exact composition of the steel and cast iron of the plunger and liners used on the test in order accurately to evaluate the coefficients of expansion of the two materials.

Further data on vapour pressure gas-lock show that it is impossible to pump oil from a well with a reasonably high pump efficiency using the ordinary sucker-rod pump, if the vapour pressure of the oil exceeds the submergence pressure on the pump. Further, it leads one to believe that better pump action can possibly be obtained on certain low-fluid-level wells by providing some means of lowering the vapour pressure of the oil entering the pump. These test results emphasize the importance of placing a pump as near the bottom of the hole as possible, in order to have a maximum submergence pressure. A. H. N.

184.* Plastic Plugbacks in East Texas. J. E. Bailey and C. E. Dimit. *Oil Gas J.*, 28.10.43, **42** (25), 52–53. *Paper Presented before American Petroleum Institute.*—Since November 1942 plastics have been used to plug off water in wells in the East Texas field, using only the dump-bailer method. The plastic now being used is similar to backelite, and is a clear amber liquid containing no undissolved or suspended particles. This particular plastic has the property of changing from a liquid into a solid by the application of heat. The higher the temperature, the faster this particular plastic changes into a solid and, conversely, the lower the temperature the slower is the transformation. The East Texas field has a bottom-hole temperature in the neighbourhood of 145° F., at which temperature this plastic solidifies in approximately 12 hrs. Because of the comparatively few jobs outside of the East Texas field, the length of time required for this hardening process to take place in wells of different bottom-hole temperatures cannot be definitely stated. The setting times at different temperatures as measured in the laboratory are given, ranging from 30 hrs. at 135° F. to 1 hr. at 195° F. Setting in wells takes longer, probably due to poor heat conductivity in the larger sample. The viscosity of the plastics at 60° F. is *circa* 200 cp. Details of penetration of strata by the plastic liquid and the use of Jelflake to reduce penetration are given. Properties of the solid—comparable to those of cement—are discussed. The equipment and method of use are described.

At the present time a minimum price of about $300 has been established for plugging services, which includes supplying 30 gals. of plastic, if needed. Charges for electrical log, tubing crews, and materials vary as desired by individual operators, but the total charges for a complete job should be in the neighbourhood of $600–1000. These costs are to be compared with costs of different types of cement jobs of $500–3000, depending on type used. It is generally conceded that the average plastic plug job is considerably cheaper than the average bradenhead squeeze or retainer squeeze (the two most successful types of cementing jobs in East Texas).

Typical results of such plug-backs are given in tables and are discussed. At the present time several plastics are in various stages of development. It is felt that desired setting times can be obtained with resins that will range from 120° to 200° F.; the low range will use a resin that sets in 6–12 hrs., and the upper range, around 200° F., will use a resin that hardens in 2 or 3 hrs. Also envisioned for the future is the use of a catalytic setting resin that will provide greater elasticity of operation than the present thermal setting resins. A. H. N.

185.* Surface Pumping Equipment—Speed Reducers. J. Zaba. *Oil Gas J.*, 28.10.43, **42** (25), 58.—A brief historical sketch of speed reducers for pumping equipment is given. Original worm-gear reducers furnished a smooth and silent medium of transmission of power, but their transmission efficiency was rather low. When the trend of field practices towards savings in operating expenses became more pronounced, the spur-gear pumping unit was introduced. The spur gear was more efficient from the standpoint of transmission of power than the worm gear, but was noisy in operation. Modern helical and herringbone-gear speed reduces combine quietness and smoothness of operation with high efficiency of transmission. A geared speed reducer consists of several elements, each of which is a factor contributing towards satisfactory service of the unit. These elements are: (1) the high- and low-speed shafts (the low-speed shaft connected through crank to the well load is subjected to torsion and bending; the high-speed shaft is subjected to torsion and also to bending if the reducer is connected to the prime mover by V-belt); (2) the bearings which are subjected to pressure; (3) the gears which have to withstand tension and wear; (4) the housing, which must resist pressure (an improperly designed housing may bring about eventual misalignment of gears); (5) the lubricating system; (6) the sealing system, the function of which is to prevent leakage of the lubricant and to eliminate intrusion of dirt and other foreign matter into the housing; (7) the foundation.

The first four items are usually beyond the control of the operator, as they are determined by the designer. The mechanics and dynamics of speed reducers are discussed. The effects of balance on load, position of crank, and length of stroke are studied in some detail. Formulae are given for calculating loads and torques.
A. H. N.

186.* Petroleum—Past, Present, and Future. P. K. Frolich. *Industr. Engng Chem.*, 1943, **35** (11), 1131.—A statistical review is given of the United States and World production and consumption of petroleum over the period 1920–1942. Graphs are presented which show the annual production of various petroleum products, the number of passenger cars, gasoline consumed, number of domestic oil burners installed, crude production, and reserve estimates. From a consideration of these data it is concluded that there will be no immediate shortage of petroleum, but that in the next or later generation a shortage of the natural product will occur. When this takes place synthetic products from gas reserves, shales, coals, and vegetable produce will gradually work their way into the picture. J. W. H.

187.* Surface Pumping Equipment—Prime Movers. J. Zaba. *Oil Gas J.*, 4.11.43, **42** (26), 51—53.—The hydraulic horsepower can be calculated from

$$\text{H.P. hydr.} = \frac{Q \times W \times L}{33{,}000 \times 24 \times 60} = \frac{Q \times W \times L}{33{,}000 \times 1440}$$

where H.P. hydr. = hydraulic horse-power; Q = barrels of fluid in 24 hours; W = weight of barrel of fluid (lb.); L = lift (ft.).

The lift, which is the distance from the surface to the pumping-fluid level, can be either measured or calculated. Measurements can be made by use of any of the available fluid-level determination methods. Calculations can be made from data on the producing bottom-hole pressure or from information on well's static bottom-hole pressure and productivity index factor. The method of calculation is given.

The polished-rod horse-power is given by

$$\text{H.P. pr.} = \frac{A \times S \times N \times C}{L \times 12 \times 33{,}000}$$

where H.P. pr. = polished-rod horse-power; A = area of card (sq. ins.); S = polished-rod stroke (ins.); N = strokes/min.; C = calibration constant (lb./in.) of card height; L = length of card (in.).

A study of efficiencies is made. An overall 40% may be taken for approximate calculations. An empirical formula may be used for power necessary for overcoming friction of the subsurface system. This formula can be written as follows:

$$\text{H.P. } f. = \frac{\frac{1}{8} Wr + 25 \times N}{33{,}000.}$$

Where H.P. $f.$ = power to overcome subsurface friction; W_r = weight of rods (lb.); S = length of polished-rod stroke (ft.); N = number of strokes/min. Power calculated with this formula added to the hydraulic horse-power as calculated from Formula 1 would give approximate polished-rod horse-power requirement. By assuming surface efficiency, brake horse-power requirements would be arrived at.

A. H. N.

188.* Abstracts of Papers Presented before American Petroleum Institute. Anon. *Oil Wkly*, 15.11.43, **111** (11), 35—38.—The following papers are abstracted: (1) Permeability as Related to Productivity Index, by N. Johnston and J. E. Sherborne; (2) A New Application of Water Injection for Maintaining Reservoir Pressure and Increasing Natural Water Drive, by W. L. Horner and D. R. Snow; (3) The Foaming Tendency and Stability of Crude Petroleum, by W. H. Somerton; (4) Preliminary Field Tests for Determining Required Injection Volumes and Pressure, and Plant Capacity, by J. H. Cable; (5) Geological Factors Involving Secondary Recovery, by C. R Fettke; (6) Influence of Fluid Saturation on Secondary Recovery of Oil, by P. A. Dickey; (7) Prediction of Secondary Recovery from Core Analyses, by R. C. Earlougher; (8) Influence of Viscosity of Crude Oil on Secondary Recovery, by W. A. Heath; (9) Theoretical Calculations for Use in the Installation and Operation of Secondary-Recovery Projects, by G. H. Fancher; (10) Surface-Tension Effects in Secondary Recovery, by P. D. Torrey; (11) Electrical Model Studies of Secondary Recovery, by W. L. Horner; (12) Economic Factors in Secondary Recovery, by W. B. Berwald; (13) Standardization of Electrical-Log Headings, by W. L. Jarvis; (14) Counterbalancing of Oil-Well Pumping Engines, by E. N. Kemler; (15) Building the "Big Inch" Pipe Lines, by B. E. Hull; (16) Manpower for Oil Production, by J. M. Lovejoy; (17) Drilling Efficiency Under Wartime Conditions, by A. H. Rowan; (18) Wartime Instruction and Training of Employees, by L. S. Wescoat.

A. H. N.

189.* Drilling and Production Patents. L. E. Couch. 2,327,340, 24.8.43. Appl. 9.12.40. Perforating gun for oil-well casings.

J. S. McDonald and W. E. A. Ruska. U S.P. 2,327,362, 24.8.43. Appl., 5.10.40. Improvement in guns for casing.

O. R. Rowe. U.S.P. 2,327,461, 24.8.43. Appl. 10.2.42. Trailer derrick in combination with a tractor.

J. D. Spalding. U.S.P. 2,327,467, 24.8.43. Appl. 18.1.38. Rotary draw-works.

T. S. Chapman. U.S.P. 2,327,501, 24.8.43. Appl. 5.12.40. Drilling fluid.

C. J. Coberly. U.S.P. 2,327,503, 24.8.43. Appl., 2.8.40. Well-pump construction.

J. C. Conrad and H. L. Conrad. U.S.P. 2,327,506, 24.8.43. Appl. 8.11.41. Footage indicator for drilling.

C. W. Savitz. U.S.P. 2,327,610, 24.8.43. Appl. 6.6.38. Circulation valve for use in oil-wells.

T. S. Harris. U.S.P. 2,327,637, 24.8.43. Appl. 10.6.40. Deep-well pump.

W. L. Horner. U.S.P. 2,327,642, 24.8.43. Appl. 3.1.38. Method and apparatus for measuring porosity of solids.

L. C. Miller. U.S.P. 2,327,658, 24.8.43. Appl. 12.12.39. Methods of and means for orienting tools in well-bores.

H. O. Williams and A. A. Jens. U.S.PP. 2,327,686, 2,327,687, 24.8.43. Appl. 1.8.38. Methods of making deep-well screens.

A. L. Armentrout. U.S.P. 2,327,693, 24.8.43. Appl. 4.4.41. Apparatus useful in directional well drilling.

T. W. Burnam. U.S.P. 2,327,996, 24.8.43. Appl. 24.11.41. Process of dehydrating mineral-oil emulsions.

D. H. Furse and L. J. Neuman. U.S.P. 2,328,001. 24.8.43. Appl. 11.3.40. Means and method of bringing oil wells into production.

M. Hattan. U.S.P. 2,328,013, 24.8.43. Appl. 8.12.41. End fitting for high-pressure hose.

C. S. Crickmer. U.S.P. 2,328,127, 24.8.43. Appl. 2.5.41. Sucker-rod stripper.

W. W. Foster. U.S.P. 2,328,133, 24.8.43. Appl. 21.11.41. Pull-line drum and mounting for catheads.

F. I. Alexander. U.S.P. 2,328,247, 24.8.43. Appl. 8.12.41. Casing gun for perforating oil-well pipes.

L. L. Hazen. U.S.P. 2,328,274, 24.8.43. Appl. 10.6.40. Earth drilling mechanism for wells.

G. F. Turechek. U.S.P. 2,328,308, 24.8.43. Appl. 30.5.42. Gun perforator for oil-well pipes.

G. F. Turechek and L. Spencer. U.S.P. 2,328,309, 24.8.43. Appl. 19.9.42. Firing-head for gun perforators.

F. K. Daniel. U.S.P. 2,328,426, 24.8.43. Appl. 26.8.38. Drilling fluid.

H. Hoover, Jr. U.S.P. 2,328,555, 7.9.43. Appl. 27.5.40. Well logging by hydrocarbon analysis.

G. W. Miller and W. L. Kimsey. U.S.P. 2,328,663. 7.9.43. Appl. 20.5.40. Well-pumping device for multi-well systems.

H. P. Miller. U.S.P. 2,328,735. 7.9.43. Appl. 7.4.41. Under-reamer for oil wells.

B. H. Barnes and B. S. Minor. U.S.P. 2,328,771, 7.9.43. Appl. 12.11.40. Apparatus for installing protectors on drill-pipe.

P. T. Bynum. U S.P. 2,328,782, 7.9.43. Appl. 23.5.41. Fluid well perforator.

J. D. Luebkeman. U.S.P. 2,328,819, 7.9.43. Appl. 14.2.42. Hose coupling.

C. M. O'Leary. U.S.P. 2,328,840, 7.9.43. Appl. 3.6.40. Liner ranger.

C. M. O'Leary. U.S.P. 2,328,841, 7.9.43. Appl. 21.1.41. Times intermitter.

A. L. Stone. U.S.P. 2,328,856, 7.9.43. Appl. 20.3.40. Composite drill collar.

G. Allen. U.S.PP. 2,329,025, 2,329,026, 7.9.43. Appl. 27.6.42. Processes for breaking petroleum emulsions.

G. H. van Leeuwen. U.S.P. 2,329,148, 7.9.43. Appl., 18.9.36. Process of impermeabilizing, tightening, or consolidating grounds and other earthy and stony masses and structures.

M. W. Frack. U.S.P. 2,329,157, 7.9.43. Appl. 30.4.41. Well-treating tool.

T. R. Thoren and B. C. Bredenbeck. U.S.P. 2,329,165, 7.9.43. Appl. 27.2.42. Thread protector.

A. E. Hambly. U.S.P. 2,329,196, 14.9.43. Appl. 15.7.40. Pipe tong.

L. A. Schmidt, Jr. U.S.P. 2,329,223, 14.9.43. Appl. 23.6.42. Substratum water control.

L. L. Snyder and A. Holander. U.S.P. 2,329,225, 14.9.43. Appl. 3.12.40. Coring device.

M. Reagan. U.S.P. 2,329,295, 14.9.43, Appl. 22.3.40. Mud screen.

H. J. Pankratz. U.S.P. 2,329,359, 14.9.43. Appl. 21.11.41. Well pump of the hydraulic type.

A. K. Flynn. U.S.P. 2,329,461, 14.9.43. Appl. 12.1.42. Mud-trap drilling pit.

F. A. Diehl and M. B. Cockburn. U.S.P. 2,329,597, 14.9.43. Appl. 10.3.42. Directional drilling sub for oil wells.

M. De Groote and B. Keiser. U.S.P. 2,329,699, 21.9.43. Appl. 8.9.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,329,700, 2,329,703, 21.9.43. Appl. 20.10.41. Processes for breaking petroleum emulsions.

F. M. Varney and J. A. Varney. U.S.P. 2,329,732, 21.9.43. Appl. 8.9.41. Signalling deviation detector for drilling wells.

W. M. Crook. U.S.P. 2,329,745, 21.9.43. Appl. 15.10.40. Means of protecting bearings of roller bits.

B. Cerf. U.S.P. 2,329,878, 21.9.43. Appl. 14.3.41. Drilling fluid and the method of drilling and lubricating wells.

A. M. Kizziar. U.S.P. 2,329,913, 21.9.43. Appl. 1.8.39. Oil-well pump.

J. T. Phipps. U.S.P. 2,329,939, 21.9.43. Appl. 15.4.40. Well tool.

M. M. Verheul. U.S.P. 2,329,960, 21.9.43. Appl. 26.7.41. Float-valve.

J. H. Wiggins. U.S.P. 2,329,965, 21.9.43. Appl. 2.12.38. Side wall for floating tank roofs.

J. H. Wiggins. U.S.P. 2,329,966, 21.9.43. Appl. 24.5.40. Floating tank roof-seal.

J. H. Wiggins. U.S.P. 2,329,967, 21.9.43. Appl. 12.2.42. Supporting structure for floating tank roofs.

W. L. Church and W. K. Holleron. U.S.P. 2,329,981, 21.9.43. Appl. 24.6.40. Drill steam valve.

B. W. Sewell. U.S.P. 2,330,083, 21.9.43. Appl. 3.3.42. Retractable drill-bit.

R. C. Buchan. U.S.P. 2,330,110, 21.9.43. Appl. 31.10.41. Method for placing explosives in shooting wells.

D. D. Powers. U.S.P. 2,330,144, 21.9.43. Appl. 4.5.39. Apparatus for treating wells.

H. A. Reimers. U.S.P. 2,330,145, 21.9.43. Appl. 2.8.40. Method of sealing pores in subterranean formations contiguous to deep-well bores.

J. C. Stokes. U.S.P. 2,330,155, 21.9.43. Appl. 11.5.42. Coring apparatus.

J. C. Stokes. U.S.P. 2,330,157, 21.9.43. Appl. 1.8.42. Wire-line core-barrel.

R. C. Baker. U.S.P. 2,330,258, 28.9.43. Appl. 22.9.41. Trip device for well apparatus.

R. C. Baker. U.S.P. 2,330,259, 28.9.43. Appl. 22.9.41. Well packer.

C. E. Burt. U.S.P. 2,330,265, 28.9.43. Appl. 16.5.41. Explosive trip for well devices.

C. E. Burt. U.S.P. 2,330,266, 28.9.43. Appl. 16.3.42. Cementing plug.

C. E. Burt. U.S.P. 2,330,267, 28.9.43. Appl. 3.4.42. Well cementing apparatus.

E. Babcock. U.S.P. 2,330,327, 28.9.43. Appl. 17.12.41. Pressure core-taker.

W. J. Crites. U.S.P. 2,330,336, 28.9.43. Appl. 9.12.40. Apparatus for pumping fluids from wells.

D. W. Jayne. U.S.P. 2,330,366, 28.9.43. Appl. 26.7.40. Apparatus for preventing evaporation from oil-storage tanks.

R. W. Stuart. U.S.P. 2,330,394, 28.9.43. Appl. 25.7.40. Detection of salt in drilling fluids.

F. A. Groetjen. U.S.P. 2,330,419, 28.9.43. Appl. 28.4.41. Oil well pumping unit.

F. N. Fossati. U.S.P. 2,330,432, 28.9.43. Appl. 6.2.42. Weight indicator.

M. De Groote. U.S.P. 2,330,474, 28.9.43. Appl. 25.6.41. Process for breaking petroleum emulsions.

O. J. McCullough. U.S.P. 2,330,509, 28.9.43. Appl. 30.6.40. Gun tester.

C. C. Dyer. U.S.P. 2,330,564, 28.9.43. Appl. 12.5.41. Mud ejection control.

C. N. Anderson. U.S.P. 2,330,659, 28.9.43. Appl. 2.5.41. Cementing plug.

M. C. Leverett. U.S.P. 2,330,721, 28.9.43. Appl. 18.5.42. Method of determining connate water content of cores.

S. T. Sikes, Jr. U.S.P. 2,330,752, 28.9.43. Appl. 24.11.41. Rate-of-penetration indicators.

S. T. Sikes, Jr. U.S.P. 2,330,753, 28.9.43. Appl. 24.11.41. Direct-reading rate-of-penetration meter.

C. L. Allen. U.S.P. 2,330,795, 5.10.43. Appl. 17.4.40. Rotary well-drilling machinery.

C. F. Terrell, Jr. U.S.P. 2,330,933, 5.10.43. Appl. 20.11.40. Drilling apparatus.

H. Schindler. U.S.P. 2,331,049, 5.10.43, 17.4.41. Drilling mud.

L. Spencer. U.S.P. 2,331,057, 5.10.43. Appl. 4.3.42. Gun perforator.

J. C. Stick, Jr. U.S.P. 2,331,058, 5.10.43. Appl. 14.8.42. Firing apparatus for gun perforators.

H. A. Hansen. U.S.P. 2,331,072, 5.10.43. Appl. 24.1.41. Method and means of developing oil-fields.

W. I. Williams. U.S.P. 2,331,151, 5.10.43. Appl. 24.1.39. Fluid-actuated pump.

F. Willis, Jr. U.S.P. 2,331,152, 5.10.43. Appl. 17.3.41. Means of logging wells.

F. N. Alquist. U.S.P. 2,331,155, 5.10.43. Appl. 15.8.39. Treatment of wells with paraffin solvents.

J. S. Gordy. U.S.P. 2,331,185, 5.10.43. Appl. 9.5.40. Cementing tool.

A. H. N.

Transport and Storage.

