Vol. 30. No. 252. December 1944.

THE STUDY OF RESERVOIR FLUIDS BY SURFACE RECOMBINATION EXPERIMENTS.

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As the rate of discovery of new petroleum reserves lags farther and farther behind consumption, production technique becomes ever more important. To obtain maximum recovery the petroleum engineer needs to know as much as possible, not only about the reservoir itself, but also about the fluids being produced. Essential production data may be generally divided into two broad categories: information about the reservoir (largely obtained from core analysis and well logging) and information about the petroleum fluids (P-V-T data).

In recent years, recognition of the importance of P-V-T data has grown rapidly.† In general these data on reservoir fluids are obtained in either of two ways: by bottom-hole sample analysis, or by recombination of fluids as produced at the surface. The apparatus described below for surface recombination experiments was not developed primarily for high accuracy, but rather with a view to obtaining as much simplicity of construction as possible to afford speed of manipulation, with as good accuracy as these factors would permit. The resulting over-all error for a single experiment is believed to be about 1 to 2 per cent., which is adequate for field use. Greater accuracy may, of course, be obtained by averaging two or more experiments. It is customary to perform at least two, and usually three, check experiments on a given set of samples, thus reducing the probable error.

The following is a description, in more or less general terms, of the procedure followed by this laboratory in procuring and studying surface samples by the recombination method, using for illustrative purposes the data obtained in experiments on the fluids from the Oak Canyon Field, California.

Field Sampling.

The first step in making the recombination experiments is that of obtaining the field samples. This is an important operation, for if the samples are not properly taken, the entire experiments are worthless. More than this, the results of the experiments on faulty samples, which are not known to be faulty, may be applied to field practice, with possible misinterpretation of the reservoir performance. Since there is no fundamental check on the accuracy of field sampling, it should be done with great care, and all precautions suggested by the laboratory should be carefully observed.

Field sampling itself may be divided into two parts: obtaining the sample, and preparing it for shipment to the laboratory. The latter step

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† A very thorough presentation of the thermodynamic significance of P-V-T data is given in the recent book by Sage and Lacey, "Volumetric and Phase Behaviour of Hydrocarbons."

is important, for improper packing occasionally results in leakage from the container *en route*, so that the entire sampling must be repeated, with resultant expense and loss of time.

The oil and gas samples should be taken simultaneously from the separator, and it is desirable, in order to facilitate experimental procedure and ensure obtaining enough gas for the experiments, that these samples be taken at pressures above 100 p.s.i. gauge, if possible. The well should be flowing under steady conditions when the samples are taken.

Two containers are provided by the laboratory, a large one for the gas sample and a small one for the liquid. The large gas container is a standard 220-cubic-foot oxygen tank. This tank is evacuated to a pressure less than 1 mm. Hg at the laboratory. It is recommended that the vacuum be tested on receipt in the field. If the vacuum is practically complete, the gas tank is connected to the separator and filled with gas. It should then be disconnected and valved to atmospheric pressure and reconnected to the separator, preparatory to taking the final gas sample. If the vacuum check shows an incomplete vacuum, or if no vacuum check is possible, the procedure of filling the tank with separator gas and valving to atmospheric should be repeated at least four or five times before taking the final sample.

The liquid container is a modified standard small gas tank, 4 inches O.D. and about 14 inches long. Its volumetric capacity is 3 litres. Normally this tank has a valve only on one end, but for use as a liquid container, a boss is welded on to the bottom, and is drilled and tapped to take a standard Kerotest oxygen valve. After the tank has been thus modified, it is tested hydraulically at 2000 p.s.i. gauge. Since there is a valve on each end of the liquid tank, it may be filled with liquid by displacement. The valve is connected to the separator and is opened. The other (outlet) valve is then barely cracked to maintain nearly full back pressure on the container while filling with liquid. The container should be connected in a vertical position, so that the inlet valve is at the bottom. After all the free gas in the container is bled off through the outlet valve, maintaining high back pressure, a volume of liquid equal at least to the container volume should be bled through the cracked outlet valve, since the initial liquid expanding from the separator into the container has lost some of its gas and is no longer representative of the separator liquid. An alternative method of filling is to fill the liquid container with separator gas at separator pressure before attaching to the liquid connection on the separator. Then when the container is filled with liquid it is not necessary to bleed off an excess volume of liquid, since the pressure on the liquid has not been reduced in the filling process, and the liquid has been in contact only with separator gas at separator pressure.

At the time of sampling, data should be taken on the producing gas–oil ratio. The reservoir temperature should also be known. Separator temperature and pressure should be recorded, since, at the laboratory, if the pressures on the samples are appreciably different from separator pressures (with suitable temperature corrections), either incorrect sampling or leakage *en route* is assumed. Table I contains a typical set of field data.

Before shipping the liquid sample, 200–300 ml. of liquid should be bled off to give a small free gas space in the container to take care of temperature changes during shipment. The liquid container is packed in a heavy wooden box with internal cleats so placed as to hold the valves away from any contact with the ends of the box, otherwise the jouncing occurring in transit is very apt to work one or both valves open, with resulting loss of sample.

LABORATORY PROCEDURE.

When the samples are received at the laboratory, they are tested for pressure to determine whether any leakage has occurred *en route.*

The following data are then obtained on the fluid samples :

Separator gas samples :

- Chemical analysis.
- Specific gravity.
- Deviation factor at 100° C.
- Deviation factor at reservoir temperature.

Oil sample :

- Expansion factor and gas content between separator pressure and atmospheric at room temperature.
- Expansion factor and gas content between separator pressure and atmospheric at reservoir temperature.
- Gravity of residual oils from both of the above experiments.

Combined oil and gas samples :

- Gas solubility at reservoir temperature and pressure, and at intermediate pressures down to atmospheric.
- Expansion factor of oil at reservoir temperature, pressure, and gas–oil ratio, and at intermediate pressures down to atmospheric.
- Formation volumes at desired temperatures, pressures, and gas–oil ratios.

DESCRIPTION OF APPARATUS.

The literature contains numerous references [1-9] to apparatus for P-V-T studies on petroleum fluids. Each laboratory has its own particular situation to meet, and therefore has its own preferred modification of the fundamental basic design common to all such equipment. No claim of originality is made for the apparatus to be described ; it is simply the result of the necessary compromises and adaptations which are inherent in the design of any similarly complicated equipment. As stated above, an attempt was made to attain as much simplicity as possible with any concomitant facility of manipulation, the accuracy desired being only that necessary for field application of the experimental results.

The apparatus is shown semi-diagrammatically in Fig. 1. *A* is the gas sample tank as received from the field. *B* and *C* are the two stainless steel cylinders of the oil–mercury gas compressor, pumping oil from reservoir *E* into cylinder *B*, which displaces mercury from *B* into *C*, compressing the gas in *C*. *F* is a 7500-p.s.i. Heise gauge which measures the gas pressure during compression. *G* are two 2-volt electric bulbs, each connected, as shown by the circuit diagram, between a top and bottom contact in each cylinder. The electrical circuit is such that when the mercury level is below the bottom contact of either cylinder, the corresponding light is out, and when the mercury level is between the bottom and top contacts the lights burn dimly, flashing to bright when the mercury reaches the top contact. The volume of cylinder *C*, between the top and bottom contact, is known to within about 0·05 per cent. and amounts to 938·7 ml. The compression system and lead lines as far as valve 3 are insulated and electrically heated to a constant temperature of 100° C. This prevents the

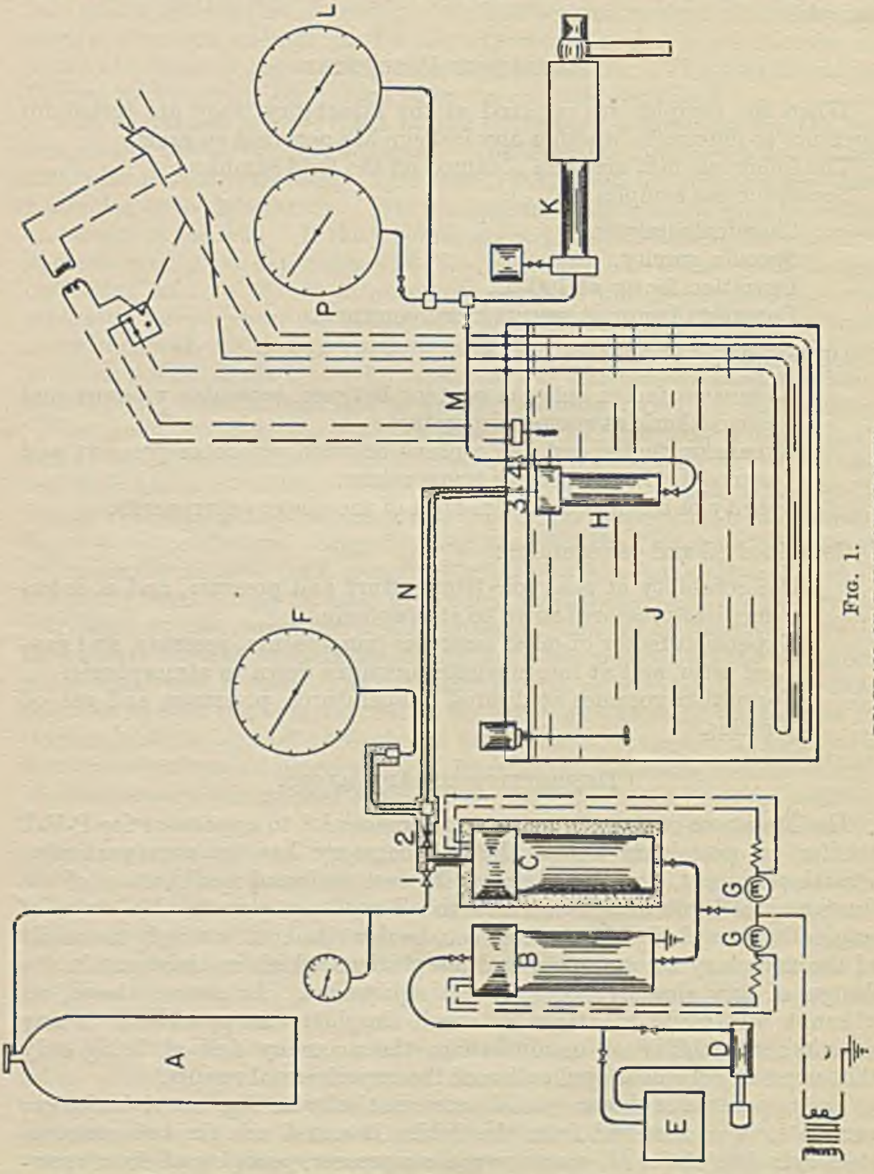

FIG. 1.
DIAGRAM OF P-V-T APPARATUS.

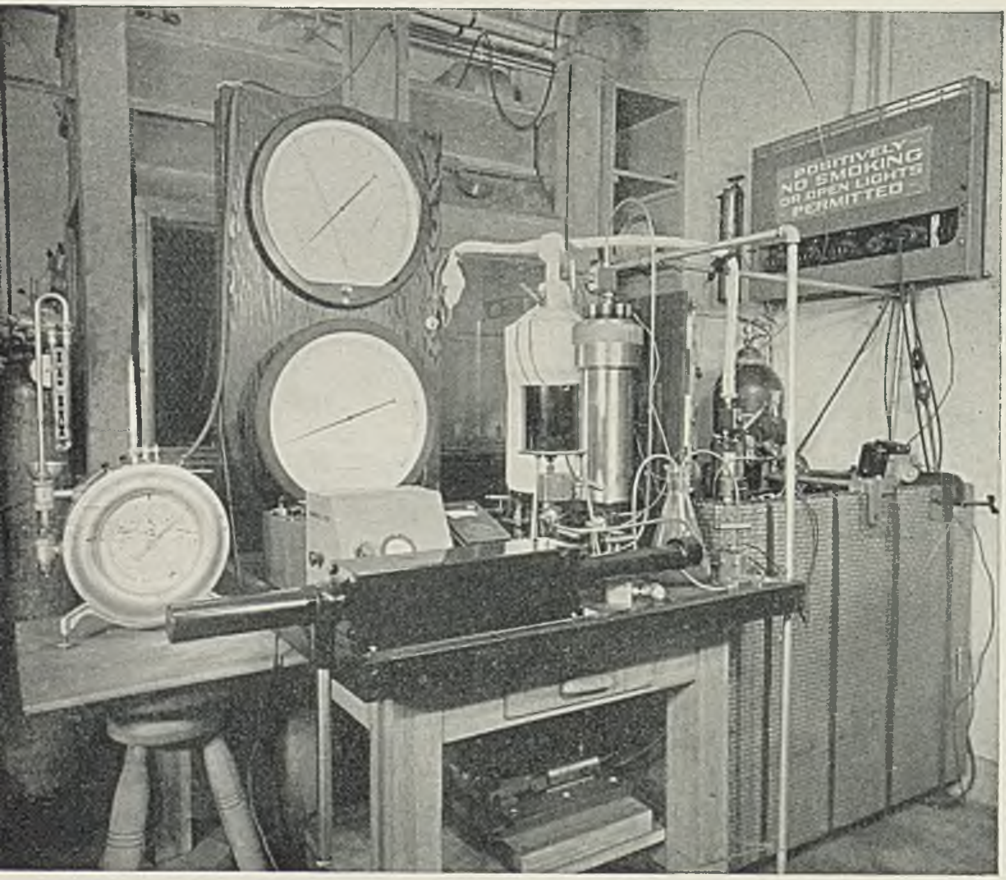

FIG. 2.
P-V-T APPARATUS.

[*To face p* .355.

possible condensation of ethane and propane during compression, since their critical temperatures are below 100° C.

The fluid samples are brought to equilibrium at the desired temperature and pressure in the stainless-steel bomb *H* (volumetric capacity 131 ml.), which is supported on a mechanical rocking mechanism * (not shown) in bath *J*. As seen from the diagram, the bath is electrically heated and thermostated, and is stirred by two electric stirrers (only one shown).