190.* Ingenious System Recovers Tank-Generated Vapours. Anon. *Oil Gas J.*, 30.9.43, **42** (21), 57.—A description is given of a small plant consisting of a scrubber and compressor, which has been installed in a Californian field, with the object of recovering vapours from the crude tanks and delivering them to the gathering system of a gasoline plant in the vicinity and fed principally from oil and gas separation units in the surrounding field. R. A. E.

191.* Bacterial Corrosion of Water-Cooling Pipes. C. L. Clark. *Oil Gas J.*, 7.10.43, **42** (22), 65.—Unexpectedly severe internal corrosion of water-cooling pipe-lines in a roller bearing factory at Canton, Ohio, has been attributed to sulphate reducing bacteria. The water, which is from a well, has a high calcium sulphate content, but from the analyses given would not appear to be corrosive, and has caused no corrosion difficulties in the city water-lines. An examination of the corrosion products from the above lines revealed the presence of large amounts of sulphur, either as sulphides or free sulphur, which were not present in the water, and could not be produced from the calcium sulphate under normal conditions. It was also apparent that H_2S was being evolved in the water system and that the corrosion was slowly spreading throughout the system. A bacteriological examination of the water was made and the sulphate-reducing bacteria identified. Cultures from this bacteria caused severe corrosion of iron in the laboratory. It is suggested that chlorination of the water is the best means of eliminating the bacteria. C. L. G.

Crude Petroleum.

192.* Refining West Texas Crude. H. H. Wenzke. *Oil Gas J.*, 14.10.43, **42** (23), 43.—Increasing quantities of West Texas crude will be available to refiners in the Mid-Continent. Problems arising from the use of these high-sulphur content oils are (1) corrosion of equipment, (2) more drastic treatment of products for the market. There are wide variations in gravity, gasoline content, sulphur content, salt content, and the form in which salt is present (brine or crystals), between crude oils from different fields in West Texas. The properties, yields of products, analyses of products (including sulphur distribution and type), and results of cracking a distillate/residue blend in a Dubbs pilot plant are given for a crude oil from the Slaughter–Duggan field. The straight-run gasoline from this crude contains 0·32% sulphur, mainly due to high boiling mercaptans, sulphides, and disulphides. It is desirable to remove mercaptans as far as possible to improve lead susceptibility. The Unisol process may be used for this purpose. The cracked gasoline contains 0·68% sulphur, of which 0·3% is present as mercaptans and much of the balance due to ring sulphur compounds. The Unisol or similar process is recommended for mercaptan removal. To reduce total sulphur content of these gasolines to maximum 0·1% is unnecessary and wasteful, and upward revision of this limit which still applies in certain States is recommended.

Experience gained in a thermal cracking plant operating on reduced crude from this crude and originally constructed without thorough appreciation of the corrosive nature of the oil is given, with inspection details. Indications are given of the type of alloy steel required in various sections and where linings are desirable. Data on the reforming of a West Texas gasoline are provided. The fluid catalytic cracking process can be utilized for treatment of gas-oils of relatively high sulphur content, using silica–alumina catalyst. Refractory linings are used in certain sections and alloy liners in others when treating such oils. Considerable sulphur reduction is obtained by one-pass treatment followed by acid refining or by a two-pass treatment, which also improves fuel quality. R. A. E.

Cracking.

193.* Cracking Technology. Part 2. Causes of Coke Formation. C. A. Wagner. *Oil Gas J.*, 9.9.43, **42** (18), 66.—The author discusses many conditions of cracking in which carbon deposition occurs. In some cases it seems certain that strongly exothermic polymerization reactions produced coke by dehydrogenation of complex polymers. The polymers separate out as a liquid on tube walls, and, owing to slow movement, are not able to escape from the zone of high temperature and are destructively distilled producing coke, asphaltenes, etc. Quenching by the introduction of controlled quantities of cooler oil, at points where the hot material leaves the reactor to enter the fractionator, avoids further decomposition by limiting the time of contact at high temperatures. Quenching temperatures must be lowered as pressure of the hot vapours is reduced; at 100 p.s.i. the vapour may be safely handled at 700° F., but at

5 p.s.i. a temperature as low as 500–600° F. is necessary to avoid coking. Large reservoirs of slow-moving hot oil enable coking to take place. Although the rate of cracking, as measured by the disappearance of charging stock, is affected by time and temperature only, and not by pressure, the character of the product is influenced, greatly by pressure as well as by temperature and time. The composition of the gas produced is a function of the temperature and pressure, and to a less extent of the composition of the charge. In general, it may be said that the olefin content of the gas produced will rise as the temperatures are increased and will decline as the pressure on the reaction zone is raised. W. H. C.

194.* Cracking Technology. Part 4. Cracking Recycle Stock. C. R. Wagner. *Oil Gas J.*, 30.9.43, **42** (21), 45.—Results of early experiments on pressure distillation of virgin gas oil and a recycle stock of similar boiling range are presented. These were carried out at a pressure of 95 lb. per sq. in. and at temperatures varying between 750° F. and 806° F., the results showing that much higher temperatures are required to crack the recycle oil. Also, when cracking the fresh gas oil, increase in distillation rate (*i.e.*, temperature) resulted in decreased polymerization of the tar for similar overall yields of distillate.

These results are supported by other experiments, leading to the conclusion that longer exposure of cracked products to cracking condition results in molecular rearrangements which enable the material left in the still to resist further treatment at the same temperature.

It would be difficult to repeat these experiments in modern plants operating at much higher pressures and temperatures, and the results would be of limited value, as the coils of a modern combination unit each receive a mixture of fresh and recycle stocks, some containing considerable heavy gasoline. Stripping of these heavy gasolines from recycle cuts is desirable as far as practical considerations, particularly in regard to fractionating tower pressures, permit. R. A. E.

195.* Cracking Technology. Part 5. Commercial Unit Yields Confirm Pilot Plant Data. C. R. Wagner. *Oil Gas J.*, 7.10.43, **42** (22), 73.—A comparison has been made between the results obtained in a commercial multiple-coil cracking unit and those in a laboratory size unit processing reformer charge, light gas oil, heavy gas oil, and visbreaker charge from Illinois crude. Five runs were made on each stock, varying the crack per pass in order to duplicate plant conditions. The result show that comparable results are obtainable, the greatest trouble being in securing a proper mixture of recycle stock and fresh charge. This is best checked by watching the distillation range and aniline point of the charge to the coils. Yields from the different stocks indicate that the light gas oil is the most resistant, as it contains recycle stock from the other charges after processing. The two heavy oil coils produce little gasoline, but mainly gas oil for the light oil cracking coil. Data on the experimental runs are given and a tabulation of the comparative yields from the light-oil charge under experimental and commercial operating conditions. C. L. G.

196.* Cracking Technology. Part 6. Catalytic Cracking Processes in Use To-Day. C. R. Wagner. *Oil Gas J.*, 14.10.43, **42** (23), 67.—Brief descriptions of the Houdry, Fluid Catalyst, and T.C.C. catalytic cracking processes are given. Few details are available concerning the Phillips Petroleum Co's. Cycloversion Process, but it is said to yield highly aromatic products from naphthas and selected gas oils. Catalytic cracking invariably produces a higher ratio of aromatics to olefines than thermal processes, but the total aromatics in the distillate of E.P. 400° F. may be little greater except under selected conditions of charging stock and catalyst.

Characteristics of catalytic processes are absence of heavy fuel-oil polymers in recycle stock and the aromatic nature of the recycle stock. Possible explanations are advanced.

At present the most common process used for catalytic reforming of naphtha is that known as hydroforming, which is briefly described and illustrated by flow sheet. Other processes are in the development stage. Hydroforming yields a product rich in aromatics—*e.g.*, from a narrow boiling cut consisting essentially of *n*-heptane and methyl*cyclo*hexane a product, rich in toluene, can be obtained. The reaction stage seem to be (1) dehydrogenation of paraffins, (2) cyclization to *cyclo*hexane derivatives, (3) dehydrogenation of the naphthenes. Higher yields and octane numbers are obtained by this process than by thermally reforming the same stock. R. A. E.

197. Cracking Technology. Part 7. Reforming Naphthas by Thermal Methods. C. R. Wagner. *Oil Gas J.*, 28.10.43, **42** (25), 62.—The effect of temperature and pressure conditions during reforming on the yield and properties of gasoline produced are briefly discussed, with tabulated data and graphs showing these relationships.

The recirculation of C_3 and C_4 gases through the reforming unit enables the temperature to be raised, increasing the crack per pass and the O.N. of the reformate, and also producing some high O.N. polymerizate, although requiring additional furnace and gas-recovery equipment. Allowance must also be made for the additional butane produced in determining the gasoline butane requirements. From data on the octane ratings of reformed 250–400° F. Illinois naphtha it is shown that the rate of increase in crack per pass does not bring about a proportional increase in octane rating. Similarly, the distillation curves approach an equilibrium point, any further increase in crack per pass increasing the production of gas and fuel oil.

Reforming tends to remove mercaptans, and hence improves lead susceptibility, but increases in coil pressure tend to favour the formation of mercaptans from H_2S and olefins. It is necessary for the refiner to determine the optimum boiling range of the naphtha and the temperature or crack per pass for reforming operations, and, in general, there should be as close fractionation as possible between the light gasoline and the naphtha to be reformed. Based on data on Mount Pleasant, Michigan crude, it is shown that all possible *n*-octane should be left in the naphtha and all aromatics and naphthenes boiling below 250° F. in the gasoline cut, whereas leaving *n*-heptane in the reformer charge would also exclude methyl*cyclo* hexane and toluene from the gasoline cut, unless very close fractionation equipment were available to separate them. C. L. G.

Refining and Refinery Plant.

198.* Removal of Organic Sulphur Compounds from Gases. N. Booth and L. J. Jolley. *J. Soc. Chem. Ind.*, 1943, **62**, 87–88.—Gases such as water gas, coal gas, and coke-oven gas contain appreciable quantities of organic sulphur compounds, chiefly as carbon disulphide and oxysulphide, and the paper describes how these compounds can be greatly reduced by water-washing under pressure. Thus at 15 atmos. pressure the sulphur in a coal gas has been reduced from 0·2 to 2·7 grains per 100 cu. ft. The 2·7 figure seems to be a minimum, probably due to the presence of water-insoluble sulphur compound such as thiophen. T. C. G. T.

199.* Handling Sour Crudes. J. P. O'Donnell. *Oil Gas J.*, 3.6.43, **42** (4), 27.—The difficulties encountered in refining sour crudes include : (1) additional refining to obtain products of good quality ; (2) danger to personnel from toxic gases ; (3) rapid corrosion of plant ; (4) fire and explosion hazard. Some experiences obtained by the S.O.C. New Jersey in handling sour crudes are described and explained.

Crudes showing H_2S concentration of more than 0·05 cu. ft. of H_2S/100 gall. are classed as dangerous. *All* W. Texas crudes are so classed, regardless of H_2S content.

A preliminary alkali wash is given to reduce corrosion on the plant. Preliminary topping in shell-stills also reduces corrosion in the pipe-stills and columns. Anhydrous NH_3 is introduced into overhead distillation plant to maintain the water in the stream at pH 6·5 approximately.

The virgin naphtha from the crude tower is high in H_2S, which is most economically disposed of by removal with the propane in a stabilizer, the mixture being burnt as fuel. The stabilized naphtha is soda washed and sweetened or treated with acid and alkali.

Fire and explosion hazards are introduced by the formation of pyrophoric iron sulphide on tank walls. The danger is reduced by use of floating-roof tanks and by suitable tank-lining compositions.

Arrangements for safeguarding of personnel include respirators, first-aid training, and a strictly organized routine for sampling, gauging, and general handling of products. C. G. G.

200.* New Data on Activated Bauxite Desiccants. R. G. Capell, R. C. Amero, and J. W. Moore. *Chem. Met. Engng*, July 1943, **50** (7), 107–110.—The new granulated desiccant described is called "Florite." It has been used both in laboratory scale and in large-scale operations of rubber synthesis and in natural gas, refinery gas, liquid propane, and pipe-line products (up to fuel oil) dehydration. Its properties and behaviour are described together with the effects of such factors as column height, fluid velocity, etc., on its dehydrating qualities. Data are presented both graphically and in tabulated form. Pressure drop for liquid drying is smaller than for gases, since linear velocities are much smaller. A plant passing 22 gals./sq. ft./min. of naphtha through a 10-ft. bed of $\frac{8}{16}$ mesh Florite will have a pressure drop of only 6·9 lb./sq. in. The pressure drop through gas-drying units is more critical because higher velocities and greater bed depths are used. For example, a pressure drop of 15 lb./sq. in. was measured across a 20-ft. bed of $\frac{4}{8}$ mesh Florite drying 2,000,000 S.C.F./hour at 920 lb./sq. in. pressure and 56° F. For this reason, $\frac{4}{8}$ mesh has been the most widely used size.

The question has often arisen as to what is the maximum velocity at which gas can be passed up through a bed of Florite desiccant without disturbing the bed and causing abrasion of the granules. Up to the present time, no satisfactory correlation of pressure, temperature, mesh size, and lifting velocity has been found. An arbitrary limit of 100 ft./min. has been set on the flow of gas through $\frac{4}{8}$-mesh Florite, although the majority of plants do not exceed 60 ft./min. and, in addition, the main drying cycle is generally carried out with the gas flowing down through the tower, only the smaller flow of regeneration gas going in the other direction. One plant operating with an upflow velocity of 180 ft./min. has shown consistently poor capacity and abrasion of the granules, regardless of the type of desiccant used; another plant with a downflow velocity of 125–150 ft./min. at 1050-lb. pressure has been troubled with abnormally high pressure drop. For liquid products, velocities range up to 30 gal./sq. ft./min. representing a good average. On regeneration, gas velocities corresponding to good practice on a gas-drying unit of similar size are used.

Regeneration and incidental operations are discussed. The paper ends with a study of possible applications in the chemical industries generally and petroleum industry particularly. A. H. N.

201. New Approach to Continuous Reactor Design. Part I. A. Brothman, A. P. Weber and E. Z. Barish. *Chem. Met. Engng*, July 1943, **50** (7), 111–114.—The paper deals with a new theoretical approach to the problem of design of continuous processing equipment for carrying out liquid-phase reactions and other combining and mixing operations. By use of the methods developed by the authors, it has been found in practice that a close approximation of the actual performance of the equipment can be predetermined, enabling the designer to calculate the number, capacity, and arrangement of the vessels required for a given throughput and degree of completion of the reaction. The mathematical derivation of the expressions used is complex, and is presented here only in summary. Use of the derived expressions, however, is not difficult, and offers a quicker and more accurate path to continuous reactor design than previously available.

The first part of the paper deals with theoretical considerations only. A. H. N.

202.* Centrifugal Separation in Process Industries. Anon. *Chem. Met. Engng*, July 1943, **50** (7), 119–126.—This paper is one of a continuous series of Reports by the Editors of *Chemical and Metallurgical Engineering*. It deals extensively with centrifuges for industrial separation, discussing particularly the newer types. Theory is very briefly discussed, attention being paid more particularly to practical aspects of centrifugal separation. Reprints of this Report may be had from the Editors.

A. H. N.

203.* New Approach to Continuous Reactor Design. Part II. A. Brothman, A. P. Weber, and E. Z. Barish. *Chem. Met. Engng*, August 1943, **50** (8), 107–110.—The simple expressions developed in Part I are elaborated and combines the formulae for time of retention of a particle in a reactor with the combining-velocity characteristics of various kinds of combining phenomena. Formulae and a monogram are presented. A. H. N.

204.* New Approach to Continuous Reactor Design. Part III. A. Brothman, A. P. Weber, and E. Z. Barish. *Chem. Met. Engng*, September 1943, **50** (9), 113–116.—Part III of this paper concludes the series. It takes an existing plant comprising ten identical reaction vessels and for a typical reaction determines the capacity of the equipment when the vessels are operated, first in batches, then continuously with four different arrangements of the vessels. The article also shows how, for a constant throughput, the various arrangements contribute to the degree of completion of the reaction. A. H. N.

205.* Tube-Heated Fractionating Tower Combination. R. G. Lovell. *Petrol. Engr*, September 1943, **14** (13), 140.—The paper gives an account of the development of pipe-stills, and simple methods for calculating the approximate duty required of a tube-heater, with graphs and tabulated data. At first it was considered that the high reflux ratios necessary would prove uneconomical, but the high heat efficiencies of pipe-stills helped to offset the loss due to refluxing. Oil velocities of only 2–3 ft./sec. and low flue-gas velocities were employed, and combustion space was insufficient without large excess of air. Efficiencies were only 25%, compared with present-day attainments of 85%. Modern furnace design with greater combustion areas has overcome the early imperfections. The recognition that radiant heat absorption must be considered separately from that of convection led to the realization of the high insulating power of the stagnant gas film surrounding the tubes. The value of turbulence in aiding heat transfer and reducing local overheating was recognized, but its effect on the flow of flue-gases was only realized later. Circulation of the flue-gases from the base of the stack to a point near the first tubes remedied greatly, by their cooling effect, the trouble of burnt tubes. Another point not recognized was that although the film of stagnant gas acted as an insulator against heat transfer by convection, it did not affect absorption by radiant rays. Brightening the surfaces of steel work by aluminium powder, etc., made the base metal more resistant to radiant heat and allowed the use of standard tee iron for tube supports. This, however, acted adversely if applied to the tubes. Modern furnaces provide area in the radiant section so liberally that a balanced draft condition exists at the top of the bridged wall, and this changes to several inches water draft in the convection section, because of its smaller area, thus sweeping away the film of stagnant gases around these tubes. W. H. C.

206.* Alloys Best Suited to Resist Sour Crude Corrosion at High Temperatures. A. L. Foster. *Oil Gas J.*, 30.9.43, **42** (21), 33.—A review is given of general experience in the handling and treatment of high-sulphur West Texas crudes from the aspects of reducing corrosion of equipment and successful refining of the products obtained. It is largely based on data supplied by the Gulf Oil Corporation.

A table shows the sulphur content, A.P.I. gravity, and gasoline content of several West Texas crudes. The corrosive nature of these crudes is due to H_2S, mercaptans, and the presence of chlorides in separated water. In the field H_2S is generally removed from the gas by the sodium carbonate process, and refinery gases are also treated by this or the sodium phenolate process. The H_2S may, in suitable locations, be used as fuel for boilers, etc., provided that a non-metallic stack is employed. The protection of tanks and other equipment involved in handling crude in the field and at the refinery is accomplished by the use of gunite, special paints, or injection of ammonia into the crude or settled water.

To minimize corrosion of topping units it is common practice to line the evaporator and fractionating tower with gunite, to construct trays, caps, risers, etc., of Mechanite (a high-carbon, high-silicon cast steel), and introduce ammonia into the vapour lines leaving the tower in order to reduce condenser corrosion. The gunite used in the Gulf Oil plants is a mixture of lumnite cement and crushed fire-brick.

Suitable treating methods applicable to straight-run distillates produced are discussed. The reduced crude may be blended with suitable fractions to reduce viscosity, or may be conveniently handled by distilling to coke, burning the H_2S and hydrocarbon gases produced under boilers, etc., and cracking the overhead distillates.

In general, corrosion experienced during cracking increases with increase in boiling range of the stock. It is generally agreed that the use of alloy steels in tubes, headers, transfer lines, etc., is essential for successful and economic cracking of West Texas crude fractions. The minimum alloy permissible increases with rise in temperature and also with rise in pressure. Thus for reforming straight-run gasoline after H_2S removal, 2–6% chromium with ½% molybdenum may be satisfactory, whereas for cracking heavier fractions at low pressures and very high temperatures 18–8 chromenickel steels may be required to avoid serious corrosion. Alloy requirement for catalytic cracking is less exacting than for thermal cracking. Gunite lining such parts as flash and vaporizer chambers, flash sections of fractionators has proved successful, but relining at regular intervals is necessary. Heavy metal catalysts are likely to be injured by sulphur, but alkaline earths, alumina, silica, etc., are probably satisfactory catalysts for these high-sulphur crudes.

Treatment of the cracked distillates is discussed, with emphasis on the need for low temperature when acid treatment is employed. Where considerable reduction in sulphur content of the refined product is not essential, the amount of acid required may be controlled by the gum content of the product. It is essential to re-run acid-treated pressure distillate to obtain a satisfactory product, and it is often desirable to refine a cut having a higher F.B.P. than that of the desired finished gasoline. Temperatures attained during re-running should be as low as possible. Where pressure distillate bottoms are treated for furnace-oil production, solvent extraction possesses advantages over acid treatment from the aspect of product quality. R. A. E.

207.* Introduction to High Vacuum in Chemical Industries. T. R. Olive. *Chem. Met. Engng*, October 1943, **50** (10), 102.—The influence of mean free path on properties of flow of gases at extremely low pressure is discussed. Knudson studied the resistance of pipe to flow of gases at low pressures, and found that the character of the resistance introduced by the pipe wall varies with the pressure, *i.e.*, with the concentration of molecules. At high pressures the flow may be calculated by conventional methods in terms of length, pressure difference, and a friction factor dependent on the Reynolds number. In the low-pressure range it may be considered that there is a stationary " tube " of molecules of considerable thickness against the pipe wall, the thickness varying in a complex manner with the molecular concentration. The high-pressure concepts of laminar and turbulent flow no longer hold. At pressures in the neighbourhood of 1 mm., Knudson found that the stationary molecule " tube " was relatively thin, and that the resistance to flow varied directly as the length of the pipe, and inversely as the fourth power of its diameter. From 1 mm. down to 1 micron, he found the wall interference effect increasing rapidly to a maximum at about 1–10 microns, and that the relation between resistance, length, and diameter was effected complexly by the concentration of molecules. At still lower pressure, however, where the mean free path becomes comparable with the pipe diameter, he found a decreasing resistance, which may be considered as a reduction in thickness of the tube of stationary molecules. Here the resistance was found to vary directly as the pipe length and inversely as the cube rather than the fourth power of the diameter. The system of measurements used at high vacuum is based on " speed " of flow in units of volume/unit time at the pressures obtaining.

Vacuum pumps are discussed together with the limitations of each type. Single-stage reciprocating pumps are inefficient below 25 mm.; multi-stage vane-type rotary pumps below 10 mm.; compound-type oil-sealed rotary eccentric-cylinder pump can work down to less than 10 microns without a continuous evolution of gas. Where gas is evolved, none of these can work at pressures of, say, a micron. Jet-ejectors working against low forepressure may be used. The best arrangement, however, appears to be the diffusion pump. In its simplest form a diffusion pump consists merely of a water-jacketed tube in which a number of jets of the motive vapour issue radially from holes in a central pipe beneath a conical umbrella which directs the jet downward and towards the walls of the tube. As molecules of the gas which is being evacuated diffuse into the curtain of motive vapour, they are mechanically entrapped and moved beyond the curtain, which has, of course, a component of motion in the desired direction. This is not to say that molecules of the gas cannot diffuse backward through the curtain, for some of them do, but about half of those which diffuse through do not return, and the concentration below the curtain increases to the point where it is possible to remove the molecules from the system by means of a mechanical pump or steam ejector. Meanwhile, the curtain of motive vapour, having accomplished its purpose, reaches the water-cooled wall and condenses, flowing back to the boiler, where it is re-vaporized for return to the jet. Pumps with only the umbrella type of jet are capable of operating at extremely low pressure—for example, at 10^{-7} mm. or even lower, using a low-vapour-pressure oil and properly designed baffles to prevent the motive vapour from backing up into the evacuated space—but they cannot operate with forepressures higher than about 0·25 mm. Therefore, the mechanical pump or jet which is used to discharge the trapped molecules must be capable of high efficiency at a relatively low pressure. Much higher forepressures are made possible by combining the umbrella type of diffusion pump with a stage of ejector-type jets. Oil-vapour pumps with such jets can operate at forepressures as high as 25 mm. No diffusion pump, however, can discharge directly to the atmosphere, all requiring operation in series with a mechanical pump or another ejector. All diffusion pumps require an efficient condensing arrangement for the motive fluid to prevent its loss in the form of vapour, along with the gas being evacuated. Mercury pumps, for example, require cooling water at a temperature below about 80° F., if loss of mercury is to be avoided. A. H. N.

208.* Commercial Alkylation with Hydrogen Fluoride Catalyst. F. E. Frey. *Chem. Met. Engng*, November 1943, **50** (11), 126–128.—The first plant to use this process has been working for over a year. The paper briefly describes the plant. Instrumentation and materials of construction are discussed. Pumps, valves, and pipings are particularly discussed. Cast iron and steel appear to be satisfactory.

Hydrogen fluoride consumption is primarily in the form of physical losses, and also chemical loss as organic fluorides occurring in the hydrocarbon stream from the reaction step. The quantity of organic fluorides in the hydrocarbon effluent from the reactor is a function of the operating variables, and by closely controlling the variables the consumption of HF by this route can be kept to a rather low minimum. Physical losses are usually experienced in the form of leaks and in purging out of shut-down equipment. Such physical losses have been reduced to a low value by making minor changes and accumulating experience in the operation of the plant.

Safety precautions and first-aid are briefly discussed. A. H. N.

209.* Materials of Construction for Anhydrous Hydrofluoric Acid. C. M. Fehr. *Chem. Met. Engng*, November 1943, **50** (11), 129.—The use of steels of different types appears to solve many constructional problems. Monel appears to be the best available non-ferrous metal for HF. Copper is a close second under certain conditions. It is attacked in presence of sulphur dioxide and oxygen. Silver and platinum are good. Among the unsatisfactory materials of construction, probably the most readily attacked are those containing silica, such as glass, porcelain, enamel ware, asbestos, and certain silica cast irons. While lead is serviceable for acids below 65%, under normal conditions it is unsatisfactory for strong acids, especially anhydrous HF. Cast iron is more resistant to HF than lead, but, probably due to silica inclusions, it is not a generally satisfactory material. Cast-iron fittings will last only a comparatively short time before replacement. Among other materials found unsuitable for anhydrous HF are wood, which chars instantly, rubber, which polymerizes and hardens, and most plastics.

Storage, piping and valves are discussed. A. H. N.

210.* Arc-Welded Stainless Steel Linings For Refinery Pressure Vessels. W. W. McClow. *Chem. Met. Engng*, November 1943, **50** (11), 134–135.—Most commonly used methods for field applications of stainless linings are known as " plug weldings " and " strip welding." The strip type has been found preferable, for the reason that it is more readily formed to the irregularities of the vessel shell without the excessive warping and twisting which is often experienced with the wider sheets employed in the plug-weld method. The strip method also allows the strips to be butted, while the plug-weld method generally necessitates that the sheets be lapped to compensate for distortion. Lapping represents a waste of material, and is another reason for adopting the strip method. This presentation deals with the field application of an arc-welded stainless-steel lining of the strip type to an existing pressure vessel, described as a cracking-still bubble tower with an inside diameter of 8½ ft., a height of about 104 ft., and an original wall thickness of 1 $\frac{9}{16}$ in. This vessel is typical of several in which stainless-steel linings have recently been applied by arc welding. The presentation is made in detail.

From experience and calculation of cost it has been concluded that the arc-welded stainless-steel lining is not only by far the most economical of the various methods tried in connection with corrosion control, but it is also the most dependable and the most durable. These statements assume added importance when it is realized that investments as high as $75,000, or even more, for a single fractionating tower, must also be guarded by some effective protection against corrosion. Unless this protection is afforded, the life of certain sections of such equipment may be limited to only two or three years, or less, depending on the rate of corrosion and the corrosion allowance incorporated in the original thickness specifications. A. H. N.

211.* Applications of High Vacuum in Chemical Industries. T. R. Olive. *Chem. Met. Engng*, November 1943, **50** (11), 136–138.—Only in the magnesium production by distillation is the extremely high vacuum discussed utilized industrially. Of interest, however, are the methods of measuring very low pressures in a plant, especially where recorded charts are necessary. The thermocouple and Pirani gauges both operate on heat conductivity as a function of pressure. The thermocouple gauge supplies a measured quantity of electric heat to the hot junction of a thermocouple installed in the evacuated space. Since the temperature of the thermocouple depends on the rate at which heat is conducted away from it by the surrounding gas molecules, the thermocouple can be calibrated for the particular gas involved in terms of the concentration of molecules expressed as pressure. The Pirani gauge is similar, consisting of a heated resistance element installed in the evacuated space, which is connected into one arm of a Wheatstone bridge circuit. The measurable resistance of the element depends on its temperature, and hence on the heat conductivity of the evacuated space, the measurements being calibrated in terms of pressure of a particular gas. For pressures much below 1 micron, and as low as 10^{-8} mm., the most commonly used continuous-type gauge is the ionization gauge, which is essentially a three-element electronic tube, the envelope of which is connected to the evacuated system. When the grid, which is between the filament and the plate, is held at a high positive potential, the flow of electrons from filament to grid ionizes some of the gas molecules. The plate, maintained at a negative potential, then collects and neutralizes these ions, resulting in a flow of plate current which depends on the number of ions present, and hence on the concentration of ionizable molecules in the evacuated space. The plate current flow is then measured by a microammeter in terms of the molecular concentration, or pressure. A. H. N.

212.* Catalytic Desulfurization of Gasolines by Cobalt Molybdate Process. A. C. Byrns, W. E. Bradley, and M. W. Lee. *Industr. Engng Chem.*, 1943, **35** (11), 1160.—The catalytic desulphurization of gasolines in the presence of cobalt molybdate and hydrogen is shown to be applicable to stocks containing up to 4% hydrogen. Thiophenes, as well as thiophanes, thioethers, and mercaptans, are decomposed to hydrogen sulphide and hydrocarbons. The reaction takes place at 650° F. at 0–250 p.s.i. In excess of 1500 liquid volumes of feed have been desulphurized by one volume of catalyst without loss in activity and without regeneration. The catalyst can be regenerated repeatedly in the conventional manner to its original activity. J. W. H.

213.* Nomograph of Dittus–Boelter Equation. C. J. Ryant. *Industr. Engng Chem.*, 1943, **35** (11), 1187.—The normal use of the Dittus–Boelter equation involves the use of self-consistent units which entails the use of conversion factors. To avoid this difficulty and to simplify the use of the equation, a nomograph in terms of mixed units is presented. J. W. H.

Chemistry and Physics of Hydrocarbons.

214. Stereochemistry of Catalytic Hydrogenation. I. Stereochemistry of the Hydrogenation of Aromatic Rings. R. P. Linstead, W. E. Doering, S. B. Davis, P. Levine, and R. P. Whetstone, *J. Amer. chem. Soc.*, 1942, **64**, 1985–1991.—The results of a stereochemical study of the catalytic hydrogenation of derivatives of phenanthrene substituted in the central ring, and the hydrodiphenic acids which can be obtained from them by oxidation, are presented in 7 parts. Parts II–VII give the experimental results and the determination of configurations, while in Part I the complete data is summarized and its application to the manner of catalytic hydrogenation is discussed. All nine compounds studied hydrogenated largely to *cis* and *syn* material. Three hypotheses are advanced to account for these results.

1. Hydrogen atoms add to one side of the molecule when one or more aromatic rings are hydrogenated during a single period of adsorption. The authors regard this as rather an over-simplification when applied to polynuclear compounds, since this theory can only account for complete *cis* and *syn* perhydrogenation of phenanthrene or diphenic acid derivatives by making two highly arbitrary and improbable assumptions. They suggest that it is more reasonable to suppose that a second determining factor operates—namely, catalyst hindrance.

2. Hindrance between the catalyst and the substrate affecting the orientation of the adsorption of the aromatic molecule on the catalyst.

3. Hydrogenation of the open-chain derivatives of diphenic acid in the coiled phase. Earlier work and the material reported in the subsequent papers are discussed with regard to these theories, and certain applications to related fields are indicated.

E. H. W.

215. Stereochemistry of Catalytic Hydrogenation. II. The Preparation of the Six Inactive Perhydrodiphenic Acids. R. P. Linstead and W. E. Doering. *J. Amer. chem. Soc.*, 1942, **64**, 1991–2003.—The preparations of the six theoretically possible inactive forms of perhydrodiphenic acid are described. The acids are shown to fall into two series of three members each, with m. p.'s of 289° C., 200° C., 223° C., and 198° C., 206° C., 247° C., interconversion is possible within either series, but not between the series. This was taken to indicate that one series consists of the *syn* acids and the other series the *anti* acids. Derivatives were also made, and products from earlier works by various authors are related to the acids now reported. E. H. W.

216. Stereochemistry of Catalytic Hydrogenation. III. Optically Active Perhydrodiphenic Acids. A Proof of the Configuration of the Backbone. R. P. Linstead and W. E. Doering. *J. Amer. chem. Soc.*, 1942, **64**, 2003–2006.—Proof is presented in this paper for the identification of the *syn* series and the *anti* series. The acids with the unlike (*i.e.*, *cis–trans*) arrangement of the carbonyl groups are also identified.

E. H. W.

217. Stereochemistry of Catalytic Hydrogenation. IV. Hexahydrodiphenic Acids. R. P. Linstead and S. B. Davis. *J. Amer. chem. Soc.*, 1942, **64**, 2006–2009.—Half hydrogenation of diphenic acid gave *cis*-hexahydrodiphenic acid, which on thermal inversion yielded the *trans* isomer. Further catalytic hydrogenation of the *cis*-hexahydro acid gave *cis-syn-cis*-perhydrodiphenic acid, and similarly the *trans*-hexahydrodiphenic acid gave *cis-syn-trans*-perhydrodiphenic acid. The configurations already assigned are thus confirmed and further hydrogenation goes almost entirely *cis*- and *syn*-. E. H. W.

218. Stereochemistry of Catalytic Hydrogenation. V. The Assignment of *cis*- and *trans*-Configurations. R. P. Linstead, S. B. Davis, and R. R. Whetstone. *J. Amer. chem. Soc.*, 1942, **64**, 2009–2014.—The work reported in this paper, together with the previous parts, proves that in the *syn* series, the 289° C. acid is the *cis-syn-cis* acid, the corresponding acid in the *anti* series, *i.e.*, the *cis* anti-*cis* being the 198° C. acid. Also the *cis* configuration is proved for the 242° C. m.pt. hexahydrodiphenic acid. *Trans*-configurations are assigned to the hexahydrodiphenic acid, m.pt. 221° C.; the perhydrodiphenic acids, m.pt. 223° C. (*syn*) and 247° C. m.pt. (*anti*). Further connections between the hydrodiphenic acids and the hydrophenanthrenes have been established by the conversion of *cis* and *trans* forms of 9-keto-*as*-octahydrophenanthrene into the corresponding nitrohexahydrodiphenic acid. The stereochemical implications of these results are discussed. E. H. W.