The fluid volumes in the bomb *H* are controlled by injecting or withdrawing mercury by means of a calibrated mercury displacement pump *K*, whose displacement is known and can be read at any point by means of a Veeder counter to within 0·02 ml., since each number on the counter corresponds to that volume. The pressure on the system is read from the 7500 p.s.i. Heise gauge *L*, or at low pressures from the 2000 p.s.i. Bellows type gauge *P*. Fig. 2 is a photograph of the apparatus, showing the bomb *H* connected to the lead line *N*, through which the gas sample is added.

EXPERIMENTAL PROCEDURE.

Experiments on Separator Gas.

The chemical analysis of the gas and its specific gravity determination are obtained by standard methods. The following is the analysis of the separator gas sample from the Oak Canyon Field: Air, 0·7%; CH_4, 84·7%; C_2H_6, 7·0%; C_3H_8, 5·1%; C_4H_{10}, 2·2%; C_{5+}, 0·3%. Total 100·0%. Specific gravity of separator gas = 0·669.

It is necessary to know the deviation factor for the separator gas at 100° C. in order to calculate the volume of gas added to the oil in the flash recombination of the fluids. This is determined by the following procedure. The reservoir bomb *H* is filled with separator gas at separator pressure or slightly higher (at least 100 p.s.i.). The bomb is then connected to the mercury displacement pump *K*, placed in the bath at 100° C., and mercury is forced into the bomb raising the pressure. The volume of mercury input (corrected for compressibility of the compressor system) is recorded for corresponding pressures, care being taken to allow thermal equilibrium to be attained before reading the pressure. After the gas has been compressed to the maximum pressure desired, the mercury is withdrawn by reversing the compressor stroke, pressures and volumes being recorded for the same pressure points as were recorded for the intervals of pressure increase. With careful operation, the mercury volumes for corresponding pressure intervals agree to within 0·04 ml. This procedure may be repeated by reinjection of the mercury to check any questionable points.

After the pressure is reduced to its original value, the gas is bled off through a wet-test gas meter, and the volume corrected to 60° F. and 14·7 p.s.i. Knowing the volume of the gas at standard conditions and its

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* This mechanism, designed by Mr. E. Topanelian, Jr., of this laboratory, is very effective. The bomb may be placed in either the horizontal or vertical position by merely loosening a set screw and adjusting, and is rocked at any desired frequency through a 15° angle on either side of the neutral position.

volume in the bomb at the various pressures, the deviation factor is calculated using the relation:

$$Z_1 = \frac{P_1 V_1 T_0}{P_0 V_0 T_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)^*$$

where P_1 represents the absolute pressure in the bomb; V_1 the volume occupied by the gas in the bomb (volume of bomb-total volume of mercury introduced); and T_1 the absolute temperature. P_0 is 14·7 p.s.i. and T_0 is 288·6° K., while V_0 is the gas volume at 60° F., (288·6° K.), and 14·7 p.s.i. Although the lowest pressure at which the container volume, V_1, is measured is generally 100 p.s.i. or higher, the deviation factor curve may be easily extrapolated to atmospheric pressure, since at this pressure the deviation factor must equal 1, by the definition of Eq. (1). Sample experimental data obtained by this procedure are plotted in Fig. 3.

The deviation factor at reservoir temperature is also determined in a similar manner.

Experiments on Separator Oil.

In order to determine the total volume of gas input by flash recombination between atmospheric and reservoir conditions, it is necessary to know the expansion factor and gas solubility for the oil, between separator pressure and atmospheric, at room temperature. These data are obtained as follows: The reservoir bomb *H* is filled with mercury, and connected to the oil sample container. A volume of mercury equal to the volume of oil sample desired is withdrawn at a very slow rate, so that the pressure in the bomb will not be appreciably below that in the sample container. The volume of mercury withdrawn, usually about 60 ml., is determined by weighing. When the bomb contains the desired volume of oil, it is disconnected from the sample container and additional mercury is withdrawn to create a free gas space in the bomb. The purpose of this is to prevent oil frothing out of the bomb when gas is bled off and the pressure drops. The top valve of the bomb is next connected, through a glass trap graduated in 0·1 ml., to a wet-test gas meter. The trap is to collect and measure any small amount of oil that, in spite of the free gas space, may be carried over with the gas while the latter is slowly bled off to atmospheric pressure. The oil and residual mercury are withdrawn through the bottom valve and their volumes determined by weighing. The gravity of the residual oil is determined. Drainage loss in the bomb must be corrected for. This correction is obtained by introducing a weighed amount of oil into the clean, dry bomb and determining the loss on draining it out.

From the volume of gas through the gas meter plus the volume of the free gas left in the bomb, corrected to standard conditions, and the initial and final volumes of oil, the gas solubility and expansion factor at separator pressure are known.

It is also of value to know the effect of temperature on the gas solubility and the volume of residual oil between separator and atmospheric pressure.

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* Knowing the analysis of the gas, and hence its average molecular weight, the absolute deviation factors could be readily calculated from the data. However, for practical purposes the definition adopted in Eq. (1) is of more immediate interest.

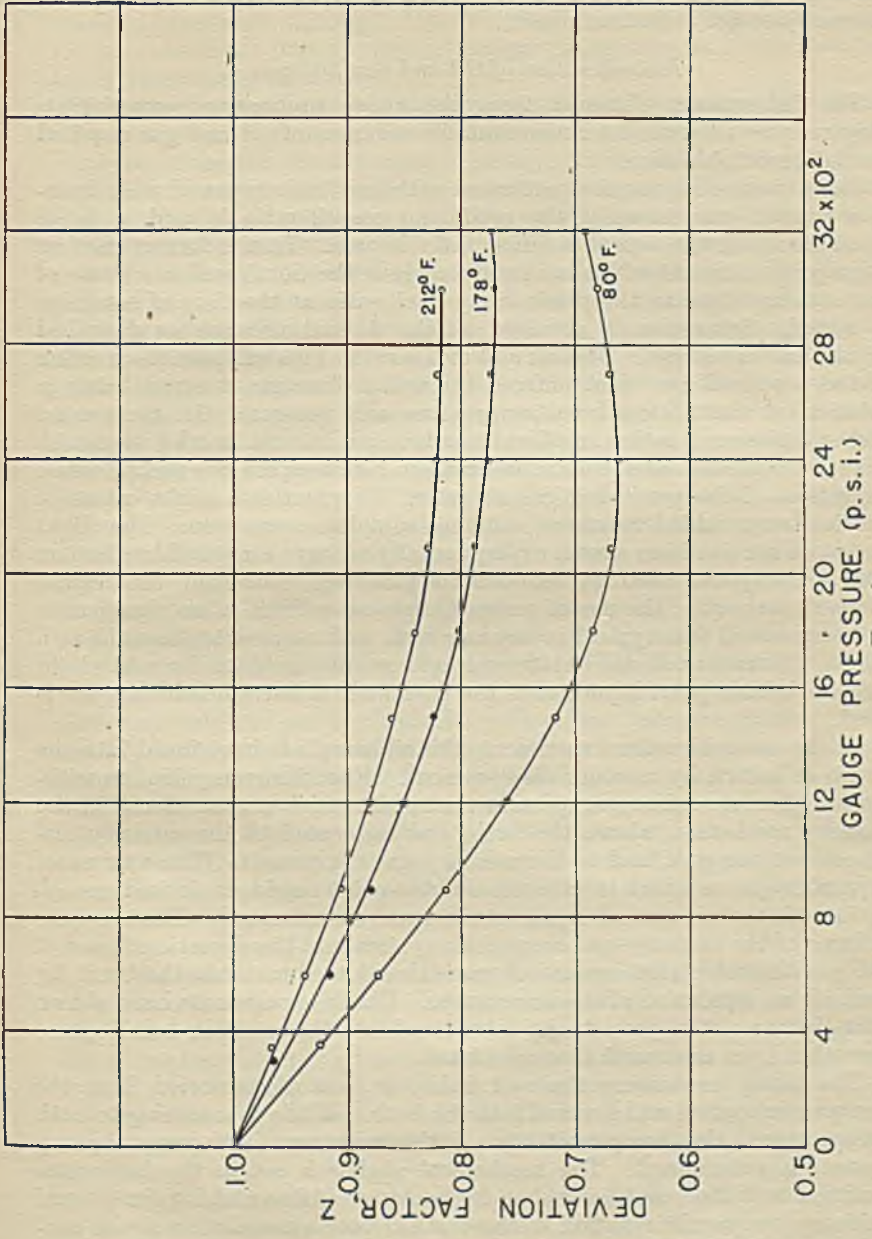

Fig. 3.

DEVIATION FACTOR FOR SEPARATOR GAS.

Hence the above experiment is repeated at reservoir temperature. All of these experiments are, of course, performed at least twice, and more if necessary to get consistent results.

Recombination of Oil and Gas Samples.

The information obtained from the above preliminary experiments may now be used to determine suitable volumes of oil and gas required for flash recombination.

The experiments may be performed with two basic types of recombination ratios: one in which the producing gas–oil ratio is used, and the other in which the actual solution ratio is used. In the former case an appropriate amount of oil is introduced into the bomb and a volume of gas corresponding to the producing gas–oil ratio at the time of sampling is added. Saturation is obtained at the desired pressure as described below, and excess gas is bled off and measured. This will give the fraction of the produced gas which entered the well as free gas, the rest being in solution at the bottom-hole temperature and pressure. In the second method of recombination an effort is made to put into the bomb just enough gas to saturate the oil at the desired bottom-hole temperature and pressure, regardless of the producing gas–oil ratio. In practice a slight excess of gas is always added to assure reaching complete saturation. The slight excess of gas has been shown experimentally to have a negligible effect on the bubble-point ratio at the desired pressure. Although the former method is simpler, the use of a specific gas–oil ratio is of no significance unless the well is a typical or average well with respect to the field as a whole. Moreover, in the latter method one obtains data for what is in effect a bubble-point liquid, as is the case when a bottom-hole sampler is used.

In the recombination experiment, the oil sample is introduced into the bomb as before, by mercury displacement. Excess mercury is then withdrawn to create a free gas space in the bomb, which is then placed in the shaking mechanism above the bath, and connected to the mercury displacement pump K, and to the mercury–gas compressor. The volume of separator gas required to give the bubble-point liquid or desired gas–oil ratio with the amount of liquid in the bomb is estimated. Knowing the volume of the mercury–gas compressor system and the deviation factor of the gas, the calculated amount of gas is then introduced into the bomb by suitable manipulation of the compressor. Check experiments have shown that the amount of gas actually introduced into the reservoir bomb agrees to within 1 per cent. with that calculated.

The bomb, containing the well fluids, is then disconnected from the compressor system and lowered into the bath. While it is coming to bath temperature, the compressibility of the mercury displacement pump system is determined. The mechanical shaker is set in the horizontal position and the bomb is shaken by rocking. After rocking for several minutes, the bomb is turned to the vertical position and the valve 4 connected to the displacement pump is opened. The pressure in the bomb is noted and mercury is pumped into the bomb until a desired higher pressure is obtained, after which valve 4 is closed, the bomb turned to the horizontal position and again shaken. This process is repeated until the desired saturation pressure is reached. At each step, of course, record is kept of the amount of mercury added to the bomb and the equilibrium pressure attained after each shaking. If at the final pressure the bomb is rocked for two 15-minute periods with no change in pressure, it is assumed that equilibrium has been attained.

The bomb is next placed in the vertical position preparatory to bleeding off excess gas at constant pressure by mercury injection.* A steel lead is attached to the top of the bomb. This lead is connected through a graduated glass separator and trap to the wet-test gas meter. After the separator is a bubble bottle, consisting of a glass delivery tube just dipping below a water surface, so that the rate of bleed-off of gas may be observed by the rate of bubbling. The bleed-off rate must be kept slow enough so that the pressure in the bomb may be maintained constant by pumping in mercury. The rate of flow of the gas through the bubble bottle must be slow enough so that individual bubbles are formed, and the end of the bleed-off is determined by the cessation of the bubbling. This has been found to be a very simple and effective way of controlling the bleeding-off process.

There is an additional check on the end point of the bleed-off (the point at which all free gas has been displaced from the bomb *H*). In the bomb *H* just below the top is fixed a very fine platinum resistance wire which is connected as one arm of a bridge circuit in which is a sensitive galvanometer. A constant current is passed through the platinum wire and the bridge is balanced. When the oil surface touches the wire, the cooling effect changes the wire's resistance and a deflection is observed on the galvanometer. This is the method used by Sage and Lacey.[6] In bomb *H* this platinum wire contact is 4·2 ml. below the valve 3. When the oil surface reaches this point, 4·2 ml. additional mercury may be pumped into the bomb before all the free gas is displaced. Thus the mercury pump counter reading and the cessation of bubbling serve as mutual checks on the complete displacement of free gas from the bomb.

When the free gas has all been displaced, the volume of oil present is obtained by subtracting the total volume of mercury from the volume of the bomb. The former is simply the sum of that initially present and that added in displacing the free gas. These volumes must, of course, always be corrected for expansion to the bath temperature, and for compressibility of the mercury pump system.

The difference between the volume of gas bled off and the total volume of gas added to the bomb *H* (including that in solution in the separator oil) is the volume which has gone into solution by flash recombination. From this the flash recombination gas–oil ratio is known.

The volume of liquid in the bomb at bath temperature divided by the volume of stock-tank liquid originally placed in the bomb (calculated to 60° F.) gives the expansion factor for the oil at the appropriate saturation pressure.

After all the free gas has been displaced from bomb *H*, the outlet valve 3 is closed and mercury withdrawn by reversing the mercury pump stroke. The pressure drops, and the bomb is shaken in the vertical position by the

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* From this point on the procedure is essentially the same as used in bottom-hole sample analysis, and is presented here for the sake of completeness.

mechanical shaker. Mercury is withdrawn during shaking until the desired pressure is obtained. When it appears that equilibrium is reached, the bomb is turned to the horizontal position and shaken for a few minutes to assure complete equilibrium. After shaking, the bomb is accurately levelled in the vertical position (to get an accurate reading on the platinum wire contact) and allowed to stand for several minutes to permit any froth formed during the gas evolution to subside. The above described procedure of gas bleed-off is repeated and a new liquid volume is measured.

The volume of mercury pumped into the bomb during a gas bleed-off at constant pressure is a measure of the volume occupied by that gas at that pressure and at bath temperature, and hence from this it is possible to calculate the deviation factor for this gas in contact with the saturated oil, at each pressure interval, using Eq. (1). This pressure reduction and bleed-off procedure is repeated at appropriate pressure intervals (usually 150–400 lb.) between the maximum saturation pressure and about 200 p.s.i. When the pressure reaches the latter value, about 10 or 20 ml. of mercury are withdrawn from bomb *H*, the valve is closed and after allowing sufficient time for any frothing in the bomb to subside, the remaining gas is slowly bled off through the gas meter until the pressure in the bomb reaches atmospheric. The bomb is then removed from the bath and cooled to room temperature. The mercury and oil remaining in the bomb are drawn off into a weighed, 100-ml. graduate. The weight of mercury and oil are obtained, and a sample of the oil taken for specific gravity determination, while the mercury is cleaned with a solvent such as carbon tetrachloride and weighed. The volume of mercury remaining in the bomb, as obtained by weight, should check the amount calculated from the mercury pump counter reading within a few hundredths of a ml. After the specific gravity of the oil has been determined, the volume is calculated from the weight. To this is added the volume, if any, in the glass trap and the drainage correction, to obtain the total residual oil. The results from a solubility experiment on the Oak Canyon fluids are given in Table II and plotted in Fig. 4.

The gas solubility at each pressure is calculated, of course, by adding all the gas which has come out of solution between that pressure and atmospheric. The total gas in solution at each pressure divided by the volume of oil (either stock tank or residual) is the gas solubility for that pressure. We have adopted the practice of expressing results in terms of stock tank oil, since that is the unit in terms of which most field data are expressed. To change the results to the basis of residual oil, it is only necessary to multiply by the ratio of the volume of stock-tank oil to the volume of residual oil.

The ideal P-V-T experiment would be designed to duplicate the pressure temperature relations of the reservoir fluids throughout their production history. This is impractical, for several reasons, the principal one being that we do not know the details of the production history of the fluids: we do not know how nearly isothermal the process is or to what extent the pressure decline-gas evolution is flash or differential. Therefore, it has been convenient to limit the experimental procedure to an isothermal process, and (particularly in the case of bottom-hole samples) results of gas solubility experiments are frequently expressed in terms of residual oil,

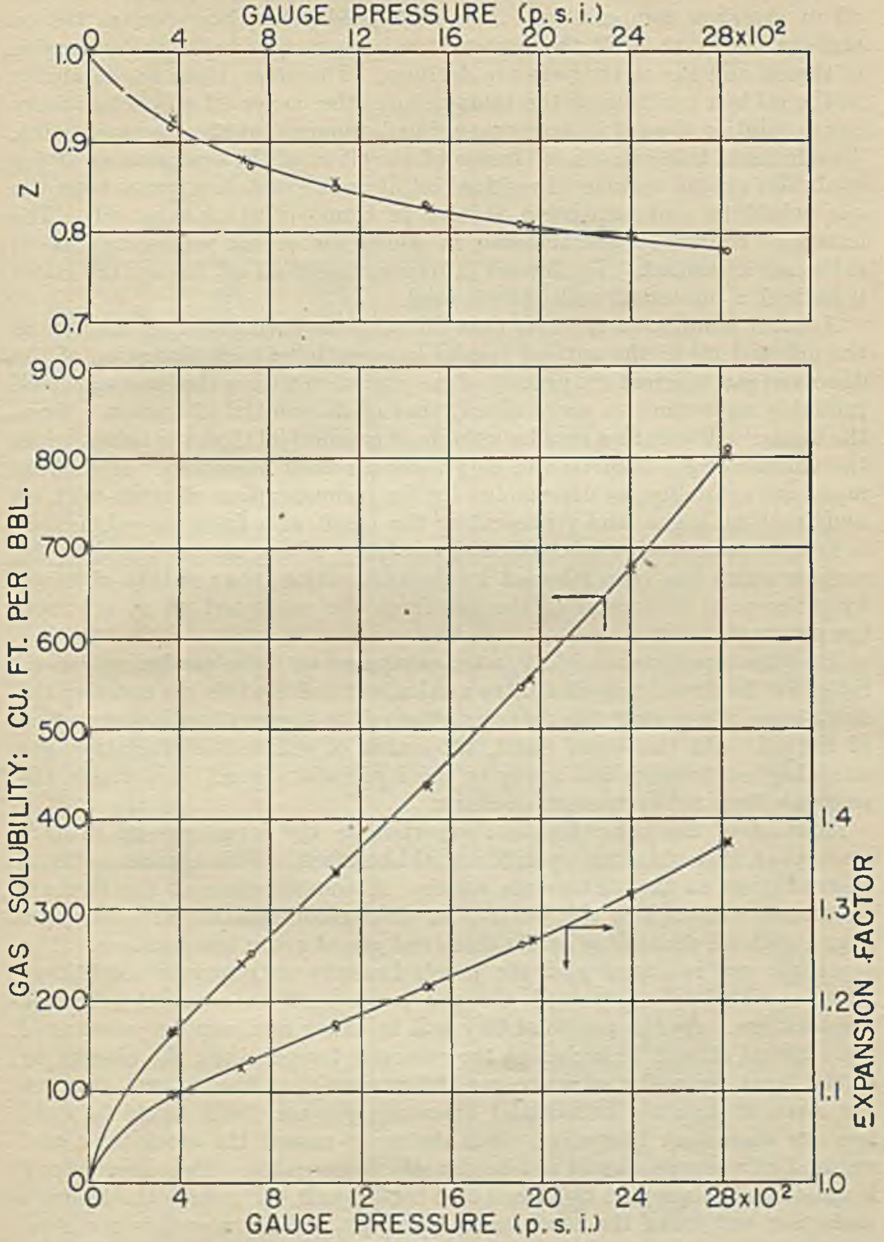

FIG. 4.

P-V-T RELATIONS FOR OAK CANYON FLUIDS.

which is the oil left in the bomb, or sampler, after all the gas has been bled off at reservoir temperature. In actual production, however, as the oil and gas flow up the well, the temperature is decreasing due to the expansion of the oil and gas as the pressure declines. Therefore, since gas solubility in the oil is a function of the temperature, the cooler oil will retain more gas in solution than if its temperature had remained at the reservoir value. To eliminate this extraneous factor of the effect of the temperature of gas evolution on the volume of residual oil, it seems best to express both the gas solubility and expansion factors in terms of stock-tank oil. The latter, of course, is also the unit in which the actual producing gas–oil ratios are measured. To convert in terms of residual oil, in case the latter is desired, a numerical multiplier is used.

Another point to be noted is that the pressure decline during the flow of the gas and oil to the surface results in essentially flash liberation of the dissolved gas, whereas the process of gas evolution within the reservoir itself probably approximates more closely that of differential liberation. Now, the former will lead to a smaller volume of residual oil than the latter, while the volume of gas evolved will be greater for flash liberation. Hence the input gas solubility, as determined by the recombination of stock-tank oil and stock-tank gas, and representing the result of a flash recombination, is more representative of the actual solubility of the gas produced at the surface which has been released by flash liberation, than is that obtained by differential liberation of the gas from the saturated oil at reservoir temperature.

Thus the input gas solubility, when compared with the producing gas–oil ratio, will be directly applicable to a calculation of the free gas entering the flow-string, if any, or to the determination of the degree of under-saturation of the oil. On the other hand, the curve of differential-liberation gas solubility *vs.* pressure will apply to the equilibrium conditions within the reservoir itself as its pressure declines.

In most of the recombination experiments the input gas–oil ratio is lower than that obtained by differential liberation. This appears to be in contradiction to the statements above. A consideration of the thermal conditions will explain this difference. The recombination experiment is begun with oil containing all its dissolved gas at room temperature. The separator gas is added and the bomb brought to reservoir conditions. After equilibrium is attained, the gas is bled off at constant reservoir temperature. As the gas solubility will be lower and vapour pressure of the residual oil will be higher at the reservoir temperature, the oil sample in the bomb may give off more gas and vapour than the volume of input gas, even though the differential liberation process itself tends to yield less gas than flash liberation. For the same reason the stock-tank and residual oil volumes should not be directly comparable. This discrepancy is mentioned in a report by Eilerts and Schellhardt,[10] in which the average molecular weight of the stock-tank liquid (C_{7+}) from a well is given as 139·9, while that of the residue from isothermal gas liberation at 228° F. is 163·7 for C_{7+}, indicating that the liquid obtained by isothermal gas liberation may be appreciably different from that obtained by the well-production process. It is clear that the closer the reservoir temperature is to room temperature, the more closely the relative volumes as obtained

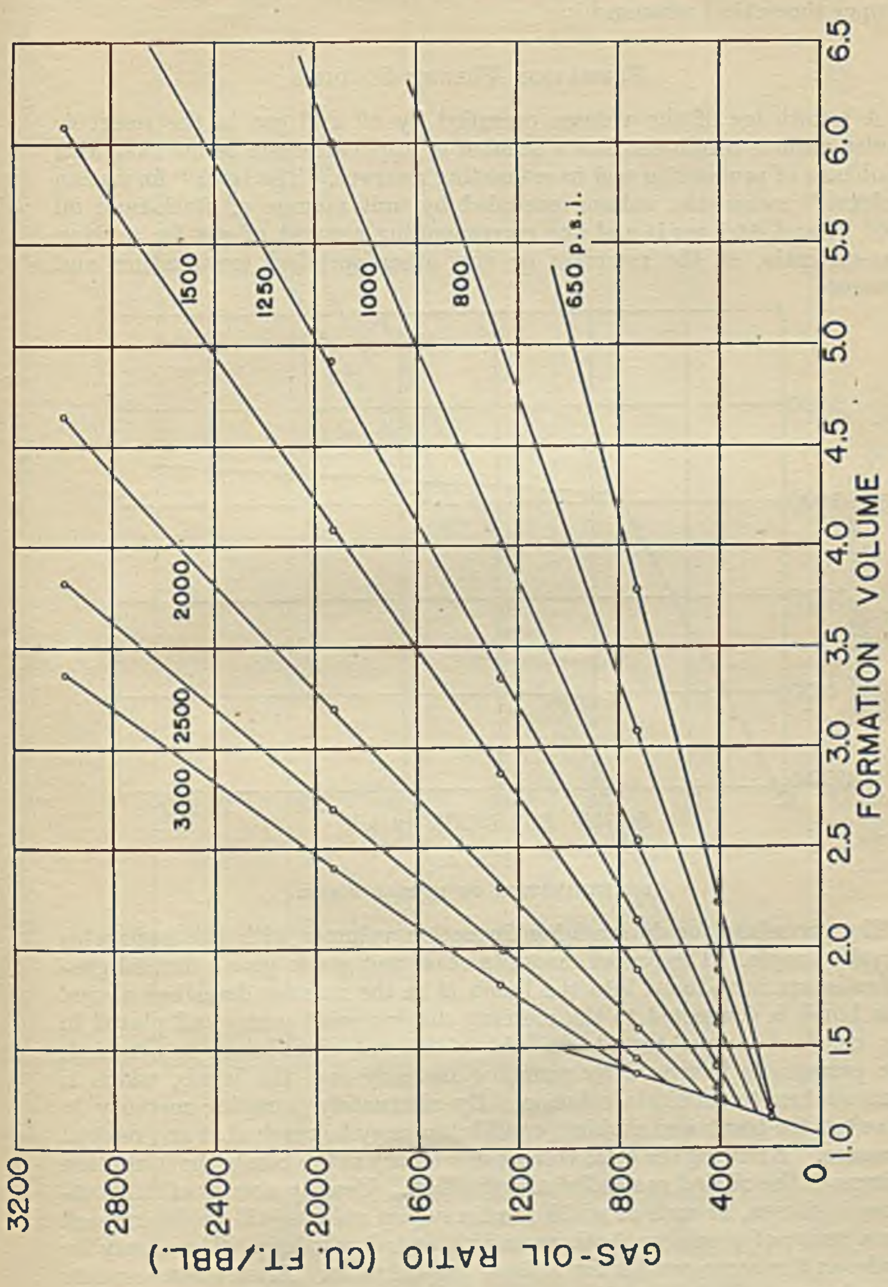

FIG. 5.

FORMATION VOLUMES AT 178° F.

by flash recombination and differential liberation will approach their proper theoretical relationships.

Formation Volume Studies.

A knowledge of the volume occupied by oil and gas in the reservoir under various conditions has a number of applications in connection with problems of production and in estimating reserves. The term " formation volume " means the volume occupied by unit volume of stock-tank oil (60° F. and 14·7 p.s.i) and the corresponding amount of gas for a given gas–oil ratio, at the reservoir or any other specified temperature and pressure.

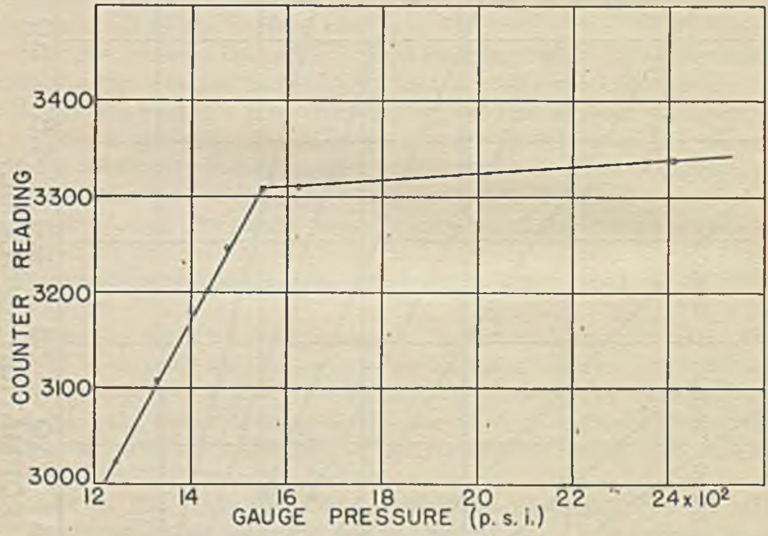

Fig. 6.