219. Stereochemistry of Catalytic Hydrogenation. VI. The Hydrogenation of 9-Phenanthrol and Related Substances and the Identification of Three of the Possible Stereoisomeric Forms of the Perhydrophenanthrene Ring. R. P. Linstead, R. R. Whetstone and P. Levine. *J. Amer. chem. Soc.*, 1942, **64**, 2014–2022.—The first derivatives of perhydrophenanthrene of definite configuration were reported earlier in the literature, and consisted of a ketone and the corresponding secondary alcohol. The ketone oxidized to a perhydrodiphenic acid now identified as the *trans-anti-trans*-modification, which is thus the configuration of the ketone. The preparation of two new stereoisomeric modifications which are proved to be respectively *cis-syn-cis* and *trans-syn-cis*-9-ketoperhydrophenanthrene, are described. These isomers were obtained in a study of the catalytic hydrogenation of 9-phenanthrol and *as*-octahydro-9-phenanthrol. Related derivatives of these compounds are studied and the results correlated with those of other workers and also with the material in this series of papers. E. H. W.

220. Stereochemistry of Catalytic Hydrogenation. VII. The Complete Hydrogenation of Phenanthraquinone. R. P. Linstead and P. Levine. *J. Amer. chem. Soc.*, 1942, **64**, 2022–2026.—An outline of the possible stereoisomers of the perhydro-9 : 10-dihydroxyphenanthrenes is given. Phenanthraquinone was perhydrogenated to various perhydro-9 : 10-dihydroxy-phenanthrenes, according to conditions. Configurations were determined by the formation of the corresponding perhydrodiphenic acids whose structures have already been proved. E. H. W.

221. Products from the Wurtz Reaction and the Mechanism of their Formation. A. Saffer and T. W. Davis. *J. Amer. chem. Soc.*, 1942, **64**, 2039–2043.—This paper reports a study of the relative probabilities of particular free radical combinations. The Wurtz reaction was thought to be a suitable way to generate free radicals in any desired proportions. Methyl or ethyl iodide or a mixture of the two who reacted at a pressure of 200 mm. with metallic sodium at 320° C. As expected, the reactions were complicated, the products being hydrogen, free carbon, saturated and unsaturated hydrocarbons, and possibly smaller amounts of higher halides. The possible mechanisms of the reactions are discussed. E. H. W.

222. Reaction of Methyl Furoate with Benzene and Chlorobenzene. C. C. Price and C. F. Huber. *J. Amer. chem. Soc.*, 1942, **64**, 2136–2139.—The reaction between methyl furoate and benzene catalysed by aluminium chloride gave a 32–40% yield of methyl a-naphthoate, with chlorobenzene a good yield of 6-chloro-1-naphthoic acid was produced. The reaction with benzene also gave a small amount of a higher-boiling product, for which evidence is produced to show that it was methyl 9-ethyl-9 : 10 dihydro-9-anthroate. E. H. W.

223. Equation of State for Gases at High Pressures involving only Critical Constants. S. H. Maron and D. Turnbull, *J. Amer. chem Soc.*, 1942, **64**, 2195–2190.—The equation of state developed for nitrogen in a previous paper (*J. Amer. chem. Soc.*, 1942, **64**, 44) has now been applied to methane, ethane, propane, ethylene, carbon monoxide, and carbon dioxide. Evidence for the validity of this extension is presented. Other common equations of state are compared and shown to be inferior to the one applied here. A generalized equation for compressibility coefficients of gases is deduced.

E. H. W.

224. Random Reorganization of Molecular Weight Distribution in Linear Condensation Polymers. P. J. Flory. *J. Amer. chem. Soc.*, 1942, **64**, 2205–2212.—This paper presents a theoretical and experimental examination of the consequences of interchange processes such as may occur in various linear condensation polymers. Equations for the entropy of mixing for a given degree of polymerization are developed. The transformation in the distribution of species in a mixture of poly-esters was observed by viscosity measurements. Both experimental and theoretical results are discussed, together with the application of the conversion of cyclic esters to linear poly-esters.

E. H. W.

225. Dipole Moments in the Vapour State and Resonance Effects in some Substituted Benzenes. E. C. Hurdis and C. P. Smyth. *J. Amer. chem. Soc.*, 1942, **64**, 2212–2216.—Dielectric constants of the vapours of chloro-, bromo-, iodo-, *p*-fluorobromo-, *p*-fluoroido-, *p*-fluoronitro-, and *o*-dichloro-benzene, and *p*- and *o*-xylene were measured, and the dipole moments of the molecules calculated from the results. Resonance structures are postulated for the *p*-disubstituted benzenes to account for the fact that their moments are larger than the differences between the corresponding mono-substituted compounds. The new value of *o*-dichlorobenzene was in good agreement with that obtained by correcting the solution value for solvent effect. An accurate value for the moment due to the attachment of a methyl group to the benzene ring was calculated from the data on the two xylenes. E. H. W.

226. Condensation Products of Ketene with Ketones. B. H. Gwynn with E. F. Degering. *J. Amer. chem. Soc.*, 1942, **64**, 2216–2218.—The reaction of ketene with ketones possessing three or more hydrogen atoms in the α position is reported. In general the acetates of the enol form are produced, and physical constants of those isolated are tabulated. Optimum conditions for the reaction with acetone were determined, including the amount and nature of the catalyst necessary. E. H. W.

227. Dissociation of Hexa-aryl-ethanes. XIV. Ethanes Derived from Mixtures of Triaryl Halides. Note by C. S. Marvel and C. M. Himel. *J. Amer. chem. Soc.*, 1942, **64**, 2224.—An interim report is presented on the treatment of an equimolecular mixture of two triarylmethyl halides with silver, in an attempt to produce a truly unsymmetrical ethane. A table is given of the chlorides thus treated, together with the degree of dissociation calculated from magnetic susceptibility measurements on the assumption that a mixed ethane had been formed. E. H. W.

228. Physical Constants of Methyl *Iso*propenyl Ketone. Note by J. H. Brant. *J. Amer. chem. Soc.*, 1942, **64**, 2224–2225.—A new series of constants are reported for freshly vacuum distilled methyl *iso*propenyl ketone made by the vapour-phase process. The need for making the determinations as soon as possible after distillation, even in the presence of inhibitors, is stressed. E. H. W.

229. Addition of Hydrogen Fluoride to the Triple Bond. A. V. Grosse and C. B. Linn. *J. Amer. chem. Soc.*, 1942, **64**, 2289–2292.—The reaction is described whereby hydrogen fluoride readily adds on to alkynes in the absence of catalysts, forming compounds of the type $R–CF_2–CH_2–R^1$. Propyne, butyne-1, butyne-2, pentyne-1, hexyne-3, and heptyne-1 reacted to give difluoro alkynes in good yield at temperatures around −70° C. The properties of the products formed are tabulated. With acetylene the reaction proceeded only after contact for a long time at room temperature and under pressure. The difluorides formed were inert, did not lose hydrogen fluoride, and had a not unpleasant odour. E. H. W.

230. Synthesis of 2 : 7-Naphthalene-dialdehyde; an Attempted Synthesis of Coronene. J. H. Wood and J. A. Stanfield. *J. Amer. chem. Soc.*, 1942, **64**, 2343–2344.—The synthesis of 2 : 7-naphthalene dialdehyde is described. Various attempts to prepare coronene via this compound were not successful. E. H. W.

231. Structure of Copolymers of Vinyl Chloride and Vinyl Acetate. C. S. Marvel, G. D. Jones, T. W. Mastin and G. L. Schertz. *J. Amer. chem. Soc.*, 1942, **64**, 2356–2362.—When vinyl chloride and vinyl acetate copolymerize, polymer chains are produced which contain both units. In a given case, the polymer molecules produced differ widely in composition, and the first chains produced are richer in vinyl chloride than in the monomer mixture from which they are formed. The copolymers made by complete polymerization of a given starting mixture of monomer, vary in composition from chain to chain. The monomer units appear to be oriented in a 1 : 3 manner in the chain. Some reactions of these copolymers are described. E. H. W.

232. Reduction of Unsaturated Hydrocarbons at the Dropping Mercury Electrode. II. Aromatic Polynuclear Hydrocarbons. S. Wawzonek and H. A. Laitinen. *J. Amer. chem. Soc.*, 1942, **64**, 2365–2368.—A polarographic study has been made of the reduction of the following aromatic polynuclear hydrocarbons: naphthalene, 1 : 2-dihydronaphthalene, acenaphthene, indene, 3-phenylindene, fluorene, biphenyl, phenanthrene, 9 : 10-dihydrophenanthrene, chysene, pyrene, anthracene, 1 : 2-benzanthracene, 1 : 2 : 5 : 6-dibenzanthracene, 9 : 10-dimethyl-1 : 2-benzanthracene, 3-methylcholanthrene, and 3 : 4-benzpyrene. The compounds gave half-wave potentials which were independent of their concentration but characteristic of certain structures. The method was shown to be useful in the quantitative determination of the hydrocarbons and for determining the arrangement of the double bonds in their various rings. E. H. W.

233. Heat Capacity of Organic Vapours. IV. Benzene, Fluorobenzene, Toluene, Cyclohexane, Methylcyclohexane and Cyclohexene. J. B. Montgomery and T. De Vries. *J. Amer. chem. Soc.*, 1942, **64**, 2375–2377.—Heat capacity measurements from the boiling points to 410° K. are reported for the vapours of benzene, fluorobenzene, toluene, *cyclo*hexane, methyl*cyclo*hexane, and *cyclo*hexene. The experimental results are compared with semi-empirically calculated heat capacities. E. H. W.

234. Friedel-Crafts Acylations of some Sterically Hindered Alkyl Benzenes. C. F. Hennion and S. F. McLesse. *J. Amer. chem. Soc.*, 1942, **64**, 2421–2422.—The Friedel-Crafts ketone synthesis (using acetyl and benzoyl chlorides in presence of aluminium chloride), when applied to 2-alkyl benzenes and *p*-di-*s*-alkyl benzenes, reacted normally without disturbance of alkyl groups. Reactions of *t*-butyl benzene, *p*-*s*-butyltoluene and *p*-di-*t*-butyl benzene were also studied; the latter was exceptional in only losing one *t*-butyl group when using acetyl chloride. Constants, yields, and analytical data for the ketones obtained are tabulated. The identities of the various ketones were proved by oxidation. Several new substituted acetophenones, benzophenones, and benzene carboxylic acids are described. E H. W.

235. Rearrangement of 1 : 1 : 3 : 3 : 5 : 5-Hexamethyl-cyclohexatriol-2 : 4 : 6 to Hexamethylbenzene. E. B. Ayres and C. R. Hauser. *J. Amer. chem. Soc.*, 1942, **64**, 2461–2462.—1 : 1 : 3 : 3 : 5 : 5-Hexamethyl*cyclo*hexatriol-2 : 4 : 6 on treatment with sulphuric acid was transformed by a triple dehydration and rearrangement of the neopentyl type to give hexamethylbenzene. This represents a new route from an aliphatic to an aromatic compound. E. H. W.

236. Heat Capacity of Benzene-d_6. W. T. Ziegler and D. H. Andrews. *J. Amer. chem. Soc.*, 1942, **64**, 2482–2485.—The heat capacity of benzene-d_6 has been measured throughout the range 100–320° K. with an accuracy of about 2%. E. H. W.

237. Halogenation of *m*-Diphenylbenzene. II. The Monoiodo Derivative. W. A. Cook and K. H. Cook. *J. Amer. chem. Soc.*, 1942, **64**, 2485–2486.—The preparation and properties of 4-iodo-*m*-diphenylbenzene are described. E. H. W.

238. Vapour Pressures of Indene, Styrene and Dicyclopentadiene. Note by P. E. Burchfield. *J. Amer. chem. Soc.*, 1942, **64**, 2501.—Vapour pressures were determined by the method of Booth, Elsey, and Burchfield (*J. Amer. chem. Soc.*, 1935, **55**, 2066) on indene, styrene, and di*cyclo*pentadiene. The results are tabulated. E. H. W.

239. Hydrogenation of Disubstituted Acetylenes. Note by K. W. Greenlee and W. C. Fernelius. *J. Amer. chem. Soc.*, 1942, **64**, 2505.—The authors outline a suggested mechanism for the reaction of dialkyl acetylenes with sodium in liquid ammonia, whereby the pure *trans* forms of the corresponding olefins are produced (vide Campbell and Eby, *J. Amer. chem. Soc.*, 1941, **63**, 216–219). E. H. W.

240. Empirical Heat Capacity Equations of Gases. Note by H. M. Spencer and G. N. Flannagan. *J. Amer. chem. Soc.*, 1942, **64**, 2511–2513.—A table is given of values of a, b, c, c', or d derived from either of the equations $C_p^\circ = a + bT + cT^2$, $C_p^\circ = a + bT + c'/T^2$, or $C_p^\circ = a + bT + cT^2 + dT^3$, representing the heat capacities of a large number of gases, including hydrocarbons and halogen substituted hydrocarbons.

References are given for the sources of the theoretical values which the equations represent. E. H. W.

241. The Reaction of Furoic Acid with Tetralin. C. C. Price and N. C. Dono. *J. Amer. chem. Soc.*, 1942, **64**, 2601–2602.—The reaction of furoic acid and aluminium chloride with various aromatics of the benzene series had previously been shown to produce naphthoic acids. The work has now been extended to the naphthalene series. From naphthalene the only product was an intractable, amorphous, neutral, black powder, but from tetralin two isomeric crystalline acids were isolated. They are believed to be sym-octahydro-1-anthroic and 1-phenanthroic acids. T. C. G. T.

242. Triptycene (9, 10-ortho-Benzeno-anthracene). P. D. Bartlett, M. J. Ryan, and S. G. Cohen. *J. Amer. Chem. Soc.*, 1942, **64**, 2649–2653.—The hydrocarbon 9 : 10-ortho-benzeno-anthracene has been prepared and its properties studied. The name triptycene is proposed for this hydrocarbon because the shape of the ring system suggests the triptych of antiquity, which was a book with three leaves hinged on a common axis. Triptycene crystallizes in fine white rhomboids melting at 254·2–255·2° C. and is advantageously crystallized from methanol-water. It is soluble in benzene, ethyl alcohol, ether, acetone, and chloroform, but only slightly soluble in methanol. It is lacking in the activity of its aliphatic hydrogen towards potassium exchange, chlorination, and oxidation which characterizes triphenylmethane.
T. C. G. T.

243. The Constitution of Pirylene : Chemical Evidence. H. Sargent, E. R. Buchman and J. P. Farquhar. *J. Amer. chem. Soc.*, 1942, **64**, 2692–2693.—Chemical evidence supports the conclusions of an electron diffraction investigation that pirylene is 1-methyl-2-vinylacetylene. T. C. G. T.

244. The Constitution of Pirylene : Electron Diffraction Investigation. R. Spurr and V. Schomaker. *J. Amer. chem. Soc.*, 1942, **64**, 2693–2696.—Electron diffraction evidence indicates that pirylene is 1-methyl-2-vinylacetylene. T. C. G. T.

245. The Viscosity of Dilute Solutions of Long-Chain Molecules. IV. Dependence on Concentration. M. L. Huggins. *J. Amer. chem. Soc.*, 1942, **64**, 2716–2718.—See Abstract No. 898, 1943.

246. Refractive Indices and Densities of Normal Saturated Fatty Acids in the Liquid State. A. Dorinson, M. R. McCorkle and A. W. Ralston. *J. Amer. chem. Soc.*, 1942, **64**, 2739–2741.—The refractive indices of the normal saturated fatty acids from caproic to stearic have been determined over the range 20–80° C. In all cases the refractive indices are straight-line functions of the temperature with an abrupt change in slope at 40° C. This, it is argued, is in agreement with present theories on molecular refractivity and on the structure of liquids consisting of polar molecules.

The densities of these acids at 80° C. have also been determined. Molar volumes and molar refractivities for the homologous series have been computed and shown to be linear with respect to the number of carbon atoms in the chain. T. C. G. T.

247. Some Boron Trifluoride Catalyzed Alkylations of Halobenzenes. G. F. Hennion and V. R. Pieronek. *J. Amer. Chem. Soc.*, 1942, **64**, 2751–2752.—Boron trifluoride, with phosphoric anhydride as an adjunct, has been shown to be an effective catalyst in the condensation of alcohols with chloro-, bromo-, and iodo-benzenes.
T. C. G. T.

248. The Nitrogen Compounds in Petroleum Distillates. XXIV. Isolation and Identification of a $C_{11}H_{17}N$ Base from Californian Petroleum. H. L. Lockte, W. W. Crouch and E. D. Thomas. *J. Amer. Chem. Soc.*, 1942, **64**, 2753–2755.—By suitable extraction and distillation the picrates of three new bases have been obtained from the Californian petroleum bases boiling at 210–213° C. One has been identified as dl-2-*s*.-butyl-4 : 5-dimethyl pyridine. The others, $C_{12}H_{19}N$ and $C_{13}H_{21}N$, are also believed to be alkylated pyridenes. T. C. G. T.

249. Ionization and Dissociation by Electron Impact : Normal Propyl Chloride and Tertiary Butyl Chloride. D. P. Stevenson and J. A. Hipple. *J. Amer. chem. Soc.*, 1942, **64**, 2766–2768.—The mass spectra of *n*-propyl chloride and *t*-butyl chloride are tabulated. Appearance potentials for some of the ions produced are also given. A calculated value of $4{\cdot}4_2 \pm 0{\cdot}2$ e.v. for the strength of the first carbon–hydrogen bond in methane was obtained, which agrees with the value deduced from other electron impact data. Results are briefly discussed, and the authors state that this work is unavoidably incomplete. E. H. W.

250. Ionization and Dissociation by Electron Impact : Isobutylene, Propane and Propylene. D. P. Stevenson and J. A. Hipple. *J. Amer. chem. Soc.*, 1942, **64**, 2769–2772.—This paper reports the mass spectroscopic examination of the dissociation products of *iso*butylene. The mass spectrum of *iso*buytlene is tabulated in detail and the appearance potentials of the ions in it are given. Values of the appearance potentials for some ions in the spectra of propane and propylene are also reported, together with vertical ionization potentials for all three molecules considered. E. H. W.

251. Dipole Moment, Induction and Resonance in Nitroethane and Some Chloronitroparaffins. Everett C. Hurdis and Charles P. Smyth. *J. Amer. chem. Soc.*, 1942, **64**, 2829–2834.—The dielectric constants of the vapours of nitro-ethane, chloronitromethane, 1-chloro-1-nitroethane, and 1-chloro-1-nitropropane have been measured and used to calculate the dipole moments of the molecules.

The moment of nitro-ethane is 0·20 higher than that of nitromethane, and very close to those of α and β-nitropropane and 2-methyl-2-nitropropane, confirming the indications of their values that the inductive effect is inappreciable beyond the first two carbon atoms of the molecular chain.