DETERMINATION OF BUBBLE POINT.

The procedure for determining formation volumes with this apparatus is quite simple. The proper amounts of oil and gas to give a desired gas–oil ratio are introduced into the bomb *H* in the manner described above. The bomb is connected to the mercury displacement pump and placed in the constant-temperature bath. After thermal equilibrium is attained, the pressure is increased by pumping mercury into the bomb, which is then shaken to facilitate solution. By alternately pumping mercury in or out of the bomb and shaking, equilibrium may be reached at any desired pressure. Knowing the total volume of mercury in the bomb, the formation volume of the oil and gas is directly obtained. Usually a series of temperatures is chosen, at each of which the formation volume will be determined for a series of pressures, both ascending and descending. These may be made on the same sample for a fixed gas–oil ratio. After measurements have been completed at the appropriate number of temperatures, a new sample with a different gas–oil ratio is taken, and the measurements are repeated. The data thus obtained are tabulated as shown in Table III.

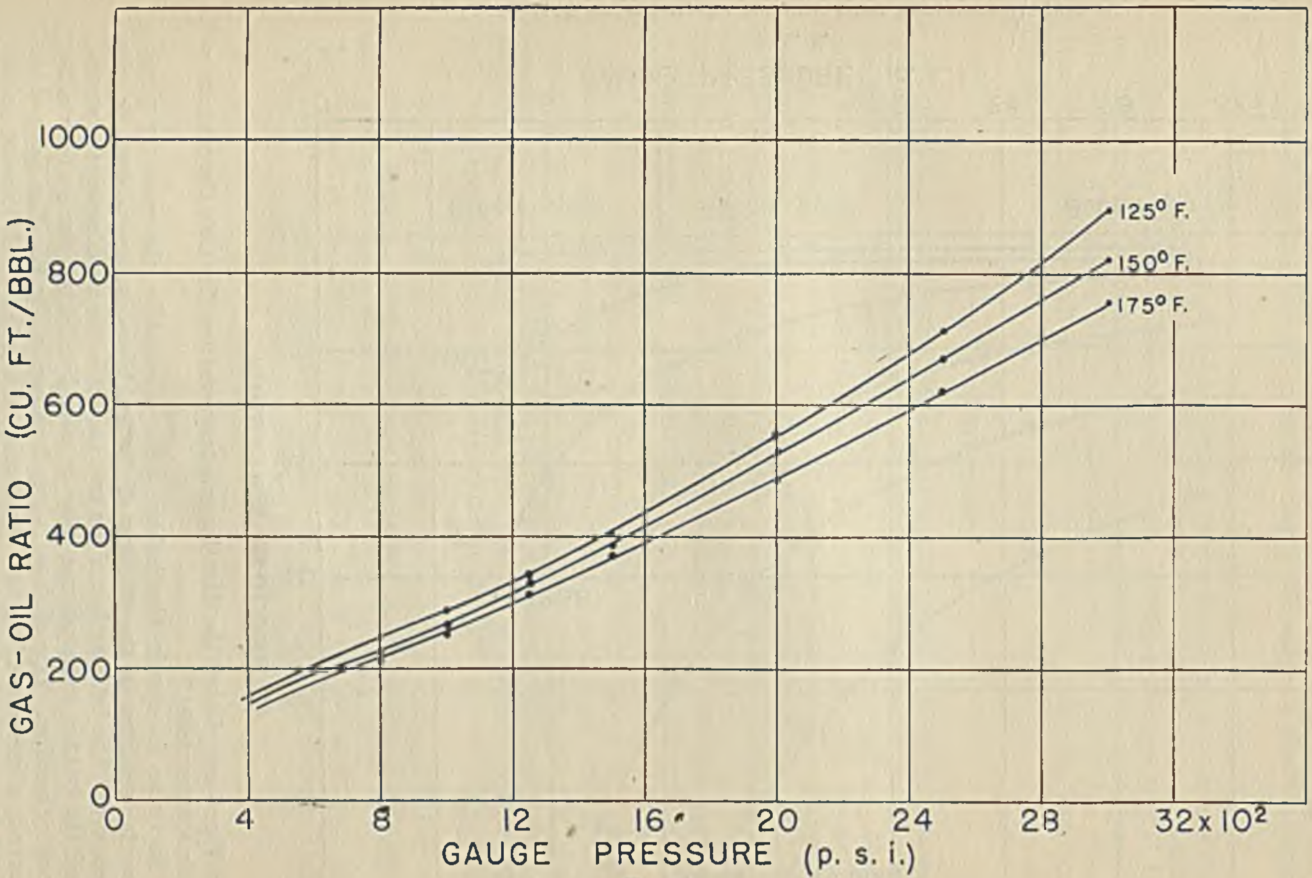

Fig. 7.

VARIATION OF BUBBLE POINT WITH GAS-OIL RATIO.

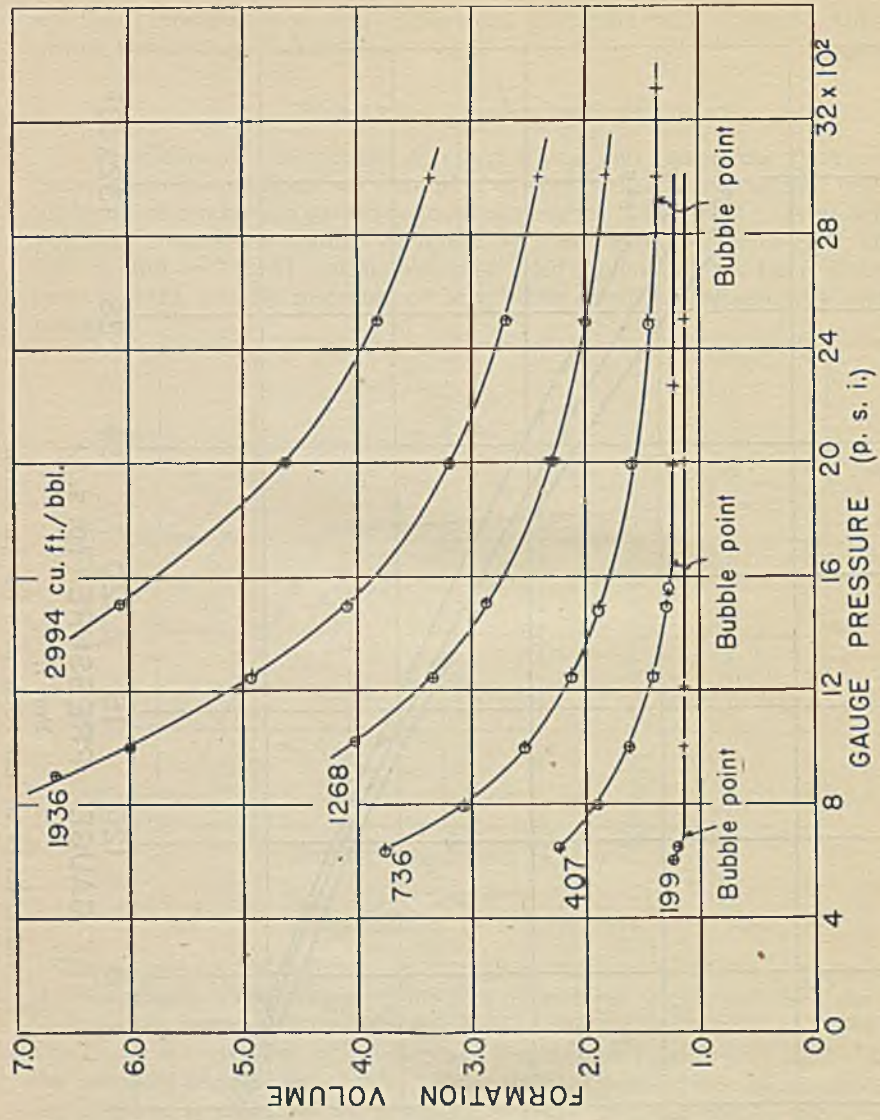

Fig. 8.

VARIATION OF FORMATION VOLUME WITH PRESSURE AT 178° F.

In Fig. 5 are plotted the data for one temperature (the Oak Canyon reservoir temperature).

In order to obtain the bubble point accurately, the mercury pump counter readings in the vicinity of the bubble point are plotted *vs.* the pressure. The intersection of the two curves is the bubble-point pressure, and the bubble-point volume may be calculated from the corresponding counter reading. One of these curves is shown in Fig. 6. The slope of the curve is a measure of the compressibility of the fluid. Below the bubble point a comparatively high compressibility is indicated by the steep slope, while above the bubble point the relative incompressibility of the liquid is shown by the very slight slope of the straight line. The slope of the two-phase portion of the curve will vary appreciably, depending on the gas–oil ratio, the higher the gas–oil ratio, the flatter the slope of the two-phase portion.

From the intercepts of the bubble point and the two-phase curves of Fig. 5, the curve relating bubble-point pressure to gas–oil ratio at a given temperature may be obtained. To do this accurately, the data of Table III should be plotted on an expanded scale and the intercepts should be read as carefully as possible. The curve so obtained from an expanded plot of Fig. 5 is shown in Fig. 7, which also includes curves for the other two experimental temperatures. Another method of presenting the data of Fig. 5 is shown in Fig. 8.

CONCLUSIONS.

In order to use successfully the apparatus and method described above, considerable care is required in all the volumetric measurements and manipulations. The volumes involved are comparatively small, and hence must be measured precisely to avoid errors exceeding 1 per cent. especially in the results on gas-deviation and oil-expansion factors. The method is relatively laborious, in that several preliminary experiments on the dry gas and separator oil are necessary before proceeding with the final recombination procedure. An important advantage of the method is that samples may be taken at the well with a minimum of interference with regular production, and at comparatively low cost. Furthermore, one set of samples is adequate for a number of duplicate experiments, so that any sporadic and possibly undetected errors which might occur in a single experiment are eliminated by this procedure. Additional information regarding the deviation factor for saturated gas in contact with the oil is also available by this method, and all results are directly obtained in terms of both residual oil and stock-tank oil. One set of samples suffices not only for expansion factor-solubility experiments, but also for formation volume studies if these are desired.

The authors wish to acknowledge the co-operation and assistance of Dr. W. N. Arnquist, formerly of this laboratory, in the design of the apparatus and in the preliminary experimental work; to thank Dr. P. D. Foote, Executive Vice-President of the Gulf Research & Development Co., for permission to publish this paper, and Mr. R. P. Huggins, of Western Gulf Oil Co., for releasing the data on the Oak Canyon Field.

TABLE I.

Field Data.

Oak Canyon Field, California.

Separator pressure	470 p.s.i.
Gravity	33·5° A.P.I.
Original reservoir pressure	2820 p.s.i. at 7331 ft.
Pressure on oil sample container	470 p.s.i. at 98° F.
Pressure on gas sample container	470 p.s.i. at 98° F.
Producing gas–oil ratio	700 cu. ft./bbl.
Reservoir temperature	178° F.

Table II.

Data Obtained in Expansion Factor and Solubility Determination.

Oak Canyon Field, California.

Pressure Gauge.	Gas from Bomb at Std. Cond. (ml.).	Cumulative Gas in Solution (ml.).	Stock-Tank Oil, ml./ml.	Stock-Tank Oil, cu. ft./bbl.	Gas Space in Bomb (ml.).	Oil Shrinkage (ml.).	*Z.*	Volume Oil in Bomb at 178° F.	Expansion Factor (Stock-Tank Oil).
2825	491	9081	144·2	809	2·43	—	0·779	95·20	1·375
2390	1585	8396	121·2	679	9·49	3·93	0·798	91·27	1·318
1910	1641	6755	97·5	547	12·32	3·93	0·808	87·34	1·261
1485	1342	5413	78·1	438	13·44	3·22	0·832	84·12	1·215
1090	1162	4251	61·4	344	16·11	2·75	0·849	81·37	1·175
715	1153	3098	44·7	251	24·83	2·73	0·872	78·64	1·136
360	1059	2039	29·4	165	47·71	2·77	0·915	75·87	1·096
0	2030	0	0	0	—	8·37	—	67·50	—

Initial oil volume at 60° F. = 69·25 ml., A.P.I. gravity = 34·6°.
Residual oil volume at 60° F. = 64·4 ml., A.P.I. gravity = 31·7°.

Table III.

Formation Volumes for 125° F.

Gas–oil ratio	199	407	736	1268	1936	2994
Bubble-point pressure	583	1468	2560	—	—	—
Bubble-point volume	1·119	1·206	1·336	—	—	—
Pressure.						
650	1·118	1·943	3·235	5·500	—	—
800	1·117	1·663	2·724	4·460	6·515	—
1000	1·115	1·444	2·224	3·566	5·240	—
1250	1·113	1·282	1·897	2·930	4·200	6·310
1500	1·111	1·207	1·700	2·530	3·558	5·290
2000	1·106	1·198	1·466	2·060	2·806	4·052
2500	1·103	1·188	1·350	1·811	2·407	3·378
3000	1·098	1·180	1·326	1·683	2·181	2·984

Formation Volumes for 150° F.

Gas–oil ratio	199	407	736	1268	1936	2994
Bubble-point pressure	635	1550	2795	—	—	—
Bubble-point volume	1·133	1·221	1·352	—	—	—
Pressure.						
650	1·144	2·068	3·450	—	—	—
800	1·132	1·768	2·875	4·850	—	—
1000	1·130	1·530	2·400	3·790	5·614	—
1250	1·127	1·343	2·004	3·106	4·510	6·690
1500	1·125	1·246	1·783	2·688	3·830	5·660
2000	1·122	1·215	1·522	2·172	3·004	4·330
2500	1·117	1·207	1·393	1·900	2·556	3·590
3000	1·113	1·202	1·349	1·745	2·296	3·164

Formation Volumes for 178° F.

Gas–oil ratio	199	407	736	1268	1936	2994
Bubble-point pressure	685	1640	2915	—	—	—
Bubble-point volume	1·153	1·241	1·370	—	—	—
Pressure.						
650	1·196	2·225	3·780	—	—	—
800	1·151	1·884	3·080	—	—	—
1000	1·147	1·614	2·534	4·010	5·995	—
1250	1·145	1·410	2·128	3·344	4·922	7·230
1500	1·142	1·297	1·884	2·863	4·080	6·080
2000	1·137	1·233	1·592	2·290	3·188	4·630
2500	1·133	1·224	1·442	1·996	2·688	3·812
3000	1·129	1·218	1·369	1·815	2·400	3·350

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OIL PROSPECTS IN PORTUGAL.

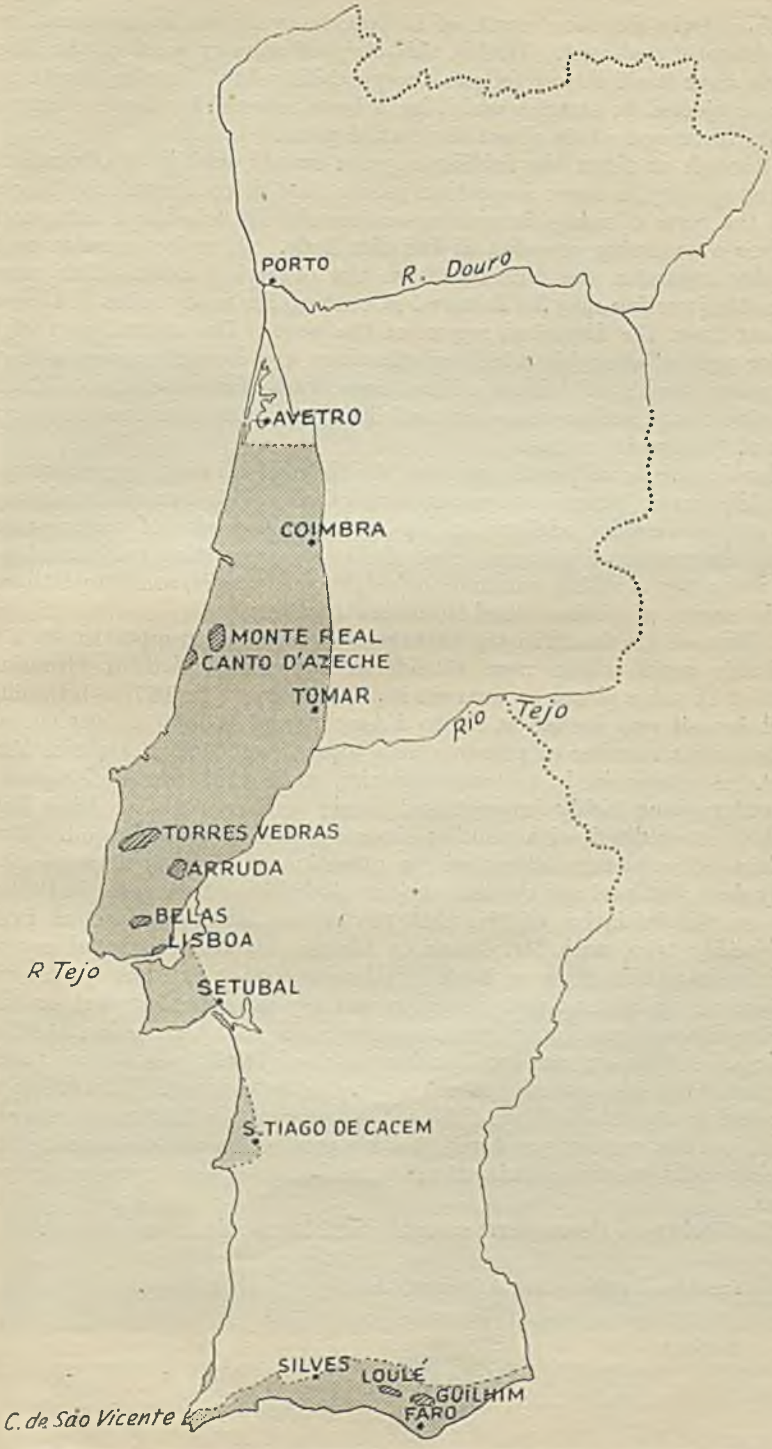
By A. Beeby Thompson (Fellow).

It is not without a certain amount of diffidence that I present this paper on the oil prospects of Portugal, as I feel that there are others better qualified to perform the task. The field work upon which the attached material is based was mainly conducted by Mr. Clive Mendelsohn, under the supervisory direction of the late Mr. James Romanes, and my personal participation was more particularly restricted to guiding the course of the operations and discussing with my colleagues on the ground the best course of action at various stages in the investigation after marshalling all collected data. Certain submissions made in the paper may be regarded by some as somewhat unorthodox, and perhaps unwarranted, but they represent qualified or tentative conclusions reached after repeated visits by all parties to the areas described, and interchange of views on the dynamics of folding, source of oil, and allied subjects. They are, however, stated with an open mind, in the hope that other, and perhaps more rational explanations may be suggested for such curious structures designated as "tiphonic" by Paul Choffat.

It would be ungracious to refrain from mentioning the very generous assistance given by Mr. Saldanha, a talented Portuguese mining engineer working at the Lisbon University. His profound knowledge of local geology proved extremely helpful, and he not only gave us the benefit of his experience, but he also proved a delightful field companion and a cheerful worker. To Mr. Saldanha must be accorded the credit for the laboratory examinations and determination of cuttings from the borehole at Torres Vedras, thereby facilitating the preparation of a very comprehensive log.

Thanks are due to the Anglo-Portuguese Oil Co. for permitting the publication of this paper.

For our knowledge of Portuguese geology we are largely indebted to Paul Choffat, who, with J. F. N. Delgado, prepared and published maps and data which have furnished the basis of all subsequent geological studies. So thorough and trustworthy was this early work that no later acquired data have seriously modified the general conclusions then reached concerning the main structure of the country and the age of the rocks exposed. Although sedimentary rocks varying in age from Palæozoic to Recent are represented in Portugal, it is strata of Mesozoic age that chiefly concern those interested in petroleum prospects, as no manifestations of its presence have been found in rocks older than Triassic. Igneous and Palæozoic rocks cover more than half the country, with or without a veneer of Tertiary or Quaternary deposits; and it is only in the western central part of Portugal and a strip along the southern coast that a well-represented succession of Mesozoic strata are found. Chief interest to an oil geologist lies in the belt of Mesozoic formations that extends in a



PORTUGAL: SHOWING APPROXIMATE MESOZOIC-PALÆOZOIC CONTACT AND SITUATION OF SURVEYED OIL STRUCTURES.

north-easterly direction north of Lisbon, more or less in alignment with the Atlantic seaboard. Within this strip of country west of the Tagus, which river itself closely follows the prevailing line of strike, strata have been subjected to stresses which have been relieved by flexures exposing highly disturbed strata about their axial parts.

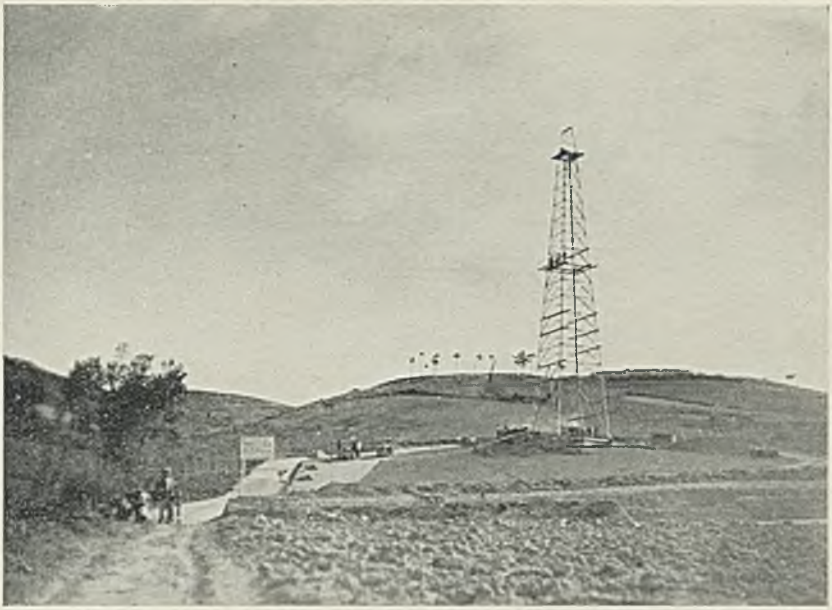
Although at times the folding appears simple, and is clearly reflected by topography, a closer inspection proves that there is much faulting and that the cores of many flexures are extremely disturbed and bring to the surface a confusing complex of Infralias beds. A major, angular unconformity separates the Infralias from the overlying rocks. This unconformable junction may be followed in outcrop for many miles in the east, distant from the disturbed region of the west. The central part of the major uplifts alongside which oil-showings are found, exposes a highly disturbed jumble of dolomitic limestones, vari-coloured shales, and often eruptive rocks, and to these zones of disturbance Choffat gave the designation of "tiphonic" areas.

Manifestations of petroleum take the form of oil seepages, outcrops of petroliferous or bituminous sands, films of oil or dried or viscous bitumen in limestone cracks, or liquid oil in calcite-lined geodes of vesicular limestone, fragments of bitumen, etc. Indirect, supporting evidence lies in the frequency of saline, sulphate, or sulphurous waters, sometimes thermal in the region of oil-shows and tiphonic structures.

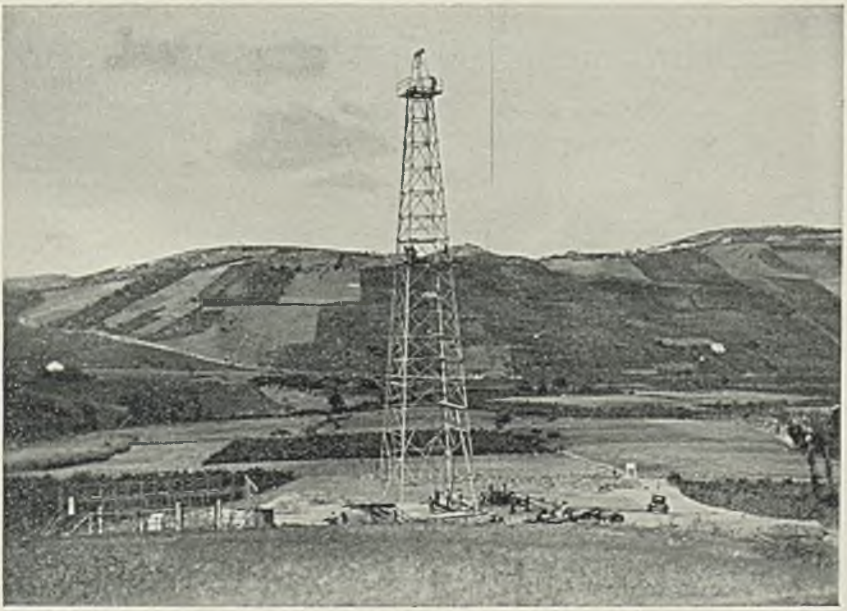
References are found in the literature to various attempts to work the asphaltic rocks which were considered sufficiently rich in bituminous content at some places to warrant its abstraction. In 1857 a bituminous sand deposit was worked at Canto d'Azeche, and in 1865 an English company sank a number of pits in a rich bituminous sand at Granja, Monte Real. At Sismaria, in the same district, some work was undertaken on an outcropping richly impregnated sand; and as early as 1850 Carlos Ribeiro is credited with sinking several abortive wells for oil. Torres Vedras seems to have attracted the attention of oil-minded people at an early date, but perhaps the first serious oil-drilling effort made in Portugal was on the initiative of Mr. Coll Taylor, a Lisbon resident of British nationality who, with Mr. Bravo, a Lisbon merchant, induced my firm to inspect certain areas in 1905. Following a visit of some weeks, when the only form of transport available was the slow country cart or horse, an English company was constituted to drill on a concession at Torres Vedras. A Star rig was used, and a depth of 740 ft. was attained before the loss of a bit caused the suspension of operations. This work was directed by the late William Calder, a member of the Institute. Showings of oil and gas were encountered, but no production was obtained. Other shallow wells proved likewise abortive, although signs of oil were frequent in all.

The Geological Formations recognized in Portugal are as follows:—

Recent and Pleistocene	Alluvium, Dunes
Tertiary	Pliocene Miocene Oligocene Basaltic



WELL 1. TORRES VEDRAS. VIEW LOOKING EAST ALONG CREST OF ANTICLINE. SANDY-SHALE SERIES OUTCROP IN FOREGROUND, LIGHT GREY LIMESTONES OUTCROP ON HILLS IN BACKGROUND.



WELL 1. TORRES VEDRAS. VIEW LOOKING WEST ALONG CREST OF ANTICLINE WITH VILLAGE OF VARATOJO ON HILLS IN DISTANCE. OUTCROPS OF OIL SANDS OCCUR ON HILL BEHIND THE DERRICK.

[*To face p.* 372.

ORRES VEDRAS. VIEW OF TOWN FROM ONE OF THE OUTCROPPING (ABADIA) BITUMINOUS LIMESTONES NEAR VARATOJO.

PICAL SCENERY IN THE MONTE REAL AND CANTO D'AZECHE COASTAL BELT WHERE PINE-CLA ALLUVIAL DEPOSITS AND DUNES CONCEAL EVIDENCE OF STRUCTURE.

Mesozoic	Cretaceous	Upper	Senonian
		Middle	Turonian Cenomanian Albian
		Lower	Aptian Urgonian Hauterivian Valanginian
	Jurassic	Malm	Portlandian Kimmeridgian Lusitanian Oxfordian
		Dogger	Callovian Bathonian Bajocian
		Lias	Toarcian Charmouthian Sinemurian
		Infralias	Lower Sinemurian Hettangian
	Triassic		
Palæozoic	Permian		
	Carboniferous	Upper Lower	
	Devonian		
	Silurian	Upper Lower	
	Cambrian		
Pre-Cambrian	Schists		

TORRES VEDRAS.