The considerable increases in moment from chloronitromethane to the ethane and from the ethane to the propane are attributed to increased stabilization of resonating polar forms by the distribution of the negative charge over two groups in the di-substituted compounds, instead of its localization on one group, as in the mono-substituted compounds. C. F. M.

252. Mechanism of Cyclization Reactions. E. Berliner. *J. Amer. chem. Soc.*, 1942, **64**, 2894–2898.—Mechanisms involving enolization as the first step in the *cyclo*-dehydration reactions of certain carbonyl compounds—*e.g.*, synthesis of naphthalene from β-styrylaldehyde—are criticised. The author suggests that addition of a proton to the carbonyl oxygen, followed by an electrophilic substitution reaction, is a more likely mechanism. Examples are quoted from the literature which can be explained in this way. Using this cyclization reaction, the synthesis is described of 9-methyl-1 : 2-benzacridene, 9-methyl-3 : 4-benzacridene, 9-methyl-1 : 2 : 3 : 4-dibenzacridene, 9-phenyl-1 : 2 : 5 : 6-dibenzfluorene and 9-phenyl-1 : 2 : 7 : 8-dibenzfluorene, starting with the corresponding methyl ketones or dinaphthylphenyl carbinols respectively. Dibenzacridenes possess carcenogenic properties and it is suggested that the meso-substituted derivatives prepared should be compared with 9-methyl-1 : 2-benzanthracene with respect to this property. E. H. W.

253. Mixed Heteropoly Acid Catalysts for the Vapour Phase Oxidation of Naphthalene. H. T. Brown and J. C. W. Frazer. *J. Amer. chem. Soc.*, 1942, **64**, 2917–2920.—A series of catalysts has been prepared from heteropoly acid crystals containing tungsten and molybdenum and their activity in oxidation of naphthalene has been studied. $H_4SiMo_9W_3O_{40}$ gave higher conversion to phthalic anhydride than did the parent acids $H_4SiMo_{12}O_{40}$ or $H_4SiW_{12}O_{40}$. T. C. G. T.

254. The Dehydration of Alcohols. XIX. *t*-Amyl Alcohol and the Related Dimethylneopentylcarbinol. F. C. Whitmore, C. S. Rowland, S. N. Wrenn and G. W. Kilmer. *J. Amer. chem. Soc.*, 1942, **64**, 2970–2972.—The article emphasizes and illustrates the difficulties in drawing generalizations on the dehydration of alcohols. The relation of acidity of the dehydrating catalyst to the equilibrium in the resulting olefin mixture is considered. Dehydration of *t*-amyl alcohol and dimethylneopentylcarbinol under similar acidic conditions showed that the ethyl group yields a proton thirty times as readily as does the neopentyl group. T. C. G. T.

255. Density and Refractive Index of Cumene. J. E. Troyan. *J. Amer. chem Soc.*, 1942, **64**, 3056.—The density of cumene over the range 6·1–37·8° C. and refractive index from 15° to 28° C. are presented. T. C. G. T.

256. Molecular Weights and Intrinsic Viscosities of Poly*iso*butylenes. P. J. Flory. *J. Amer. chem. Soc.*, 1943, **65**, 372–382.—Four different specimens of poly*iso*butylene are fractionated by successive selective precipitations with acetone from solutions in benzene.

The determination of the osmotic pressures of solutions of these fractions in benzene and *cyclo*hexane is described, and results tabulated for concentrations from 0 to 2 gms. per 100 c.c., using membranes of cellophane and denitrated collodion.

The ratio of the osmotic pressure to the concentration increases only slightly with the concentration in the case of the benzene solutions, but, if $\frac{\pi}{c}$ is plotted against c for the *cyclo*hexane solutions, curves are obtained which have a definite upward concavity and the slope of which appears to be independent of the molecular weight.

Extrapolations of the π/c vs. c curves yield values for $\left(\frac{\pi}{c}\right)_0$ from which the number average molecular weights of the polymers are calculated by application of the van 't Hoff equation $\overline{M}_n = RT/(\pi/c)_0$.

Application of this method to twenty-three fractions representing relatively narrow cuts in the range of molecular weights from 5000 to 1,000,000 gives results which, at the higher values, are more than ten-fold those calculated from Staudinger's equation, which assumes a linear relationship between intrinsic viscosity and molecular weight. Results obtained with solutions in di*iso*butylene indicate that the relationship between these characteristics is represented by the equation $[\eta] = KM^a$, where $K = 3{\cdot}60 \times 10^{-4}$ and $a = 0{\cdot}64$. This is equivalent to an equation recently proposed by Houwink for other polymers where a was found to be equal to 0·6.

It is demonstrated that application of this formula to a heterogeneous polymer yields a " viscosity average molecular weight " which is greater than the number average determined osmotically, but less than the weight average given by Staudinger's equation.

The structure of poly*iso*butylene in relation to viscosity is considered. The evidence indicates that the chain is not branched or cross-linked, but coiled in a spiral encompassing a volume of solvent which moves with the meandering chain. C. F. M.

257. Thermal Data XVI. The Heat Capacity and Entropy of Isopentane. The Absence of a Reported Anomaly. G. B. Guthrie, Jr., and H. M. Huffman. *J. Amer. chem. Soc.*, 1943, **65**, 1139–1143.—Repeated attempts have been made to reproduce the anomalous results which were obtained by Aston and his co-workers (*J. Amer. chem. Soc.*, 1942, **64**, 1034 and 1039) in their heat-capacity measurements, and which had been attributed to hysteresis in the establishment of equilibrium between isomeric forms due to hindered rotation.

Results obtained for the molal heat capacity over the temperature range 13–300° K. differ from Aston's by as much as 8% at the lowest temperatures and are not anomalous. The value of $62{\cdot}24 \pm 0{\cdot}10$ cal. degree^{-1} mole^{-1} obtained for the entropy of liquid *iso*pentane at 298·16° K. is, however, in good agreement with Aston. C. F. M.

258. Some Friedel-Crafts Type Alkylations with Boron Trifluoride. G. F. Hennion and R. A. Kurtz. *J. Amer. chem. Soc.*, 1943, **65**, 1001–1003.—The alkylation at atmospheric pressure of benzene and toluene with secondary, tertiary, and allyl type halides has been accomplished with boron trifluoride catalysts in the presence of water, alcohol, or other polar compounds reactive to boron trifluoride. The addition of sulphuric acid is necessary to obtain a good yield from the secondary halides.

C. F. M.

259. Hydrogenolysis of Sulphur Compounds by Raney Nickel Catalyst. R. Mozingo, D. E. Wolf, S. A. Harris, and K. Folkers. *J. Amer. chem. Soc.*, 1943, **65**, 1013–1016.—

Certain representative sulphur-containing compounds (aliphatic and aromatic sulphides, disulphides, sulphones and sulphoxides) have been submitted to hydrogenolysis by the hydrogen contained in Raney nickel catalyst in the absence of added hydrogen. They have been found to undergo cleavage with the replacement of the sulphur atom by two hydrogen atoms. C. F. M.

260. The Heat Capacity and Entropy, Heats of Transition, Fusion and Vaporization and the Vapour Pressures of Cyclohexane. The Vibrational Frequencies of Alicyclic Ring Systems. J. G. Aston, G. J. Szasz and H. L. Fink. *J. Amer. chem. Soc.*, 1943, **65,** 1135–1139.—Using methods described in previous papers (*J. Amer. chem. Soc.*, 1939, **61,** 1533 ; 1941, **63,** 2029 and 1943, **65,** 341), measurements have been made of complete thermal data from 10° to 294° K. and of heats of vaporization at 298·16° K. for *cyclo*hexane from which the entropy of the ideal gas has been calculated at 298·16° K.

Comparisons of the experimental entropy with that calculated from statistical and molecular data yield values for the γ frequencies (vibrations perpendiclar to the ring) of $\gamma_1 = \gamma_2 = 210$ cm.$^{-1}$, $\gamma_3 = 377$ cm.$^{-1}$ These results (based on a "chair" configuration for the *cyclo*hexane molecule) are in good agreement with previous assignments on similar molecules. C. F. M.

261.* Hydrogenation of Sulphur Compounds. C. M. Cawley and C. C. Hall. *J. Soc. chem. Ind.*, 1943, **62,** 116–119.—Hydrogenation processes produce, from sulphur-containing crudes, gasoline and oil that are extremely low in sulphur, so it has been decided to investigate the behaviour on hydrogenation of certain sulphur compounds, such as phenyl mercaptan, carbon disulphide, and thiophen.

Carbon disulphide seems to be completely desulphurized at 250° C. under 20 atm., yielding methane and hydrogen sulphide. Under milder conditions the products of hydrogenation are methyl mercaptan and thioformaldehyde.

Phenyl mercaptan is completely hydrogenated at 200° C. and 20 atm. to benzene and hydrogen sulphide.

Thiophen required the higher temperature of 300° C., when it hydrogenated fairly completely. The products of this reaction are butane, ethane, and hydrogen sulphide, but the reaction probably proceeds first to the formation of a tetrahydrocompound followed by a ring opening to form a mercaptan before the reaction is completed. T. C. G. T.

262.* Catalytic Hydrogenation of Dimedone (Dimethyldihydroresorcinol) and a Preparation of 1 : 1-Dimethylcyclopentane. T. Henshall. *J. Soc. chem. Ind.*, 1943, **62,** 127–128.—At 180° C., 100 atm. hydrogen, 6 hours reaction and Raney nickel catalyst, dimedone hydrogenates to yield 75% 3 : 3-dimethyl*cyclo*hexan-1-ol. Oxidation of the latter with nitric acid gave $\beta\beta$-dimethyladipic acid, which was cyclized by distillation in the presence of baryta to yield 3 : 3-dimethyl*cyclo*pentanone, which hydrogenated at 125° C. and 100 atms. with Raney nickel to give 3 : 3-dimethyl*cyclo*pentan-1-ol. Phosphorus pentoxide dehydrated the latter at 145–150° C., and the 1 : 1-dimethyl-Δ^2-*cyclo*pentene so produced was hydrogenated (100° C., 75 atm. in the presence of Raney nickel) to yield 1 : 1-dimethyl*cyclo*pentane. T. C. G. T.

263. Preparation of α- and β-Methylnaphthalene from Tar-Oil Fractions. Part II. α-Methylnaphthalene. E. A. Coulson. *J. Soc. chem. Ind.*, 1943, **62,** 177–179.—In the preparation of β-methylnaphthalene (Part I, *J. Soc. chem. Ind.*, 1941, **60,** 123) from tar-oil, fractions are inevitably obtained which are rich in α-methylnaphthalene, a possible intermediate for the preparation of the valuable root-growth-promoting plant auxin, α-naphthylacetic acid.

A convenient method of sulphonation-fractional desulphonation has now been devised which permits enriched fractions of each of the two isomerides to be readily isolated. Separation of α-methylnaphthalene in a state of purity exceeding 98% has been effected by sulphonating the enriched fraction with about twice its weight of 98% sulphuric acid in the presence of silver sulphate. Diluting the acid to 34% precipitates 1-methylnaphthalene-4-sulphonic acid, which, after purification by reprecipitation, is desulphonated to give a yield of pure α-methylnaphthalene equal to 21·8% of the estimated content of the neutral tar-oil β-methylnaphthalene residues.

Two variations are considered: (*a*) fractional sulphonation and (*b*) fractional crystallisation from water of the barium, sodium, potassium, and ammonium salts of the mixed sulphonic acids. Neither give favourable results. C. F. M.

264.* Preparation of Cyclopentane. J. W. Tooke. *Industr. Engng Chem.*, 1943, **35**, (9), 992.—A description is given of the apparatus and method employed for the preparation of 44 gallons of 91% pure *cyclo*pentane by precise fractionation from a pentane–hexane stock containing 5·7% vol. of *cyclo*pentane. This starting stock represented a cut from an Oklahoma natural gasoline (Burbank Field). The pentane–hexane cut was charged to a batch still fitted with a 6-in. dia. fractionating column packed with 17 ft. of 0·5-in. Lessing Rings, and the distillation was carried out at a reflux ratio of 50 : 1 to prepare a cut boiling between 110° and 130° F. This narrow cut was charged to a second still fitted with a 6-in.-dia., fractionating column packed with 19 ft. of 0·5-in. stoneware Raschig rings, and the distillation was carried out at a reflux ratio of 115 : 1. The most concentrated *cyclo*pentane fraction produced was of 95% purity. J. W. H.

265.* Film Formation by Pure Liquids. C. W. Foulk and J. E. Barkley. *Industr. Engng Chem.*, 1943, **35** (9), 1013.—The film-forming tendencies of water, benzene, nitrobenzene, *n*-heptane, and methanol have been examined by three methods. It was found that that when these substances were highly purified film formation was reduced to a negligible amount. The addition of an extremely small amount of water to an organic material restored the film-forming properties. J. W. H.

266.* Vapour Pressure Slide Rule. F. T. Miles. *Industr. Engng Chem.*, 1943, **35**, (10), 1052.—Precise instructions are given for the construction of a slide rule designed to give the variation of vapour pressure with temperature for all pure liquids with normal boiling points in the range −38° to 400° C. The precision of this instrument is about 1° C. for a known vapour pressure, except in the critical region, where the error may rise to 15° C. J. W. H.

267.* Surface Tension of *n*-Heptane and *n*-Butane Containing Dissolved Nitrogen. G. J. Reno and D. L. Katz. *Industr. Engng Chem.*, 1943, **35** (10), 1091.—Data are given for the surface tension of *n*-butane and *n*-heptane containing dissolved nitrogen over the pressure range 0–1000 p.s.i. and the temperature range 77–185° F. The surface tension decreases with increasing pressure and temperature, and the value for *n*-heptane is approximately twice that of *n*-butane at 77° F. From these data the parachor of nitrogen has been calculated, and found to be 41 in *n*-heptane solution and 60 in *n*-butane solution. This latter value is in agreement with the figure for pure nitrogen. J. W. H.

268.* Viscosity of *n*-Paraffin Solutions. A. R. Kemp and H. Peters. *Industr. Engng Chem.*, 1943, **35** (10), 1108.—Data are presented on the viscosities of pure *n*-paraffins (C_{10}–C_{28}) in carbon tetrachloride, benzene, chloroform, and *cyclo*hexane solution which show nonconformity to the Staudinger rule that viscosity increases proportionately with increase in carbon atoms in the chain and that the solution of these paraffins in *n*-hexane obey the Staudinger rule.

An analysis of viscosity molecular-weight data on various linear polymers has led to the development of a new constant based on the contribution to viscosity of a chain atom. The present work provides evidence for the basic soundness of the viscosity method for the determination of molecular weights of linear polymers when proper procedure is followed and a suitable solvent is chosen. J. W. H.

269.* Heat of Solution of Ethane and Propane. R A Budenholzer, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1943, **35** (11), 1214.—The heats of solution of ethane and propane in a non-volatile hydrocarbon oil of 342 molecular weight have been determined up to pressures of 450 p.s.i. and at 100°, 160°, and 220° F. for propane and at 100° and 160° F. for ethane. A comparison is made between the results obtained from calorimetric determinations and those calculated from the volumetric behaviour of the system, and the agreement is within the maximum experimental error. The accuracy of the smoothed results is considered to be 2·0 B.Th.U./lb. J. W. H.

Analysis and Testing.

270. Peroxides in *iso*Propanol. C. E. Redemann. *J. Amer. chem. Soc.*, 1942, 64, 3049–3050.—The author gives a warning that *iso*propanol when stored in contact with air or oxygen develops peroxides and the care exercised in handling ethyl ether, *iso*propyl ether, and dioxane should be extended to *iso*propanol. T. C. G. T.

271.* A Vibratory Shaker for Laboratory Use. A. R. Gilson. *Chem. and Ind.*, 1943, 62, 214–215.—The simple electrically-driven shaker described accommodates containers of almost any shape and size up to about 1000 c.c. C. F. M.

272.* A Portable Gas Generator. R. Sutcliffe. *Chem. and Ind.*, 1943, 62, 310.—A small-capacity substitute for a Kipp Gas Generator is described. C. F. M.

273.* Permeability of Transparent Wrappings. C. R. Oswin. *J. Soc. chem. Ind.*, 1943, 62, 45–48.—The permeability of a variety of transparent wrappings to air, water, vapour, carbon dioxide, hydrogen, helium, and ammonia are recorded and methods for carrying out such determinations critically discussed. Typical examples for water vapour in gms./m.^{2}/24 hrs. under similar conditions are: moisture-proof regenerated cellulose 0·27, rubber hydrochloride 1·02, yellow waxed paper 1·0, waxed glassine 3·7, cellulose nitrate 4·1, cellulose acetate 17·4. For carbon dioxide in c.c./m.^{2}/hr./1 atm.: regenerated cellulose 900, cellulose acetate 2400, nitrocellulose 1300, sheet rubber 2500, waxed glassine 2400. In these latter figures the thicknesses of the films are respectively 0·001, 0·002, 0·004, 0·005, and 0·0015.

The article specializes in data on moisture-proof cellulose film, but figures are given for the permeability of seams, joints, etc., and it is shown how to assess the overall permeability of a package and to predict its safe shelf life according to its contents. T. C. G. T.

274.* Determination of Phenol and *m*-Cresol in Coal Distillation Products by Means of the Spekker Photo-Electric Absorptiometer. T. S. Harrison. *J. Soc. chem. Ind.*, 1943, 62, 119–123.—The author has, like the S.T.P.T.C., employed Chapin's method for the estimation of phenols, but has introduced the Spekker absorptiometer to replace the eye for colour comparison. Time and labour are saved by effecting the separation of phenol and cresols from creosote oil by a single wash with warm 10% caustic soda. It is claimed that the method described is more accurate and more rapid than the S.T.P.T.C. method C.C. 15–38 (for phenols), and, furthermore, requires considerably less sample and does not use formaldehyde. The estimation of *m*-cresol by this method does not achieve the accuracy obtained with phenol. T. C. G. T.

275.* Rapid Ring and Ball Softening-Point Test. D. M. Wilson. *J. Soc. chem. Ind.*, 1943, 62, 140–141.—Certain improvements have been effected on the modification of the normal ring and ball softening-point test (I.P.–58/42) suggested by Hersberger and Overbeck (*Proc. Amer. Soc. Test. Mat.*, 1942, Preprint 78), whereby the time is noted for the ball to drop 1 in. in a bath at constant temperature. Calibration curves are given for conversion to Softening Point.