The Torres Vedras structure, which is roughly expressed topographically. has a length of 12½ km. and an average width of about 4½ km., and comprises the two domal areas of Varatojo and Abadia, separated by a central complex of rocks older than those on the flanks. Both at Varatojo and Abadia valleys have been deeply eroded in the relatively softer Upper Jurassic (Abadia) beds, leaving flanking scarps of outwardly dipping younger formations which form crescent-shaped edges to the softer Abadia group. The fold is, in reality, part of a much longer line of uplift which continues westwards to the ocean and northwards to Monte Junto, where the land surface rises to 660 m. The centre of the Torres Vedras structure is broken by a core of highly distorted and steeply dipping red sandstones, shales, and dolomitic limestones of Infralias age, against which unconformably rest less-inclined crystalline limestones of Lower Jurassic age. The structure takes the form of two structural noses plunging in opposite directions from the central complex. The regional stratigraphical succession as identified by Choffat, Saldanha, and Mendelsohn is given at top of p. 374, the total thickness of sedimentaries below the Corallian to Lower Lias aggregating 2600 m.

On the Varatojo (Torres Vedras) nose, where indications of oil are more pronounced than on the Abadia sector, the strata dip at angles fluctuating between 15° and 40°, the anticline being slightly asymmetric in form, with steeper dips on the southern limb than the northern. The Abadia beds that form the valley floor and sides of the structure consist of about 800 metres of greyish shales with ochreous concretionary nodules of limonite and fine-grained soft and grey calcareous sandstones, which latter, due to weathering of the intervening shales, often stand out boldly

JURASSIC	Upper (Malm)	*Abadia beds*	Grey shales with concretionary limonite nodules, fine-grained micaceous and calcareous sandstones	say 800 m.
		Compact Limestones	Heavily jointed and fissured light grey limestones	500 m.
		Oxford Shales	Laminated argillaceous limestones	200 m.
	Middle (Dogger)	*Callovian*	Grey argillaceous limestone	say 500 m.
		Bajocian and Bathonian	Grey compact limestones	say 400 m.
	Lower (Lias)	*Upper and Middle*	Marls and Marly limestones	about 400 m.
		Lower	Dolomitic limestones	
		Infralias	(Lower Sinemurian) Dolomitic limestones Friable Red and Green Marls with gypsum	

as scarps in the vineyards that cover the district. The normal succession is broken by occasional strike and oblique faults, and by a few intrusions of eruptive rocks, which latter have doubtless risen along planes of rupture. As the central complex of Infralias is approached, dips steepen and discordances are more prevalent, as might be expected nearer the centre of main disturbance.

The River Sizandro tends to follow a line of faulting, and springs of mineralized water at Cucos likewise indicate the existence of faults. In sections showing such little dissimilarity in the character of the beds, the location of faults is not an easy matter, especially as a thick soil covers much of the ground.

On the high ground near the village of Varatojo, not far from the Corallian junction, are found some quite imposing outcrops of oil-impregnated sands, and on the sloping ground to the valley floor there are other exposures of bituminous sandstones, all in the Abadia beds. Some of the outcropping sands are darkly stained, and most exhibit all the characteristics of a true oil-sand as found in oil measures. When freshly broken they emit a strong and not unpleasant odour of petroleum, and on the face of some scarps semi-liquid oil may be observed in joint cracks or as trickles of solidified oil which has defaced the surface. It is particularly noticeable that where the sandstones are hard and calcareous, oil occurs only in the softer uncemented parts and along cracks or joint planes. Another noteworthy feature observed is a definite relationship between oil-showings and faulting, for distant from faults little or no evidences of oil are to be found.

The limestones underlying the Abadia series in the Varatojo sector give widespread proof of their petroliferous character. Near the Cabrito railway tunnel, which pierces the limestones just east of Torres Vedras, bituminous matter is seen filling the innumerable joint cracks and calcite-lined veinlets which permeate the mass, and semi-solid lumps of asphalt have formed at some points where oil has exuded and congealed.

Much the same geological conditions pertain in the Abadia section of the structure. Here also a considerable expanse of Abadia beds is exposed, dipping at angles of between 10° and 25° until near abutment with the Infralias, when they rise to 55° or more. Scarps of Corallian limestone almost encircle the picturesque valley, and on the slopes to its floor good outcrops of the formations are found. Oil-sands are less numerous than in Varatojo, but nevertheless several heavily impregnated oil-sands are seen in the immediate vicinity of faults. A few developments of igneous rocks show, as in Varatojo, that lava forced a passage into the beds along avenues of weakness. Numerous strike and cross faults break the continuity of the beds and bring rocks of different age in contact.

Monte Real District.

The oil occurrences at Monte Real, 12½ km. north-west of Leiria, are found on the western edge of a "tiphonic" area, in which are exposed severely contorted and intricately faulted, steeply dipping Infralias rocks, invaded at places by igneous dykes or bosses. The axis of this belt of disturbance runs nearly north and south for a distance of 11 km., following the direction of the Liz until that river turns abruptly westwards to the ocean. Beyond the river the zone of disruption can be traced as far north as Monte Redondo by a line of ophite domes. Near Monte Real the affected region widens and an east–west group of eruptive bosses denotes a transverse line of rupture.

Where exposed, the Infralias is composed of yellow dolomitic limestones and hard dark grey limestones over red and green gypseous marls, and the very typical thin bands of glistening platey limestones.

Important deposits of gypsum are also found in the district and quarried in open cast workings.

A major part of the territory in this region consists of plateau covered by Pliocene and Recent deposits thickly overgrown with forest, but the River Liz has carved out a passage in these superficial beds exposing sections of the lower strata. To the east of Monte Real, Middle Cretaceous sandstones make a faulted contact with the Infralias for several kilometres. On the western limb of the structure Cretaceous strata are also found in juxtaposition to the Infralias both north and south of the River Liz at Granja and Sismaria respectively.

At Granja, 2 km. west of Monte Real, an oil-impregnated sandstone of Middle Cretaceous age is exposed for some distance on the surface before passing beneath the alluvium of the River Liz. At one time attempts were made to exploit this deposit commercially for asphalt production. Here the oil-saturated sandstone rests unconformably upon steeply dipping Infralias limestones which in places have reversed dips. It was thought that this sandstone might be in part of Upper Jurassic age. As elsewhere, the degree of impregnation bore a relationship to the extent of induration by calcareous cementation. In the harder sandstones, oily matter occurs only in joint cracks, slip planes, and the like.

At one point in the Granja outcrop metamorphosed Infralias limestones are seen in contact with igneous rocks, but nearer the river-bed red and green marls, platey limestones and gypsum denote the position of the Infralias.

Along the direct line of strike north of the River Liz at Sismaria oil-impregnated Cretaceous sandstones are found resting unconformably upon steeply-dipping Infralias limestones. Nearer the river, oil-saturated

Pliocene sands immediately overlie the same limestones, which themselves showed oil in fissures and cracks.

In addition to these positive and direct manifestations of oil in the Monte Real district, there are indirect evidences of hydrocarbon influences in the presence of springs of saline, sulphate, and sulphurous waters that issue at various spots in the tiphonic belt. Monte Real owes its fame and popularity to the alleged benefits patients derive from bathing in the mineralized waters, in addition to the pleasing surroundings for holiday-making.

Prior to the cessation of operations due to war conditions, a site had been provisionally selected for drilling west of the oil shows at Granja, where it was expected to strike more gently dipping and less disturbed beds some distance from the crumpled Infralias.

CANTO D'AZECHE.

Distant about 24 km. south-west of Monte Real, on the Atlantic seaboard, an outcrop of upturned Infralias strata marks the existence of another tiphonic area, and associated with it are found showings of oil. Much of the surroundings of Canto d'Azeche are covered with pine-clad Pliocene beds and Recent Aeolian sands which conceal the Mesozoic rocks known to underlie these deposits. Such observations as could be made pointed to the axis of the disturbed belt taking a north-east direction after curving westwards near Canto d'Azeche. In one locality where the cliffs on the shore-line are deeply eroded, there is an exposure of gypseous marls and upturned dolomitic limestone of the Infralias, against which coarse Cretaceous sandstones make unconformable contact on the south-east side and soft micaceous Pliocene sands on the north. Both these sandy bodies are highly bituminous where they come in contact with the Infralias; and the Infralias limestones likewise show oil in joint cracks and fissures. At one time these rocks were worked for asphalt production.

A single exposure of Infralias at Paredes about 1 km. distant to the north-east from Canto d'Azeche also showed oil in the limestones.

Proceeding northwards along the coast from Canto d'Azeche, western-dipping Middle Liassic limestones can be traced on the cliffs for a distance of 6 km., representing the west era flank of the anticline.

To the east of San Pedro de Muel a group of eruptive igneous bosses have been located beneath the Pliocene and Recent alluvials that cover much of the terrain, and these are in some cases flanked by Infralias limestones. At Pedras Negras there is a coastal outcrop of the typical Infralias beds.

ARRUDA DOME.

Some 3 km. north-east of Arruda there is to be seen a beautifully symmetrical dome on which low-dipping Upper Jurassic beds are exposed in the central part. Due to the relatively soft nature of the Abadia beds forming its axis, a pronounced depression has been formed by erosional influences, leaving a bold surrounding scarp of the more resistant Corallian limestone which clearly outlines the structure. This encirclement of limestones is broken only where surface drainage has carved out a gap.

Faults cross the structure, but only one seems to have any considerable throw. Several ridges and bosses of basalt form prominent landmarks in the topographic basin, and the bordering fault-breccias make it clear that the lava has risen through fault planes or fissures. Dips in the Abadia beds are fairly consistent at about 4–5°.

Although diligent search was made, no signs of oil were found during the survey, even in the vicinity of faults, but the proximity of this dome to a tiphonic area showing evidences of oil gives it very definite interest. In the absence of any other reasonable explanation, the formation of such a symmetric structure was attributed to upheaval by some deep-seated central body, the nature of which is discussed elsewhere in the paper. Failure to find showings of oil could not in itself be regarded as proof of its non-existence at depth where a considerable thickness of competent strata might be expected, closure ensuring prevention of leakage of oil or gas.

BELAS DOME.

This very striking domal structure derives unusual interest, as it lies 15 km. north-west of Lisbon and 3½ km. north of the town of Belas. Its shape takes the form of an elongated dome with its longest dimension in an east–west direction, and the Upper Jurassic limestones forming its centre are exposed over an area of about 4 sq. km. The centrally outcropping limestones dip at low angles, and are surrounded by gently dipping Lower and Middle Cretaceous strata clearly defined by pine trees which thrive on the sandy soils covering the sandstone formations of that age. Part of the dome has been deeply eroded by water action, leaving clearly developed scarps where observations can be made.

Several igneous intrusions on the south-east side of the dome take the form of long dykes in general alignment with the strike of the beds, and are clearly associated with faulting or fissuring. The limestones in contact with these dykes show signs of heat metamorphism. No showings of oil were discovered during the survey of this area, but it was generally agreed that such a regular structure warranted test drilling. This structure, it was realized, is not far from a region of great volcanic activity of post-Cretaceous age centred round Cintra, but the low dips of around 10° and the presumed presence of a considerable thickness of little disturbed Jurassic rocks were considered to outweigh other objections. The only outcrop of deeper Jurassic beds in the district does not exhibit a facies of the Torres Vedras (Abadia) type, and it may be that the lithological character of the underlying beds differs from that farther north.

Very naturally the mode of formation of such a domal structure was critically debated, and it was generally agreed that it was due to uplift by some deep-seated mass such as a laccolith. If due to a volcanic intrusion into the sedimentaries, the extent of its interference could only be ascertained by drilling, and the presence of gas was regarded as a possibility. The development of a gas-field so near Lisbon would be a very valuable asset.

ALGARVE.

The occurrence of a belt of Mesozoic rocks in the Province of Algarve, along the southern coastline of Portugal, was the sole cause for extending geological investigations to that quarter. No showings of petroleum had been reported from the district, and a geological survey led to no encouraging conclusions being reached. Two anticlinal structures were mapped where Jurassic rocks are exposed in the neighbourhood of Loulé and Guilhim, north of Faro. The Guilhim dome exposes about its axis oolitic limestones, and on the flanks grey marls and marly limestones, both of Middle Jurassic age. The anticline is asymmetric in form, with dips around 50° on the south and 28° on the northern limb, but the strata are disturbed and faulted, with much consequent discordance of dip and strike. There is little or no flattening of dips about the axis, which is delineated solely by a reversal of dips. The position of faults is marked by steeply dipping or even vertically disposed beds. Some of the hard limestones break with a conchoidal fracture, and, when struck, those of a somewhat darker colour emit that distinctive odour that gives to limestone the common appellation of stinkstone. A strong spring of sweet water rises at one spot and flows down a gulley in which many wells are sunk for local domestic water requirements.

The Loulé dome is somewhat larger, and on its axial part marls and marly limestones of Middle Jurassic (Callorian) age outcrop, followed on its limbs by hard compact limestones of Upper Jurassic age. Here likewise the axis is marked only by a reversal of dips, with no arching or noticeable diminution in the angles of dip, which average about 20°. The beds are much cracked and faulted.

The only springs seen in this district yielded fresh potable water, neither saline nor sulphurous, thereby discouraging the views favouring an upheaval due to Infralias influences.

No other regions that were visited seemed to merit geological mapping or more than casual attention for procuring consequential information.

ORIGIN OF STRUCTURES.

From the descriptions given of districts showing indications of petroleum, it will be self-evident that all manifestations of its presence are found near so-called tiphonic areas, where the central core of folds is a highly disturbed complex of Infralias beds. Although many of the most striking exposures of oil-impregnated strata appear on the flanks of such disturbed areas, the connection is none the less convincing. The Infralias complex and the condition of the neighbouring strata exhibit so many of the features that one has come to associate with salt domes that one's imagination is almost instinctively inclined to this mode of formation for the tiphonic areas. The origin of these " tiphonic " areas has never, to the knowledge of the writer, been satisfactorily explained, and the novel and expressive designation given to them by Choffat rather denotes his uncertainty about their formation. At the date when he worked on the geology of Portugal little was known concerning salt-dome geology, or about the flowage of salt and gypsum under pressure; indeed, the origin of salt domes was the subject of all kinds of speculation.