It is claimed that not only is it possible to obtain a softening point in ten minutes (provided that the sample is submitted in a molten condition), but that the result so obtained is more easily reproduced than by the usual method. C. F. M.

276.* Rapid Determination of Carbon and Hydrogen in Coal. G. W. Fenton. *J. Soc. chem. Ind.*, 1943, 62, 160–163.—0·2 gm. of coal is burned in a fast (250–300 mls. per min.) stream of oxygen through the usual combustion tube at a furnace temperature of 800°. Combustion is complete in 10 mins. The temperature is unusually low for coals, but the temperature of the burning coal in the oxygen stream is considered to be much higher than that of the furnace. Water is absorbed by magnesium perchlorate and carbon dioxide by 4–14 mesh soda asbestos. A warning is issued for the handling of the perchlorate.

Oxides of sulphur and chlorine are absorbed on a packing of granular lead chromate, 3 in. long, held between ½-cm. plugs of oxidized copper gauze, 3 to 6 in. from the exit end of the tube.

Under the above conditions the combustion of benzoic acid is not complete, but succinic acid and sucrose have been found to be suitable as standards.

T. C. G. T.

277.* Use of Silver Vanadate in Micro-Combustion of Organic Compounds. G. Ingram. *J. Soc. chem. Ind.*, 1943, **62**, 175–176.—Errors in the combustion-analysis of nitrogenous organic compounds, particularly those containing chlorine and sulphur, can frequently be traced to the inefficiency of granular lead peroxide in decomposing oxides of nitrogen. This latter fault is due to poisoning of the lead peroxide with the elements mentioned. Silver orthovanadate suspended on pumice granules as the main oxidation filling has been used with success.

To prepare the silver vanadate a solution of 18 gms. of vanadium pentoxide in 2N caustic soda is filtered. Excess of silver nitrate solution is added, the whole boiled, and the yellow precipitate filtered off. 5 gm. of the dry material are suspended in 8 gm. of 10–14-mesh pumice by heating and stirring until melted. The product is heated strongly for 4 hours with stirring until all the volatile products are removed.

A suspension of the oxides of cerium or magnesium on silver chromate has also proved to be successful in decomposing oxides of nitrogen. T. C. G. T.

278.* The Control of Tar Viscosity by Standard Gravity and Other Means. T. H. Blakeley and J. G. Mitchell. *J. Soc. chem. Ind.*, 1943, **62**, 179–181.—Two methods for controlling the viscosity of mixtures of pitch and tar oils are described. The first method is applicable only to materials from the same crude tar, for which, as Blakeley (*J. Soc. chem. Ind.*, 1938, **57**, 7 and 1940, **59**, 87) has shown, there is a definite relationship between the viscosity and specific gravity. The specific gravity is adjusted to a value which is calculated to correspond with the desired viscosity. The second method has wider applicability, and depends on the close approximation that E.V.T. (equiviscous temperature) of a fluxed pitch is a linear function of the proportions of constituents. (G. H. Fuidge, *Chem. and Ind.*, 1936, 301; *J. Soc. chem. Ind.*, 1937, **56**, 427). The "E.V.T." of the flux oil is determined by actual mixings, and the proportion required to give the desired viscosity calculated by the simple mixture rule.

C. F. M.

279.* Estimation of Mercaptan Sulphur Alone or In Presence of Elementary Sulphur in Petroleum Products. E. R. H. Davies, and J. W. Armstrong. *J. Inst. Petrol.*, November 1943, **29** (239), 323–328.—The publication is sponsored by Sub-Committee No. 3 of the Institute of Petroleum for the purpose of evolving a method considerably more satisfactory than the present qualitative "Doctor" Test. Experimental results show that the precision of the method should be ±0·02% for 1·0% of RSH in sample; ±0·2% for 0·1% of RSH and ±2·0% for 0·01% of RSH. A. H. N.

280.* The Filter Freezing Temperature of Aviation Fuels. J. M. A. Court. *J. Inst. Petrol.*, November 1943, **29** (239), 329–331.—When a fuel flows under controlled conditions through a wire gauze filter of defined dimensions, the highest temperature at which the rate of flow falls below a specified critical value is defined as the filter freezing temperature. The apparatus and procedure are discussed. A. H. N.

Synthetic Products.

281.* Solvent Uses of Nitroparaffins. R. L. Ericsson. *Industr. Engng Chem.*, 1943, **35** (10), 1026.—The physical properties of nitromethane, nitroethane, and nitropropanes are given, together with a discussion on the value of these solvents in lacquers, coating materials, and synthetic rubber cements. It is shown that the evaporation and flow characteristics of the solutions are improved when one of the nitroparaffins is used to replace a commonly used solvent. J. W. H.

282.* Recent Developments in Nitroparaffins. H. B. Hass. *Industr. Engng Chem.*, 1943, **35** (11), 1147.—Research on the low-pressure vapour phase nitration of paraffins has enabled the following generalizations to be reached : (i) Polynitroparaffins are not formed unless paraffins of rather high molecular weight are used ; (ii) any hydrogen atom in the hydrocarbon molecule may be replaced by a nitro group, and (iii) any alkyl group present in the hydrocarbon may be replaced by a nitro group. The physical properties and commercial uses of the nitroparaffins are discussed. It is shown that relatively simple reactions on the nitroparaffins result in the formation of dinitroparaffins, amines, diamines, alkylhydroxylamines, oximes, hydroxamic acids, carboxylic acids, aldehydes, ketones, halogenated nitro compounds, nitro-alcohols, nitroglycols, nitro-alkanetriols, organic esters of the three preceding types, inorganic esters, amino-alcohols, aminoglycols, amino-alkanetriols, amino-acetals, soaps of the four preceding types nitro-olefins and nitro-ketones. J. W. H.

Motor Fuels.

283.* Gasogenes and their Limitations. *World Petrol.*, October 1943, **14** (11), 48.—In view of suggestions that vehicles propelled by gas obtained by burning wood or charcoal might be used to relieve the motor-fuel situation in the U.S., Egloff and Truesdell have reported their investigations on the subject. Upwards of 820,000 such vehicles were in use in 1942 in other parts of the world. Of the four types of producer-gas engines developed in Europe, the down-draft is said to be most suitable for wood or charcoal. Construction, mounting, and operation of the gasogene engines are described.

The conclusion is reached that gasogenes would be used only where an absolute dearth of petroleum prevailed.

It is calculated that to replace the 32 million gasoline-propelled vehicles is the U.S. by gasogenes would necessitate cutting down some 3 billion trees per annum.

R. A. E.

Gas, Diesel and Fuel Oils.

284.* Stability of Furnace Oil. A. B. Hersberger, H. C. Cowles, and B. Zieber. *Industr. Engng Chem.*, 1943, **35** (10), 1104.—The use of unstable domestic fuel oils results in sludge formation and corrosion of metal parts, particularly brass, which leads to clogged strainers and valves. A stability test is described which consists essentially of heating 50 ml. of the sample in a 4-oz. bottle at 210° F. for 4 days in the presence of two metal pairs—namely, iron-copper and iron-lead. The bottle is filled and the oil saturated with oxygen before commencing the test, and the bottle is closed with a neoprene stopper. The amount of sludge formed in the presence of each pair of metals is determined by filtering the oil through a tared Gooch crucible. Comparative data are given for seven fuel oils examined by this test, and the behaviour of these oils in the essential parts of a burner system under normal operating conditions is discussed. A satisfactory correlation is obtained for refined and unrefined straight-run oils, but the test failed to rate cracked oils correctly. J. W. H.

Lubricants and Lubrication.

285. Emulsion Lubricants. H. Strommenger. *Oel u. Kohle*, 1943, **39** (15/16), 412–416.—There have been several previous reports in the literature on the use of lubricating-oil emulsions. The blending figure is generally 50/50 (by volume) oil and water. The emulsion should be finely divided, stable, and non-corrosive, have a high V.I. and low pour-point, these properties being attained only by careful control. Either finished emulsion or emulsifiable oil is sold—the latter for large gas engines, low-pressure compressors, general machinery, and bearings—the former for steam engines, high-pressure and special compressors.

Stirring and/or heat is used to give fine division and stability. The condition of preparation must be well defined and a suitable apparatus used.

Emulsion lubricants are best suited for systems using new oil continuously—*e.g.*, drip-feed— the advantages being less with other systems. The viscosity of the blend depends on the working up of the emulsion, and with cylinder oils and oils for high-pressure compressors the viscosity of the emulsion is relatively high. Four types of emulsion are discussed.

Cylinder-oil emulsions are well suited to steam engines, and were used in the last war and for some time following. The German State Railways have lubricated locomotive cylinders for some years with an emulsion made by emulsifying saturated lime-water in steam-cylinder oil. Emulsions have also been used by firms, even when straight oils were readily available and there were no economic reasons for their use. In steam cylinders, emulsion lubricants have good adherence and film strength, and there is also a cooling effect due to evaporation of water, so that oils of a lower flash point than usual could probably be used. Furthermore, residue formation on piston and slide valve is diminished. The initial oil for the emulsion should be similar to the pure oil it is replacing. Emulsions can be recovered as well as pure oils. Dipping lubrication in mining machinery in Upper Silesia has used a blend of 1 part cylinder oil (flash point 240° C.), 1 part dark axle oil, and 2 parts water.

High-pressure and special compressors can use emulsion lubricants. Thermal stability is not as important as the degree of lubrication with compressors, blowers, vacuum pumps, and especially those conveying gases. The oil quality available to-day may not be good enough for these valuable machines. Thickening or coking through oxidation or polymerization may take place, or the lubricant may be diluted by the conveyance of gasoline or compressed hydrogenation products. Experiments have shown emulsion lubricants to be well suited for air and petrol-gas pumps owing to the cooling effect, resistance to oxidation, and dilution. A mixture of 78% hydrogen sulphide, 8% hydrogen cyanide, and 14% carbon dioxide was successfully pumped using emulsions, where previously soft soap had had to be used. Large gas engines have previously been lubricated with emulsions, which can be supplied either ready for use or as emulsifiable oil. Tests on gas engines, low-pressure condensers, compressed-air motors, air compressors, and vacuum pumps have confirmed the possibility of saving 50% of the lubricants. In a large mining company of the Ruhr where emulsions were in general use the consumption was decreased to 64% of the amount previously used. Emulsion lubrication will be continued after the war in mining, at least with machines working on compressed air.

The article concludes with a summary of the advantages and disadvantages of emulsion lubrication. It is acknowledged that the emulsions offer some difficulties in the recovery of used oil, but the difficulties are not as great as generally believed. It is also agreed that on storage the viscosity of the emulsions tends to increase.

The advantages are—saving of about 40–50% of mineral oil, less residue formation, greater stability against chemical effects (*e.g.*, oxidation or polymerization) and a better lubricating effect. The finished emulsion has a viscosity roughly double that of the original oil, enabling thinner oil to be used. The higher-viscosity oil gives better sealing, and, with a lower tendency to creep, there is a smaller loss of oil. It has been observed in mining that emulsion lubrication diminishes the icing of compressed-air motors. The fact that so much water does not cause difficulties in lubrication is probably due to several factors. There is a lowering of the freezing point which, even without emulsifier, amounts to about 5° C., this being effected by soap solution. The lubricant does not freeze into a solid mass, but forms a mush, which does not destroy the oil film, so that lubrication is still possible.

This paper has only touched upon the many problems involved, and users are advised to consult lubricant producers or qualified engineers before applying emulsion lubrication. In this way trouble will be avoided and the full benefits reaped.

A thorough treatment of the nature of water-in-oil-emulsions is to be given in later papers. E. H. W.

286.* A Note on " Oiliness " and Surface Roughness. J. J. Bikerman. *J. Soc. chem. Ind.*, 1943, **62**, 41–42.—E. Heidebroek (*Angew. Chem.*, 1941, **54**, 85) recently demonstrated that if a small tension "F" takes "t" seconds to separate two steel plates having a film of oil of viscosity η between them, then $\frac{Ft}{\eta}$ is a constant independent of temperature. Different oils were found to yield various constants, but the variations failed to show any regularity, and it was concluded that these results were connected with the " oiliness " of the oils.

Hydrodynamical considerations, however, yield the relation $\frac{Ft}{\eta} = \frac{3}{4} \cdot \frac{a^2}{{h_2}^2}$ where a is the radius of the plates and h_2 is the effective clearance between them. Thus, since h_2 represents the height of protuberances on the surfaces, the roughness of the latter can be estimated. According to Heidebroek's results, h_2 for a steel surface finished with a coarse file is about 2·2 times that for a finely ground surface.

C. F. M.

287. Frictional Phenomena. Part XVI. A. Gemant. *J. Appl. Phys.*, October 1943, **14** (10), 510–521.—The following technical applications are dealt with in this chapter : (1) belt drives, (2) clutches, (3) brakes, (4) vibration dampers, such as the Lanchester damper, (5) self-excited vibrations, such as shaft whipping and sound production in a violin, and (6) grinding and crushing. In most cases a brief outline of the mechanism of operation is given, followed—in the first three of the above-mentioned applications—by principles of design, chief types of construction, and necessary numerical data on friction coefficients. A. H. N.

288. Rheological Properties of Colloidal Solutions, Pigment Suspensions, and Oil Mixtures. R. N. Weltmann and H. Green. *J. Appl. Phys.*, November 1943, **14** (11), 569–576.—The law of Arrhenius which correlates the viscosity of a colloidal solution logarithmically to the volume per cent. concentration of solid matter has previously been tested only for dilute suspensions which appeared to the investigators to behave like true Newtonians. Similar suspensions have been tested at higher concentrations of solid matter, and the authors found that although Arrhenius' law could not be checked, a similar exponential law evolved, which, however, is correct only within the tested region of viscosity. The authors realized that with the increase of solid matter the suspension can become plastic or pseudo-plastic, and may also show thixotropic behaviour. Therefore it was considered as a major part of this investigation to determine the validity of Arrhenius' law in that region of concentration, where plasticity occurs. Although Arrhenius' law was not found to be applicable for plastic materials, two exponential laws, similar to Arrhenius' law, have been established between the plastic viscosity and the volume per cent. of pigment content of a plastic suspension on the one hand, and between the yield value and the volume per cent. of pigment content of a plastic suspension on the other hand. The two constants in the exponents of the two equations have been shown to be logarithmically related to the average diameter, d_3, of the pigment particles contained in the suspension. Oil mixtures with the same and with different type constituents have been tested below a certain rate of shear, called " the limiting rate of shear," where they are Newtonian liquids, and also above this limiting rate of shear where they behave like thixotropic plastics. Their Newtonian viscosities, obtained at rates of shear below the limiting rate of shear, have been found to increase logarithmically with the volume per cent. of one of the oils contained in the mixture, which is in agreement with Arrhenius' exponential law. However, above the limiting rate of shear, oil mixtures deviate from the exponential law, which is logically expected, since their limiting rate of shear depends on the Newtonian viscosity, and therefore is different for each oil mixture. A. H. N.

289.* A Study of Oil Oxidation as Related to Lubrication. Part I : Apparatus, Technique, and Preliminary Results. P. G. Exline, W. E. Kramer, and J. R. Bowman. *J. Inst. Petrol.*, November 1943, **29** (239), 295–307. *Paper Presented before the Division of Petroleum Chemistry, American Chemical Society.*—Experimental results are presented and discussed on the influence of the bearing atmosphere on bearing load and torque and on the viscosity and neutralization number of the oil when the bearing is run at high temperatures. Oils of different V.I. and bases were used. A. H. N.

290.* Oxidation—Corrosion of Lubricating Oils. C. L. Pope and D. A. Hall. *Petroleum*, November 1943, **6** (11), 168–177. (Adapted from *A.S.T.M. Bulletin*, 1943, pp. 25–28).—A rapid laboratory method has been developed for determining the suitability of an oil for a given service or for comparing relative merits of oils in service.

The procedure consists in passing oxygen saturated with moisture at the rate of

3 litres per hour, into a specially closed beaker containing 250 mls. of oil with which a metal strip is held in contact. Reaction temperature is maintained at 100° C. ±0·5° C. by means of a heated oil-bath, the oil under test and the bath being stirred by means of suitable paddles. A reflux condenser returns most of the volatile oxidation products to the reaction. Test-strips are varied according to the application of the oil. Tests and inspections are made every 24 hrs., and at the end of 96 hrs. the oils and strips are further examined and the oils classified accordingly. Oils were divided into four groups, according to visual examination of corrosion of strips. As regards oxidation stability of the oil, it was found that the rate of loss of interfacial tension against distilled water provided a better single criterion than neutralization number. Oils were divided into three groups on this basis, the lower the loss of interfacial tension the less corrosive the oil. Further tests at varied intervals according to grading were made where necessary. Correlation of the gradings resulting from these tests with service results are reported. The test may be applied to control blending of used oil with new oil, where desirable to prevent initial corrosion under certain conditions of operation, and to determine the remaining useful life of an oil already in use. R. A. E.

Asphalt and Bitumen.

291.* Surface Consistency Characteristics of Asphalts. E. C. Knowles and F. C. McCoy. *Industr. Engng Chem.*, 1943, **35** (10), 1118.—The normal routine tests carried out on asphalts reflect the flow properties of the material in bulk. In practice asphalts are applied in relatively thin layers or coatings, which become progressively harder with time and service conditions, and the object of the present work is to provide a test which will reflect the characteristics of the exposed working surface of an asphalt layer. With this object, the A.S.T.M. penetrometer has been modified to function as a constant-depth penetrometer by the provision of a suitable range of weights. Tests are carried out to determine the load required to cause penetrations of 0·04, 0·15, and 0·30 cm. The results are given of a series of tests carried out on seven asphalts of different types at different temperatures. In addition examples are given of the application of the test to the ageing of asphalt surfaces under various conditions. J. W. H.

Special Products.

292. 3, 2-Nicotyrine. Insecticidal Properties of Certain Azo Derivatives. R. L. Frank, R. W. Holley and D. M. Wikholm. *J. Amer. chem. Soc.*, 1942, **64**, 2835–2838.—The preparation of 3 : 2-nicotyrine from nicotine by means of a palladium on asbestos catalyst is described. 3 : 2-Nicotyrine couples with diazonium salt to form azo-dyes which show activity as insect-proofing agents. T. C. G. T.

293. Insulating Oils for Cables. S. Beckinsale. *J. Inst. Elect. Engrs*, 1943, **90** (2), 3–14.—Pennsylvanian and naphthenic oils, with or without rosin, are used as cable compounds, but naphthenic oils have advantages; thus they have greater solvent power for the rosin which is frequently a component of the compounds. The electrical and physical characteristics of these oils and the methods of testing as carried out by a cable manufacturer are described. For resistivity and dielectric losses many cells have been tried, but all have the common feature of testing the oil between plates or concentric surfaces. The author uses a Gambrell oil-testing cell and Schering bridge which with a battery-operated amplifier can be used to obtain power-factor readings to the fifth place of decimals. The precautions necessary when determining power factors of highly refined oils are emphasized.

Breakdown strength is mainly a test for dryness and cleanliness, and is carried out accordingly to the B.S. method 148. In such an apparatus results of 70 k.v. to 100 k.v. are found on good oils.

Viscosity is of considerable importance, and the desirability of a poor viscosity index is indicated. Naphthenic base oils are best in this respect.

Oil and rosin oxidation are dangerous to cable-makers. Oxidized rosin tends to produce water at temperatures of 125° C. The danger of oxidation has led cable-makers to careful studies of the solubility of gas in oil, and as 6 mls. of oxygen are found in

100 mls. of oil at N.T.P., the technique of degassing oil has received much attention. It has been found desirable to degassify under vacuum at temperatures of about 80° C. and then to introduce carbon dioxide which sweeps out residual oxygen. After this the temperature is raised to 140° C. and the inert carbon dioxide is removed. This technique prevents the rapid oxidation of the oil which occurs at the higher temperature required for complete degassing.

The coefficient of cubical expansion of cable oil is of some note. Most oils vary between 0·0006 and 0·0008 per 1° C., with naphthenic oils having the lower coefficient. Oil-rosin compounds have coefficients of about 0·00065.

Specific gravity is of little moment, except that the higher specific gravity oils are usually better solvents for rosins.

The types of rosin available for blending with mineral oils and the dangers of rosin crystallizing out of oil blends are discussed. The general test for stability involves maintaining the oil at 60° C. for 24 hrs., and if a compound passes this test, it is considered stable. The development of rosin oxide must be closely watched, and if this rises to 2%, precipitation may occur. Stable blends of rosin and oil are obtained by blending at 140° C. under vacuum.

Some attention is given to methods of "cleaning up" aged cable oils and compounds. The aged straight mineral oils can be improved by earth treatment, but the oxidized compounds containing rosin oxide need much more difficult treatment. The latter is done by agitation with Fuller's earth followed by allowing the earth to settle together with the coagulated rosin oxide. The clear compound is then filtered with the assistance of a filter aid. It is necessary to keep the treating temperature below 20° C., or the rosin oxide will not be reduced below 1%. A further method of removing rosin oxide is by wet steam, whilst a third method involves diluting the compound with a low-boiling petroleum solvent, whereupon the oxide is precipitated.

Apart from the straight oil and mineral oil plus rosin cable impregnants, there is a tendency to study the oil plus petroleum polymer.

Brief mention is made of the low-viscosity type of oil used for oil-filled cables of the Pirelli type. T. C. G. T.

294. Mineral Oils for Transformers and Switchgear. A. A. Pollitt. *J. Inst. Elec. Engrs*, 1943, **90** (2), 15–22.—A brief summary of the hydrocarbon constituents of insulating oils and their reaction to refining treatments is followed by a survey of the causes of transformer and switchgear oil deterioration and of the products ensuing from this deterioration. An outline of the evaluation of such oils and their maintenance control is also recorded.

The detrimental effect of over-refining is reflected in the growing preference of electrical engineers for the less refined B. 30 in place of the highly refined A. 30 transformer oil. There are two main factors in the deterioration of insulating oil, one being physical and the other chemical, although both result in chemical change. The physical factor is electrical discharge in voids formed prior to or during use of the equipment concerned. Electrical discharge results in gas formation (hydrogen and hydrocarbons), together with polymerized bodies. Oxidation is of course the main chemical factor and the reaction is influenced by the voltage obtaining. The effects depend more upon the type of oxidation product than on the quantity.

Deterioration of transformer oil is indicated by a decrease in the electric strength, but power-factor increase is a more sensitive indication.

The products of oxidation are numerous, but may be regarded generally as sludge, water, and acidity. Water and acidity are probably the most detrimental products. Acidity leads to reaction with metals present in the system, and the soaps so formed catalyse the further oxidation. Furthermore, the acidic bodies have a detrimental effect on cellulosic material (*e.g.*, cotton and paper), leading to a reduction of their mechanical strength.

The polar bodies formed by the oxidation process tend to re-orient themselves every half-cycle of alternating current, absorbing energy and developing heat, or, in other words, increasing the power factor. The extent to which the power factor is increased by the presence in an oil of dipole molecules is dependent also on the viscosity of the oil; thus the more viscous an oil, the greater will be the molecular friction retarding the orientation of the molecules, and hence a lower power factor will result than if the orientation was more freely permitted by a more fluid, or hotter, oil.

The main fault with sludge, of the polymerized hydrocarbon type, is that its accumulation on conductors retards heat dissipation. Furthermore, it increases the oil's viscosity, leading again to poor cooling properties.

The tests forming the basis of most insulating-oil specifications are enumerated and their value discussed. The tests for resistance to oxidation are very important, but those in use are not quite satisfactory. It is suggested that the most logical test could be one measuring the amount of oxygen absorbed in an oil. Such tests have been developed, but are in the research stage, and not yet applicable to widespread use.

The maintenance of insulating oils in service is reviewed and stress is laid on the necessity of giving the equipment a good start by ensuring that all " shop debris " is removed and that clean oil is used. It is wise to watch the acidity increase of the oil in use, and whilst an acidity of 0·3 mg. KOH per gm. need not be regarded as dangerous, figures of 0·5–0·75 indicate the need for very careful observation. Sub-station transformers are often troublesome, as these are frequently in hot, ill-ventilated and high-humidity buildings. Furthermore once installed, these transformers are apt to be poorly maintained, or even forgotten.

The author concludes with a suggestion that transformers should be constructed which contain above the oil not oxygen, as air, but rather an inert gas such as nitrogen.

T. C. G. T.

295. Insulating Oil in Relation to Circuit-Breaker Failures. W. Fordham Cooper. *J. Inst. Elect. Engrs*, 1943, **90** (2), 23–28.—The paper deals primarily with the failures which can be attributed to oil deterioration associated with switches subject to frequent routine operations, such as arc furnace switch-gear and industrial control-gear which can be attributed to a deterioration of the oil.

In his capacity as H.M. Inspector of Factories, the author has over the last ten years investigated a considerable number of accidents and dangerous occurrences due to the explosive failure of oil-circuit breakers and oil-immersed control gear, and in doing so it has become apparent that not all were due to inadequate rupturing capacity or defective insulation.

The main types of failure are: (1) destructive failures due to arcing under oil following failure to clear a short-circuit or failure of insulation; (2) arcing under oil generates inflammable gases and vapours which, when mixed with air, may be ignited to cause an explosion; (3) either (1) or (2) may be followed by a short circuit above oil level; (4) ejection of flame from any of these causes may result in further short-circuits in open or cubicle gear; (5) ejection of hot or burning oil frequently, but not invariably results in fires and explosions of great violence.

The author attempts to outline the points to be watched in order to obtain some correlation between the occurrence of failure and the condition of the oil. The main tests supported by the author are breakdown strength, resistivity, suspended matter, volatile hydrocarbons, hard asphalt, acid content, and iodine value. T. C. G. T.

296. Maintenance of Insulating Oils in the Field. L. H. Welch. *J. Inst. Elect. Eng.*, 1943, **90** (2), 29–34.—Insulating oil deteriorates in use, and the maintenance engineer has to see that the working conditions are such as to minimize this loss of quality. The causes of deterioration are enumerated and the normal systems of cleaning oil in service (filtration and centrifuging) are discussed.

The author concludes that (1) minimum operating temperature of transformers and kindred apparatus should be ensured by adequate ventilation for indoor transformers and correct adjustments of controls on forced cooling systems; (2) adequate breathers should be used and maintained; (3) careful selection should be made of both mechanical and electrical design of apparatus, particularly in relation to tap-changing gear; (4) use of grade B oil should be recommended as grade A oils are liable to develop excessive acidity and sludging in service; (5) cold purification is preferable, and a filter is generally more useful and easier to operate than a centrifuge.

The paper ends with a suggestion that the present B.S./148 specification requires revision. It covers six oils of the same viscosity, and these could all be replaced by one oil—B. 30. There is also a need for a more viscous oil for switchgear.

T. C. G. T.

297. The Manufacture and Testing of Oils and Oil-rosin Saturants for use in Electrical Equipment. A. W. Thompson and J. C. Wood-Mallock. *J. Inst. Elect. Engr*, 1943, **90** (2), 35–53.—As the polar bodies which depreciate the electrical properties are largely the asphaltic compounds that concentrate in petroleum distillation residues, it is preferable to obtain insulating oils from distillates. Sulphuric acid is by far the best method of refining for insulating oils, and, unlike some methods, has been found to remove the objectionable polar bodies without decreasing the gas-absorption characteristics of the oil. Data are tabulated indicating the effect of varying acid strengths on the oxidation and electrical features of the oil.

Solvent extraction methods are not considered to be as desirable as sulphuric acid, as they tend to produce paraffinic oils, from which have been removed desirable constituents, such as hydrogen-absorbing hydrocarbons, and which have too high a viscosity index. In addition, solvent processes are often inefficient in removing unidentified compounds, which on oxidation cause high power factor and increased conductivity. It is acknowledged that the solvent processes have been successfully applied to the production of B. 30 transformer oil. Solvent processes have a further interest, in that the extracts may prove of value to the electrical industry. An example is given of a material with a specific gravity of 1·00, which is solid at atmospheric temperature but quite fluid at 80° C., contains no wax, and has a specific inductive capacity 3·5.

The value of clay treatments which are necessary to give the final finish to an insulating oil is emphasized. A table illustrates the effect of various proportions of earth upon an oil. Traces of metallic sulphonates are removed by earth treatment, and the necessity for doing this is shown by data to be very important. As an example, 10 parts per million of iron naphthenate increases the conductivity of an oil ten-fold.

The essential requirements of transformer oil, in that it should be of low viscosity for cooling, low vapour pressure to reduce evaporation and of low setting point, are the subject of internationally recognized tests, but the very important oxidation stability is in need of standardization. Several of the better-known oxidation tests are tabulated. The Michie Sludge test is not favoured by the authors, who recognize advantages in the methods of Anderson and of Clark, but at the same time point out their disadvantages. It is hoped that the acidity forming A-type oil has been finally displaced in this country. Curves are presented illustrating the effect of acid refining on the tendency of transformer oil to develop acidity, and a brief account is given of the various anti-oxidants which have been tried on a laboratory scale. So far the use of anti-oxidants has not been extended to commercial application. 0·5% of the pour-point depressant " Paraflow " can be added to oil without affecting the electrical tests.

It has been claimed that acid-refined switch oil produces less carbon than does solvent-processed oil, and as solvent processing is favoured for transformer oil, this fact may mean that the practice of using transformer oil for switch-gear will have to be modified.

Condensers utilize oils of the transformer class, paraffin wax and petrolatum. The necessity of good gas-absorption characteristics is emphasized. Chlorinated compounds have an extending market for condensers because of their high dielectric constant. The chlorinated product can, however, develop serious corrosive troubles.

Hollow-core cable oils gave considerable trouble until the value of gas-absorption characteristics was fully appreciated. The gas (hydrogen) absorption is increased by raising the proportion of unsaturated hydrocarbons present in the oil. The authors have found that the unsaturated, should be in the more volatile fraction of the oil, because it is in the vapour phase that most rapid absorption occurs. Aromatic hydrocarbons, such as naphthalene, have proved quite useful for increasing the hydrogen absorptive properties, but it is suggested that an oil of good characteristics can be obtained by blending a suitably refined aromatic extract fraction with a highly treated paraffinic raffinate.

Power-cable saturants are produced from viscous naphthenic or paraffinic oils, though the former are favoured because of their greater solvent power for rosin.

The use of rosin in cable oil is very extensive, in fact, only one cable-maker does not use it. Its value lies in the fact that it is very stable under electrical stress, achieves a desirable thickening of the oil, and the double bonds of the abietic acid absorb hydrogen. Careful selection and refining of the rosin are necessary. Solvent refining is not very successful with rosin, but good results are obtained by a vacuum distillation in which the oxidized rosin is left as a residue, whilst the resenes and terpenes are isolated from the main condensate of purified rosin. The plant for this treatment is constructed largely of stainless steel.

In recent years there has been a development of pressure cables in which sufficient pressure is maintained in the cable to prevent ionization. A very suitable compound for these cables is a blend of naphthenic oil and polymerized butylenes.

The article concludes with a review of the physical, chemical, and electrical tests used to assess insulating oils. When an oil of suitable physical tests has been obtained, the power-factor and gas-absorption tests are the most informative tests applied.
T. C. G. T.

298.* Butyl Rubber Production. J. A. Lee. *Chem. Met. Engng*, July 1943, **50** (7), 102–103.—Certain operations at the Baton Rouge synthetic rubber plant of Standard Oil Co. are briefly described. The properties of butyl rubber are very briefly discussed. The unit used combines *iso*butylene, produced at the refinery, with a small amount of *iso*prene to form the synthetic rubber. Feed-stocks start at the oil-cracking unit where a gas oil is taken from crude and subjected to high-temperature cracking in the presence of steam. In this cracking operation are produced numerous gases, such as ethylene, propylene, butenes, and gasoline fractions. The butene fraction is sent to the extraction plant for removal of butadiene, leaving a mixture of butenes and *iso*butenes. The mixture of butenes and *iso*butenes is sent to another plant where *iso*butene is extracted for subsequent use in the butyl rubber manufacture. The remaining butene is sent to the dehydrogenation plant, where it is converted into additional butadiene. At the butyl plant the *iso*butylene extraction is subjected to a redistillation to remove traces of moisture and any undesirable fractions. It is then ready for utilization in the polymerization reaction. *iso*Prene is now brought from outside, but a new plant is being built to recover it from the gasoline refinery. The reaction is maintained at −150° F. The reactor, as well as the operation of the catalytic synthesis, are described.
A. H. N.

299.* Butadiene from Petroleum. Anon. *Chem. Met. Engng*, July 1943, **50** (7), 104–106.—A short historical development of the subject is given. The concentration of butadiene is given only in outline, as war-time conditions do not allow of detailed description. Concentration by absorption has proved successful. Dehydrogenation of butylene to butadiene catalytically, using steam as a diluent, is discussed. In carrying out butene dehydrogenation, the refinery gas stream, rich in normal butylene, is first purified so as to increase to a maximum the concentration of normal butylenes in the feed-stock. These gases are then diluted with steam and subject to high temperatures in contact with the dehydrogenation catalyst. The reaction vessels in which this contact is accomplished are of a highly intricate design, but their details cannot now be disclosed for reasons of national security. As the reaction progresses, the catalyst gradually loses activity, and it is necessary periodically to regenerate the catalyst by treatment with steam, also at elevated temperature.

Substantial conversion of butene into butadiene is accomplished, and the reacted gases are then fractionated, separating normal butylenes for recycling, and providing a butadiene-rich stream to the final purification system. The purity of butadiene is an important criterion in its use.
A. H. N.

300.* Density of Carbon Black. R. P. Rossman and W. R Smith. *Industr. Engng Chem.*, 1943, **35** (9), 972.—The densities of commercial carbon blacks have been calculated from X-ray diffraction data and compared with the values obtained by immersion in helium and water. Consideration of these results shows that the density in the strict sense of the term may be determined only from the diffraction data. Immersion methods give an apparent density which is a measure of the effective free space within the particles, and for all practical applications this is the value to employ. The choice of helium or water depends on the nature of the application, helium being the correct fluid for surface-area determinations and water when assessing ink and rubber compounding. Water and helium densities are of the same order for ordinary carbon blacks, but are different for acetylene black, the helium density giving a higher value for this substance.
J. W. H.

301.* Petroleum Solvents. E. M. Toby. *Industr. Engng Chem.*, 1943, **35** (9), 1044.—The specifications and evaporation rates are given for fourteen grades of standard aliphatic and naphthenic solvents, six grades of aromatic solvents, and six grades of close-cut solvents. A discussion is given on the uses of these solvents, and it is shown that, due to war-time restrictions, there is a shortage of aromatic solvents available for general use. J. W. H.

302. Butadiene Production Under Way at Southern California Gas Co. Plant. H. L. Masser. *Oil Gas J.*, 28.10.43, **42** (25), 45.—The butadiene plant constructed by the Southern California Gas Company will produce 35,000 short tons of butadiene per annum from the vapour phase cracking of about 1 million tons of 200–500° F. naphtha. The plant consists essentially of a gas-generating plant (mostly from remodelled equipment) and an absorption unit to extract butadiene/butylene. The new equipment is estimated to cost $5,750,000, the remodelled existing equipment being valued at $6,250,000. The naphtha is cracked in 10 firebrick checkerboard reactors at 2 lb. gauge, 1 sec. residence time, and at 1350° F., using equal weights of oil and steam. The gas, representing 60% wt. of the charge, is quenched with water, passed to oxide purifier boxes to remove H_2S, and thence to the compressors and absorption unit, where butadiene/butylene is recovered. The latter is then passed by pipe-line to the Shell Chemical Co.'s purification plant. Use is made of existing lines for the receipt of naphtha from different companies and the return of light oils. Tabulated data on operating material quantities and the compositions of wet gas to the absorption plant are given. C. L. G.

303. Modern Plastics for Insulation. J. Voit. *British Plastics*, November 1943, **15** (353), 360.—The present uses and future possibilities of plasticized polyvinyl chloride in the manufacture of insulated cables and wires are discussed, with details of technical requirements and specifications and a description of different types of insulated cables. Although the present value of P.V.C. is due to shortage of other raw materials, it possesses outstanding characteristics—*e.g.*, electrical properties which are of permanent value.. The P.V.C. resin is compounded with plasticizers, stabilizers, pigments, and extenders, the flexibility of the product depending on the quantity and type of plasticizer used. Increasing quantities of plasticizer make the product softer and of better low-temperature resistance, but affect the electrical properties. The main plasticizers used are tricresyl phosphate, which is not volatile, so that heat resistance is given at the expense of low-temperature resistance, and dibutyl phthalate, which is volatile, and hence imparts the opposite characteristics. Less widely used plasticizers are Arochlor, butyl acetyl ricinoleate, and dibutyl sebacate, but an all-purpose plasticizer still remains to be found—since the temperature requirements may vary from 130° C. to −50° C.