Wherever exposed to view, the hearts of these structures appear as a crumpled conglomeration of limestone, dolomites, shales, more or less mingled with gypsum and eruptive rocks, and although salt as such in solid form has nowhere been reported, this does not necessarily infer that it has never existed or that it does not occur in places. Waters rich in sodium chloride are about as frequent as the sulphate variety near tiphonic areas, proving the presence of salt somewhere in the immediate vicinity. Gypsum and salt are so commonly and obviously connected that the discovery of the latter would be no occasion for surprise. It may be recalled in this connection that the presence of great masses of rock salt on the Red Sea littoral of Egypt was only disclosed by drilling, although gypsum was almost everywhere in evidence.

These typhonic areas seem to bear many resemblances to salt-dome structures about which the flowage of salt and gypsum towards points of pressure relief have transmitted to superincumbent and neighbouring strata deformation that varies in degree with the character of the strata in contact. Whereas unconsolidated plastic sediments yield readily with a minimum of disruption when pierced, harder compact rocks suffer a considerable amount of faulting and shattering, typically exemplified by the salt domes of Germany. Such hard rocks as those constituting much of the Infralias and Lower Jurassic formations of Portugal would necessarily suffer much formational disorder from an intruding mass. The frequent presence of intrusive igneous rocks introduces an unusual factor into the question, but as most of these invasions are of an age much later than those immediately concerned, it points to the view that the Molten Magmas used for their escape avenues of weakness formed by earlier disturbances. Another complication arises from the fact that the tiphonic areas in some cases lie on the edge of the main tectonic uplift, and not along the axis, as might be expected. However, there may be unrevealed reasons for this departure from what would seem to be the most obvious line of weakness. Salt-dome growth may commence at any period and at any spot where conditions favour its initiation.

The Arruda and Belas domes must await exploration with the drill for a solution of their origin, but their regularity and form virtually precludes acceptance of the usual explanation of cross-folding for doming. In the absence of any more rational interpretation, their form is attributed to vertical uplift by some rising deep-seated body of the character of a laccolith. Although the Belas structure is far removed from the province of known Infralias eruptions, the presence of an incipient saline bulge cannot be dismissed offhand; and in the case of Arruda it would appear a perfectly justifiable deduction. The Belas dome lines well within territory that has been subjected to intense volcanic activity and is, in fact, only a short distance from the granite mass of Cintra, so that a laccolitic origin cannot be entirely ignored as a possible cause for its origin. Intrusive igneous dykes pierce the sedimentaries at several places, but their presence gives no particular countenance to a volcanic origin, as they are found in practically all the main structures with which this paper deals.

The Guilhim and Loulé domes in Algarve present features which do not admit of a simple explanation, although they appear to be too far removed from known tiphonic areas to associate them with salt-dome tectonics.

SOURCE OF PETROLEUM.

Very naturally as much thought has been given to the possible source of oil in Portugal as in other countries, with perhaps as little success as has rewarded explorers in other countries where extended developments alone have for practical purposes eliminated all but a single or several genetic sources. No positive conclusion has been reached, although collected evidence points to an Infralias or Triassic origin. Once the source of oil in a territory has been determined, many other considerations are influenced and the extent of investigations restricted to prescribed limits. Only Jurassic strata seem to warrant consideration as possible source-beds, except the Infralias, for such oil-shows as are found in Cretaceous and Tertiary formations undoubtedly owe their presence to migration. Jurassic strata do contain bands of shales in places which might have contained sufficient macerated organic matter suitable for conversion into oil. The Upper Jurassic (Abadia) beds as exposed at Torres Vedras have the appearance of source-beds, for arenaceous bands are quite subsidiary in extent to argillaceous, and their general aspect and constitution are reminiscent of oilfield lithology as viewed in other parts of the world. In the Varatojo nose many of the sands are richly impregnated with oil, although such appear to be connected with faults, but on the Abadia nose strata identical with those of Varatojo show few signs of oil, and those observed are most certainly connected with faulting. The Abadia beds at Aruda presenting the same facies as at Torres Vedras likewise show no signs of oil. These facts rather discourage an indigenous and support an adventitious origin for petroleum found in the Abadia series.

Lower Jurassic strata are a potential source of oil genesis, although a preponderance of limestones is an adverse factor in the eyes of the writer, who is perhaps unfairly biased in the matter of limestone origin. One fact does, however, merit serious thought—namely, the presence of true oil-shales in the lower Lias. Where exposed at Peniche, S. Pedro de Muel, and Quiaios, the seams are thin and unimportant, but on subjection to heat they decompose, emitting the strong oily odour recognizable by most oil geologists. These shales would certainly undergo distillation on subjection to the heat from hot igneous magmas, and the resulting hydrocarbons could travel in a gaseous or liquid form into any nearby formation favourable for reception. This has happened in many parts of the world, as in Scotland and South Africa, producing small oil- and gas-fields in some instances. Against this hypothesis is the fact that such oil as is found in Portugal has properties more characteristic of a natural oil than that of a shale distillation product. Nevertheless, it is irrational to deny such an eventuality, although no actual contact between oil shales and volcanic dykes has been seen where neighbouring suitable beds would be expected to be bituminous.

The argillaceous limestone of the Lias are very petroliferous in places, but they are for the most part hard and compact, showing oil or bitumen only in the numerous cracks, crevices, and vesicles which permeate their mass. Near the Cabrito tunnel at Torres Vedras the compact limestones are particularly petroliferous, stringlets of soft or indurated bitumen in various stages of consistency filling innumerable veinlets or collecting in calcite-lined cavities. The occurrence of oil under such conditions favours a migratory origin from some deeper source rather than its formation from some occluded organic substance; and the conclusion was reached that the oil must have originated in some deep-seated formation in or below the Infralias and about which we have no knowledge.

The few occurrences of oil in beds of Cretaceous age and other strata newer than Mesozoic are almost certainly due to vertical or lateral migration via lines of fissuring.

Drilling Results.

Unfortunately the commencement of drilling was coincident with the early stages of the present war, and this naturally imposed a whole host of obstacles in the way of procuring and shipping plant and materials. Nevertheless, after disheartening delays and irritating hindrances, a start was made at Torres Vedras on 19th December, 1939, on a location that it was thought would yield valuable evidence, if not tangible results. As a compromise between a full-sized development rig and an exploration outfit, the machine selected was a Wilson Super-Model Portable Rotary considered good for 4000 ft. It was deemed expedient to postpone ordering a heavy drill for several reasons, including the obtaining of more precise knowledge of the hardness of the rocks it would be necessary to attack, and the recognized need for training local personnel speaking only Portuguese. Many of the sandstones and crystalline limestones would, it was appreciated, prove very destructive to bits, whatever the kind used, and drilling in inclined and fissured rocks would, it was felt, not be easy. As fuel is scarce and expensive in Portugal, it was determined, not without misgivings, to employ diesel engines for power, notwithstanding their manifest disadvantages in a new field. Rock-bits and Zublins were included in the cutting tools specified. Qualified staff proved difficult to engage in war-time, and no men with useful experience could be found locally, so a commencement was made on two shifts with one skilled driller for each tour.

As luck would have it, the site selected for the well on a piece of flat land convenient of access from the main road proved to lie directly above one of the gritty calcareous sandstones in the Abadia beds, and the making of the rat holes and the drilling of the first 180 ft. in the equivalent of a grindstone proved a very tedious and lengthy performance, with insufficient weight to give the bits a bite. However, once away, the rate of progress was highly commendable, especially so since through illness and accidents to staff three tours were rarely run, and often only a single tour of eight hours. The execution of repairs involved exasperating delays, and failure to find adequate water supplies made it necessary to lay a pipe-line from the Sizandro river at a point where it was said to have a perennial flow near the Cabrito tunnel.

Showings of oil were first encountered at 300 ft., and then continued at intervals in the Abadia sand and shale series, which was left at about 700 ft. to enter compact argillaceous limestones. The change was quite abrupt, with no noticeable transition stage. Faint signs of oil were noticed in the limestones at intervals, taking the form of oil odours and blobs of heavy oil in the returns. At about 1000 ft. a fault zone was indicated by the appearance of a breccia in a core and the presence of much calcite with more pronounced oil-showings and some fresh oil in goedes. At 1320 ft. a better showing of oil was met with, but at 2000 ft. the mud returns brought up more oil than had hitherto been seen. Coincident with this oil-strike, coring showed a marked increase in the dip of the limestones, with signs of brecciation, slickensiding, and calcite-lined fissures. Oil was visible in hair-like cracks in the limestone. Increasing dips were measured up to 65° before reverting again to about 30° at 2100 ft., clearly denoting the passing of a faulted zone. Between 1900 ft. and 1970 ft. the showings of oil and gas were very strong, and the drillers considered the well good for a yield of from 20 to 30 brls. a day. A drilling rate of about 10 ft. per hour was made at this point. A fair amount of oil collected on the mud pit, and on examination was found to have a density of 0·928. The decision was reached to proceed deeper without a cementation or test, but although a depth of 3820 ft. was eventually attained, no more than slight traces of oil were encountered, showing that to the depths reached oil in quantity was confined to fissured and disturbed ground. At 2170 ft. a lithologic change was noted and many samples showed oolitic structure, and again at 2490 ft. white limestones indicated another change in the succession.

From 2300 ft. onwards considerable trouble was occasioned by lost circulation, and the adoption of various expedients became necessary to obtain returns and release "frozen" drill pipe. Clay of a suitable consistency to make mud had to be carted a long distance, as that found locally had a poor colloidal property. Cores taken in the latter part of the hole showed no trustworthy bedding planes, although etching with acid was tried. The deviation of the well from vertical was only 1·5 degrees. Wear and consumption of rock-bits were heavy, the wastage representing about one set of cutters per 100 ft. in the argillaceous limestone when using 9¾ Hughes bits. It was considered unsafe to proceed deeper, as the rig was showing unquestionable signs of overstrain, and we did not wish to risk a serious accident. We were then drilling with 6⅝-inch bit and 4½-inch drill pipe. For a test well on new territory the drilling results are regarded as highly satisfactory. The averge rate per drilling day was 29 ft., but as the average rate per drilling tour was 15·7 ft., it is obvious that had three tours been run the daily average would have far exceeded the 47·1 ft. indicated mathematically. Drilling tours only represented 62·5 per cent. of the total possible tours due to mishaps, delays for material, shortage of drillers or such-like causes. Down to 2000 ft. the drilling rate per drilling tour averaged 21·5 ft.

The stripped derrick at Torres Vedras received the full blast of the violent hurricane that struck Lisbon and district on February 15th, 1941, causing widespread havoc on sea and land.

Summarizing the results of the Torres Vedras well, although not conclusive, they cannot be regarded as unfavourable for a first test. Once the argillaceous-arenaceous Abadia group was passed, the only really suitable reservoir rock was the softer brecciated fault zone passed at about 2000 ft., and at that point liquid oil of commercial quality was struck in some quantity. Many of the cores and cuttings from the limestone showed numerous cracks, with films of oil indicative of the widespread movement of oil wherever a path existed for its travel, so that at greater depths, where higher pressures might reasonably be anticipated, production from fractured limestones would appear well within the range of probability.

A local analysis of the oil from 2000 ft. gave the following results :—

Sp. gr.	0·934 at 15° C.
Colour	Dark brown
Sulphur	2·48 per cent.
Hard Asphalt	6·09 per cent.
Soft Asphalt	9·06 per cent.
Ash	0·65 per cent.

Distillation.

I.B.P.	88°					
Gasoline	4·52	0·741	I.B.P.	88°	F.B.P.	195°
Kerosine	9·82	0·816	I.B.P.	179°	F.B.P.	278·5°
Gas Oil	9·40	0·849	I.B.P.	272°	F.B.P.	332·5°
Fuel Oil	74·30	0·982				

THE INSTITUTE OF PETROLEUM.

A MEETING of the Institute of Petroleum was held at Manson House, 26, Portland Place, London, W.1, on Wednesday, 14th June, 1944. The President, Professor F. H. Garner, was in the Chair.

A paper on "Oil Prospects in Portugal" was presented by Mr. A. Beeby Thompson. [See pp. 370–388.]

DISCUSSION.

DR. G. M. LEES said that, although he had no personal experience of the geological conditions in Portugal, he had studied the literature at various times in the past and had been very much interested by the curious, complex structural features now described by Mr. Beeby Thompson. He thought that the explanation now given was the most reasonable one—namely, that they were a manifestation of salt tectonics. Similar types of structures were well known in Algeria, and were now generally believed to result from salt intrusions.

It was difficult to pass an opinion on the value of these structures in Portugal for giving conditions for accumulating oil in important quantity, but the evidence of the oil-sands indicated that a considerable richness of oil-generating conditions did exist. As usual in so many oil problems, it was exceedingly difficult to attribute an age to the source of the oil. Mr. Beeby Thompson stated that a Palæozoic source was ruled out because of the complexity and metamorphism of the adjacent Palæozoic area, but he asked whether Upper Carboniferous and Permian were affected by these processes.

Mr. Beeby Thompson mentioned the presence of oil shales in the Jurassic, but rejected the possibility of the free oil being a distillation product from them through the agency of the intrusive igneous rocks, as analyses of the samples showed them to be of normal crude type. This was a questionable deduction. The shale oil produced by a works retorting process contained unsaturated and therefore unstable compounds, but it was possible that further change towards stabilization would take place during millions of years of underground storage.

In conclusion, he wished to thank Mr. Beeby Thompson for his most interesting lecture and to express admiration for his persistence through a period of more than forty years. The name Torres Vedras rang a bell in British memories, and he hoped that it was a good omen for a successful outcome of this example of British enterprise.