Government Department Electrical Specification No. 18/1943 covers products Nos. 1001 for the sheathing of electrical cables, 1002 for insulating conductors of electric cables, and 1003 for insulating conductors of special cables.

P.V.C. is also approved for use in shipbuilding, owing to its good fire-resisting qualities and resistance to solvents, chemicals, water, insect attack, oxidation, and ageing, but use at temperatures above 45° C. may cause difficulties owing to the relatively low softening point (55° C.). Use of P.V.C. at very much higher temperatures is, however, permissible for other purposes, particularly when a suitable plasticizer is used, and considerably improved temperature resistance has been obtained by placing a textile braiding directly on the insulation and impregnating this with P.V.C. Further advantages of P.V.C. for insulating work are : (1) inertness to copper, so that tinning is not required ; (2) ease of handling and simplicity of plant required, no vulcanization being necessary ; (3) availability in a wide range of colours, and (4) high speed of production by extrusion. P.V.C. has also been used for the outer covering of high-frequency cables made from polythene. It should also be a valuable asset for domestic wiring. C. L. G.

304. Peat Wax and Montan Wax. L. Ivanovsky. *Petroleum*, 1943, **6** (11), 170.—A sample of peat wax (s.p. 65° C.) from New Zealand was examined and compared with pre-war Riebeck Montan Wax. The sample was separated by extraction with hot alcohol and petroleum ether into four fractions, which were characterized and classified as follows:—(1) yield 17·3%; soluble in cold alcohol; reddish-brown, sticky material which melts to a viscous, stringy liquid. Classified as *Peat Wax Resin.* (2) yield 37·1%; soluble in hot alcohol, insoluble in cold; light to medium brown, hard, brittle, wax-like solid with conchoidal fracture. Melts and sets rapidly, the liquid being non-viscous. *Peat Wax Proper.* (3) Yield 20·6%; insoluble in alcohol, soluble in petroleum ether. Dark brown, hard, waxy solid, very brittle, and showing a "resin-like" conchoidal fracture. *Peat Wax P.S.* (4) Yield 21·8%; insoluble in both solvents; black, asphalt-like, granular solid; insoluble in benzene, and of ester composition. Although not strictly correct chemically, it was classified as *Asphaltic Matter.*

The peat wax itself resembles Montan Wax fairly closely, but has rather higher content of "asphaltic matter," which might be eliminated by further processing or, probably better, by alteration of production methods. C. G. G.

Coal and Shale.

305.* Oil and Smokeless Fuel from Coal. Plan for Development of Carbonization Industry. W. D. Spencer. *Petroleum*, November 1943, 6 (11), 163–167.—In order to utilize the gases from low-temperature carbonization of coal to better advantage than as plant fuel, proposals are made for combining low-temperature and high-temperature carbonization of coal with Fischer–Tropsch synthesis in such a manner that the final marketable products obtained would be smokeless fuel, liquefied gases, motor spirit, diesel oil, tar acids, wax, and pitch. Coke from the high-temperature carbonization would be used to manufacture producer gas for use as plant fuel and the water gas required by the Fischer–Tropsch plant. Gases from both carbonization units would be scrubbed to remove crude spirit and benzol, purified, and treated with steam in the presence of a catalyst to convert the methane into H_2 and CO, so as to provide, together with the water gas, the feed for the Fischer–Tropsch unit.

Treatment of the tars is envisaged, and blending of products from various stages of process. Consideration is given to yields from each stage, balancing of the three stages and the overall steam supply and heat balance. Capital cost requirements and economics of the plan from the aspect of utilization in the U.K. are discussed.

R. A. E.

306.* Synthetic Lubricants from Coal. Part I. P. W. Pickston. *Petroleum*, November 1943, 6 (11), 175.—General considerations relating to the possibility of preparing lubricants from coal by synthetic methods in the U.K. are discussed and a general flow-sheet of the processes involved is provided. R. A. E.

BOOKS RECEIVED.

Investigation of Concentration of Economic Power. Monograph No. 39-A, Review and Criticism on Behalf of Standard Oil Co. (New Jersey) and Sun Oil Co. of Monograph No. 39 with Rejoinder by Monograph Author. Pp. 96. Temporary National Economic Committee, United States Government Printing Office, Washington.

The Junior Institution of Engineers. Journal and Record of Transactions. Vol. LIII, 1942–43. Pp. 318. Percivall Marshall & Co., Ltd., *Honorary Publishers to the Institution*, Cordwallis Road, Maidenhead, Berks.

INSTITUTE NOTES.

February 1944.

DEATH OF MR. CHRISTOPHER DALLEY, M.I.E.E.

It is with deep regret that we have to record the death of Mr. Christopher Dalley, President of the Institute, on Friday, 28th January, at the age of sixty.

The Council tenders its sincere sympathy to Mrs. Dalley and the members of the family in their bereavement.

DEATH OF MR. J. McCONNELL SANDERS, F.I.C.

It is with deep regret that we also have to record the death of Mr. J. McConnell Sanders on Friday, 4th February, in his seventieth year.

The Council tenders its sincere sympathy to Mrs. McConnell Sanders and the members of the family in their bereavement.

ROLL OF HONOUR.

The deaths are announced with much regret of:

G. K. Beaumont (Student), died whilst a prisoner of war in Japanese hands.

F. R. Wellings, B.Sc. (Assoc. Member), killed in air operations.

ELECTION OF OFFICERS.

The Council has elected Professor F. H. Garner, O.B.E., Ph.D., M.Sc., to be President of the Institute for the Session 1944–1945. Professor Garner has been elected by Council to fill the casual vacancy created by the sudden death of Mr. Christopher Dalley.

The following have been elected Vice-Presidents of the Institute for the Session 1944–1945:

Ashley Carter, A.M.I.Mech.E.
G. H. Coxon.
A. C. Hartley, O.B.E., F.C.G.I.
V. C. Illing, M.A.
J. S. Jackson, B.Sc., F.I.C.

ELECTION FOR COUNCIL.

In accordance with the Articles of the Institute, the following members of Council retire at the next Annual General Meeting, but offer themselves for re-election: E. A. EVANS, C. A. P. SOUTHWELL, A. BEEBY THOMPSON, and C. W. WOOD.

Three new nominations have been received on behalf of H. HYAMS, LT.-COL. D. S. PAUL, and RICHARD R. TWEED.

The Council has decided that, in view of present circumstances, a postal ballot will not be held, and the names of the above seven candidates will be submitted to the Annual General Meeting of the Members to fill seven vacancies on the Council.

FORTHCOMING MEETINGS.

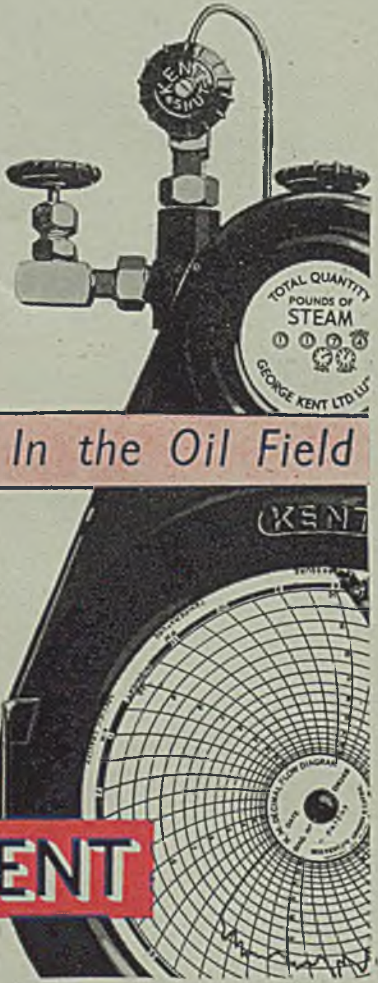
Thursday, 2nd March, 1944. At 5 p.m. at 1, Grosvenor Place, S.W. 1. "Recent Developments in Connection with the Application of Soil Stabilization in Practice," by J. S. Jackson (Joint Meeting with the Roads and Building Materials Group of the Society of Chemical Industry).

Friday, 24th March, 1944. At 4 p.m. at 26, Portland Place, London, W. 1. Discussion on "Standard Methods for Testing Petroleum and its Products," 1944 Edition, introduced by the Editorial Sub-Committee.

PERSONAL NOTES.

Major G. G. JACKSON, who has been serving in the Middle East, is now back in this country.

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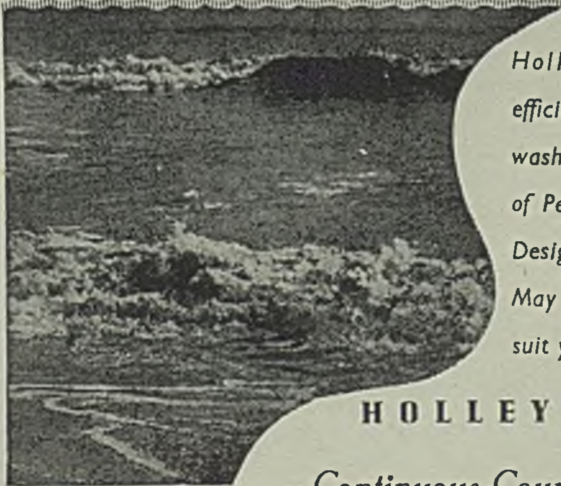

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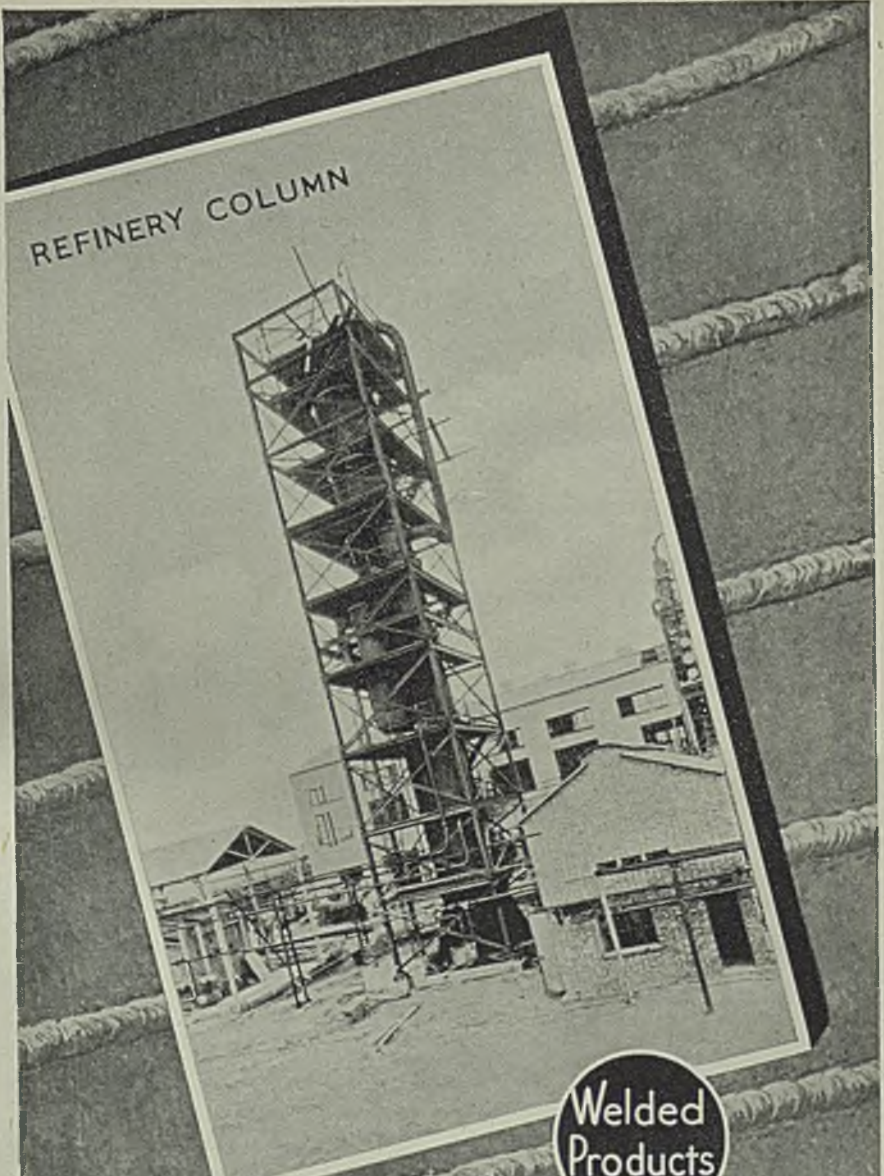
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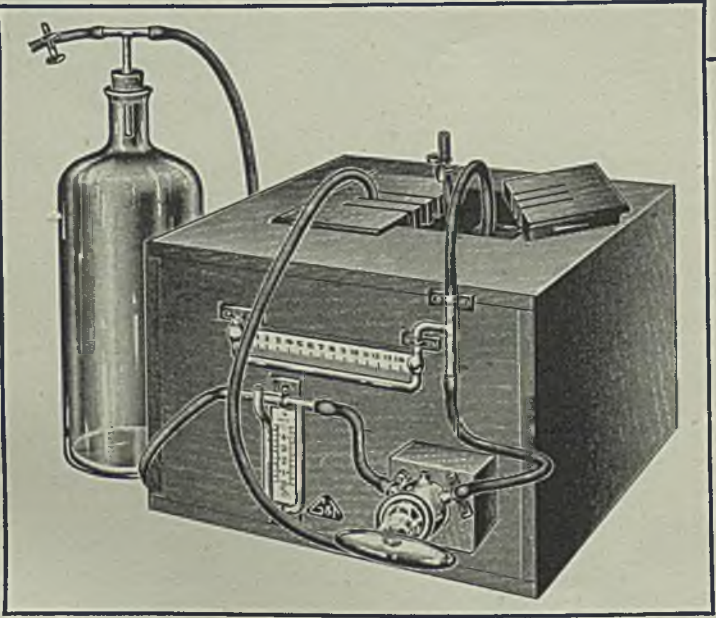

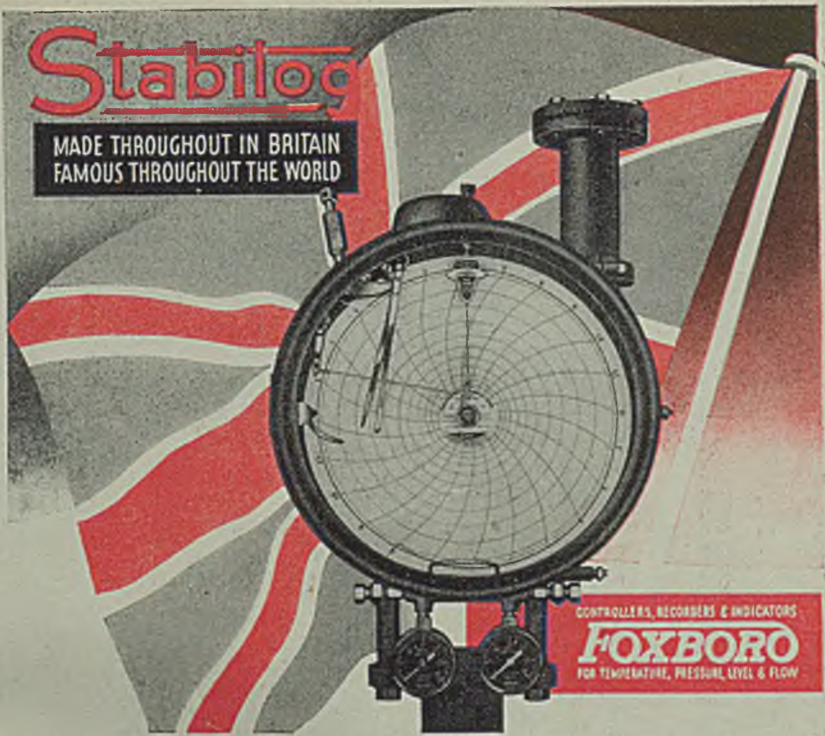
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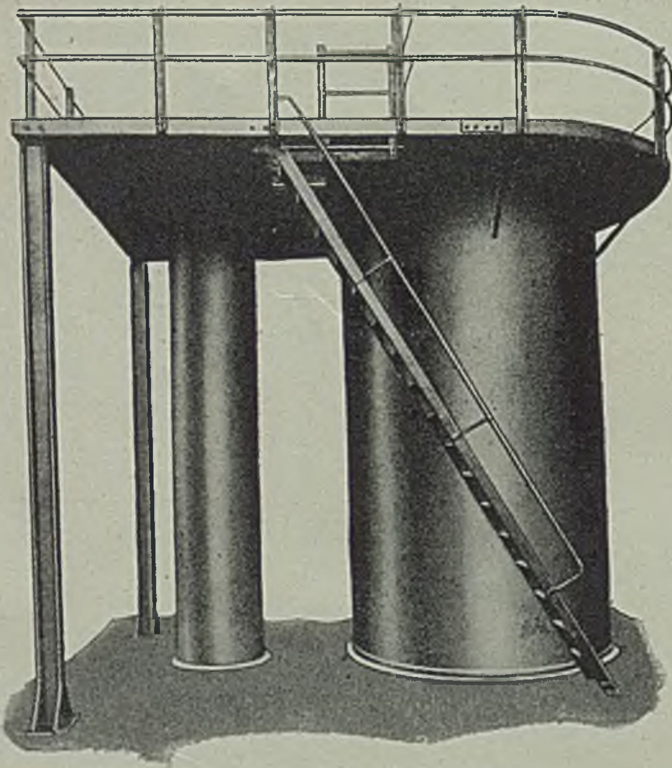

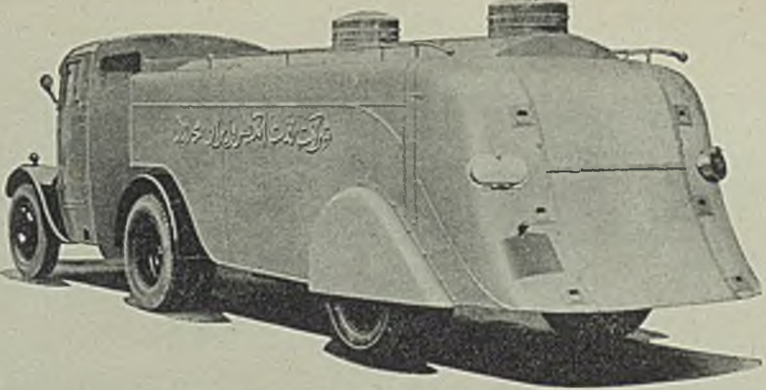


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