MR. BEEBY THOMPSON said in reply to Dr. Lees that he realized that he was on rather weak ground when he spoke of the analysis of the oil as unlike that of a shale-oil product, for it was indeed remarkable what high-grade qualities of oil were obtained in fields where all evidence pointed to a shale distillation product. Little was known to-day of the changes in the character of an oil wrought by time and diffusion through many different kinds of strata.

Consideration had been given to the probabilities of a Palæozoic origin for the oil, but the conclusion was reached that these beds were not a likely source of oil. Nevertheless, there was the probability. Such surprises as those in the Red Sea oil-fields of Egypt had greatly upset preconceived notions concerning the genesis of oil in that part of the world.

The PRESIDENT said in connection with the remarks just made, the oil mentioned had a sulphur content of 2·48, which was rather high. It was somewhat similar to a Venezuelan oil. Had any tests been made on the oil obtained from the shale by distillation, because if its sulphur content had been about the same it would give some indication? If the shale gave a very sulphurous oil, it might have passed through some filtering medium.

MR. BEEBY THOMPSON replied that they had not troubled to do that. But in the sections examined they had found only very thin seams of shale which were regarded as an unlikely source.

There was no further discussion. On the motion of the PRESIDENT a very hearty vote of thanks was accorded Mr. Beeby Thompson for his very interesting paper.

SINTERED GLASSWARE.

By I. C. P. Smith.

Sintered glassware of British manufacture is available in all the forms which came from Germany before the war, and in many further developments. The porosities available as are follows :—

Porosity.		Pore size (microns).	Generally supplied.
No. 00	Between	200–500	250–400
„ 0	„	150–200	150–200
„ 1	„	90–150	110–130
„ 2	„	40– 90	55– 75
„ 3	„	15– 40	20– 30
„ 4	„	5– 15	7– 12
„ 5 on 3	„	0·7– 3	1– 1·5

Gooch crucibles are generally employed with No. 3 or No. 4 porosity; the former covers the coarser precipitates, such as nickel dimethylglyoxime and the silver halides, while No. 4 is required for barium sulphate or lead chromate. The range of apparatus, which may be provided with discs up to 6 inches diameter, includes Buchner funnels, immersion filters, pressure filters, pipeline filters, micro-chemical apparatus, extractors for solids or liquids, apparatus for gas reactions, and is of particular value for gas filtration, gas washing, gas distribution, aeration, etc. Due to the fact that the No. 4 disc forms a non-return valve for mercury, the discs may be built into vacuum gauges, vacuum controllers, etc.

The majority of the apparatus consists of a disc sealed into a tube or other form of apparatus, but the sinter is also available in tube or thimble form.

Agitation and Emulsification.

The value of sintered glassware in assisting agitation or emulsification should be given attention as it may prove useful in certain applications. In liquid-liquid extractions or in reactions between immiscible liquids, contact between the two liquids is assisted either by breaking the one liquid into a stream of fine droplets by passing it through the sinter, or by direct agitation by means of a stream of air or inert gas. In each of these cases mixing is carried out in conditions which cause little emulsification.

Fig. 1 shows the application of an air stream in a small reaction tube. In this a film of the lower liquid is carried up on each air bubble into the upper liquid, separating as a droplet which falls back, keeping up a continuous extraction process. Figs. 2 and 3 are liquid-liquid extractors in which the sintered disc is arranged to break up the refluxing solvent into a stream of fine droplets which will pass either upwards or downwards through the liquid to be extracted. Fig. 4 is a sintered glass thimble of 15 sq. in. area sealed to a glass delivery tube; this will pass 10 cu. ft. of air per minute under 1 lb. pressure and may be employed for agitation by air or, if connected to a low pressure water main, in a washing process.

FIG. 1.

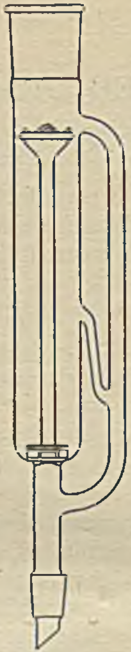


FIG. 2.

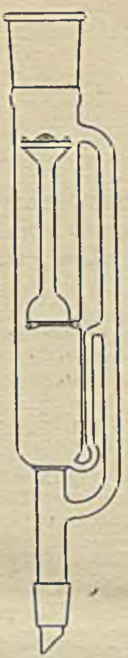


FIG. 3.

FIG. 4.

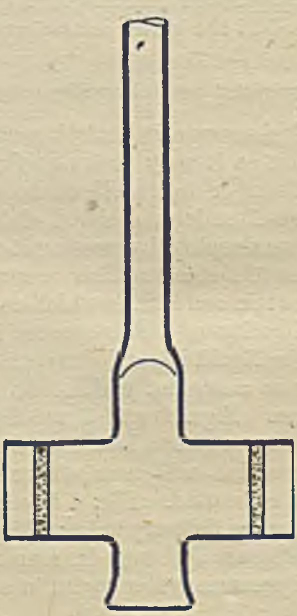


FIG. 5.

FIG. 6.

Agitators of an entirely different nature, which have been developed by the writer, are shown in Figs. 5 and 6. They are constructed as stirrers, Fig. 5 having a coarse sintered disc in each side arm, and Fig. 6 consisting of a sintered glass tube of coarse porosity having the lower end brought down to an opening; the stirrers, when rotated rapidly in a vessel containing two mobile but immiscible liquids, carry the two liquids up through the bottom opening and by centrifugal force bring them into intimate contact as they pass through the sinter. This action causes fine subdivision of the two liquids and greatly increased rate of reaction, but is not applicable to those mixtures which are liable to form viscous emulsions. These stirrers are, however, valuable in washing, for instance, petrol with sulphuric acid or other reagents.

AN EMULSIFYING MACHINE.

As a further development of the second form of agitator described above, a sintered disc has now been incorporated as the obturator of an emulsifying machine. A disc or plug whose porosity and thickness may be varied according to the nature of the emulsion to be formed, is clamped into the outlet of the emulsifying machine, and has been found to give very good subdivision of the droplets with permanence of the emulsion. Application has been made for this particular use of sintered glassware.

CLEANING.

Cleaning generally, as in the case of crucibles or Buchner funnels, should be carried out first by reverse filtration, in order to wash off the precipitate; a funnel should not be connected to a high pressure water main as the apparatus will not generally stand more than 14 lb. pressure.

Following this, chemical means of cleaning should be employed. Organic matter may be oxidized off in the case of the coarser filters, using chromic mixture or, preferably, and particularly in the finer filters, using strong sulphuric acid at 80° C. containing about 1 per cent. each of solid sodium nitrate and potassium chlorate. When a small electric muffle is available, organic matter or charcoal may be burnt off by putting the article in the muffle, raising the temperature slowly to about 550° C., then turning off the current and allowing it slowly to cool down again. The heating up of small articles should take not less than 1 hour, and the cooling down to 400° not less than 1 hour, and to 200° a further 1 hour. Small articles may be removed at this temperature. In the case of the very large Buchner funnels, these times should be at least doubled.

ANNUAL GENERAL MEETING.

FRIDAY, 3RD NOVEMBER, 1944.

THE ADJOURNED THIRTY-FIRST ANNUAL GENERAL MEETING of the Institute was held at Manson House, 26, Portland Place, W.1., on Friday, 3rd November, 1944, when Professor F. H. GARNER, President, occupied the Chair.

ANNUAL REPORT.

The Auditors' Report on the Accounts was read by the Secretary.

The Chairman stated that the Annual Report of Council was before the meeting, and proposed that it should be taken as read. This was agreed.

The Chairman then called upon Mr. G. H. Coxon (Chairman of the Finance Committee) to present the Annual Accounts.

There being no questions the Chairman then moved :—

> " That the Annual Report of Council for the year 1943, together with the Accounts and Balance Sheet as at 31st December, 1943, be and are hereby adopted."

Mr. F. G. Rappoport seconded the motion, which was carried unanimously on being put to the meeting.

ELECTION OF AUDITORS.

Dr. F. B. Thole proposed the following Resolution :—

> " That Messrs. Price, Waterhouse & Co. be and are hereby appointed Auditors for 1944."

The Resolution was seconded by Mr. R. R. Tweed and carried unanimously.

The meeting then terminated.

STUDENT'S SECTION (BIRMINGHAM).

ANNUAL REPORT.

There have been four meetings of this section during the past year. On 2nd November, 1943, Professor F. H. Garner presented two films on synthetic rubber to a large audience, which included many visitors. The films were " Synthetic Rubber," which dealt with the United States war production of this commodity, and " Bouncing Molecules," which explained the chemical formulæ of the various synthetic rubbers manufactured. On 16th November, 1943, the Final Year Students gave lectures on the subjects chosen for their theses, the prize for the best thesis going to Mr. A. Winward. Two meetings had been arranged for the Lent Term, but unfortunately both had to be postponed until the Summer. On 2nd May, 1944, Dr. Howes spoke on " Research and Industry." He stressed the important aspect of a research organization as an economic project, and explained the essential team work of research. On 16th May, 1944, Mr. Southwell talked on the hypothetical case of " The Search for Oil in Tropicalia." He outlined the problems an oil company faces in searching for oil in a foreign country, drawing on his own experience to provide examples.

The following have been elected officers for the Session 1944–1945 :—

Chairman—M. J. LOXLEY.
Secretary—D. S. PETTY.
Treasurer—Dr. A. H. NISSAN.

THE CORRELATION OF CETANE NUMBER WITH OTHER PHYSICAL PROPERTIES OF DIESEL FUELS.

The Report of the Diesel Index Panel of Standardization Sub-Committee No. 4 on the above subject was recently published in the *Journal* (July 1944, 30 (247), 193). Unfortunately, an error occurred in the printing of Figures No. 3 and 4. Both these figures as issued are incorrect. They have been redrawn, and at the same time, scales covering specific gravity and degrees Centigrade have been incorporated.

It is recommended that the original Figures Nos. 3 and 4 be removed from the July issue of the *Journal* and destroyed. The enclosed new issues of these figures should be used to replace the original ones.

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

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

Geology and Development.

1376.* Economic Palæontology and Mineralogy—an Appraisal. H. L. Driver. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 938–947.—A conservative estimate of new discoveries of oil in 1942 in the U.S.A. is 421,128,000 brl. and a maximum estimate amounts to 800,859,000 brl. These new reserves replace only 30–57% of the oil consumed during the same year.

Historical outlines of the use of fossils and micro-fossils in oil-finding have been published by H. G. Schenck (*Bull. Amer. Ass. Petrol. Geol.*, **24**, 1940) and by C. Cronois (*ibid.*, **25**, 1941). The first examination for Foraminifera in a North American well is attributed to Chapman in 1897, and not till 1918 did the Rio Bravo Oil Company, followed shortly by the Humble Oil Company, established in Texas the first laboratories for applied palæontology. Mineral-grain investigations can usually be dealt with in the same laboratories. Very seldom have these been discontinued once they were started, and the expansion of the work can be seen in such publications as the *Journal of Paleontology* and the *Journal of Sedimentary Petrology*, as well as in the catalogue of foraminiferal data started in 1940 by the American Museum of Natural History, under the direction of B. F. Ellis and A. R. Messina, and already covering 1500 generic names and 18,000 specific designations. Ecology has also been studied : it appears that Foraminifera are usually associated with fine sediments, for neither they nor the small organisms which constitute their food supply can withstand rapid currents. The larger " snails " and clams usually thrive in sands which are deposited in more rapidly moving water between highest and low tides. In this connection it is important to correlate information from both macro- and micro-organisms. Difficulties arise from the fewness and similarity of brackish-water organisms of different ages. Deep-water assemblages of successive epochs also frequently have more " species " in common than contemporaneous deep and shallow faunas.

Well-marked palæontological horizons are useful as starting points from which to run electrical logs. Identification of shales overlying water sands is also important as permitting completion of wells before bottom water is reached. On the mineralogical side, ash-beds, because of their widespread nature and limited vertical range, are excellent stratigraphical markers. Matching of mineral assemblages involves comparison of specific mineral identifications, abundance of each, colour, crystalline character, grain size, degree of angularity and sorting, and character of induration and preservation. As shore-lines are approached the sediments become coarser and more irregularly deposited, so that correlation is less certain, apart from fossils.

Plano-convex organisms, like sand-dollars, which generally lie on the flat side, may be used in determining which way up beds in a core were deposited. Rhythmic sedimentation (graded bedding) and wash-out phenomena are also helpful in giving information about tops and bottoms of cores.

It is a pity that Palæontology does not appear, as do Geology and Geophysics, in lists of methods by which oil-fields have been found. It almost always plays its part. Another thing to be deprecated is the confinement of palæontologists to routine identification work in laboratories, when actually they are capable of seeing more than any others in fossiliferous strata in the field. Greater co-operation in sharing of data and samples would set palæontologists free for additional outdoor observational work. This would help to obviate such an anomaly as that by which a stratum with *Dentalium pretiosum* Nuttall was designated as a " snake-tooth " bed.

For the training of a specialist in palæontology, a course of five years or more at a University is recommended. A. L.

1377.* Maintaining an Adequate Level of Geophysical Prospecting. F. Goldstone. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 948–953.—See Abstract No. 623, 1943. A. L.

1378.* Reserves in Action. W. B. Heroy. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 954–959.—Oil in store above ground represents less than 20% of the annual production, and must be replenished five or six times a year from the reserves. In 1940, these latter were roughly 18 billion brl., and with an anticipation of restricted civilian demand the situation seemed secure. But war needs have been unprecedented. Fields which did not go in for conservation have been feeling the pinch.

As significant of recent trends, we note that 40 principal Illinois fields, discovered since 1937, reached peak productivity on the average in 15 months after discovery. In another State the total proved reserve was less than 100 times the daily output. Such high production usually implies rapid decline.

Oil-finding at present engages about 25,000 persons—a bare minimum—of whom about 5500 are in geology, 4500 in geophysics, 1500 in leasing and land-work, and 12,000 doing wildcat drilling.

Petroleum products at present form the largest part of the supplies being shipped abroad. A. L.

1379.* Some Factors Influencing Declining Rate of Crude-Oil Discoveries—The Geologist's Responsibilities in the Present Situation. L. F. McCollum. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 960–969.—See Abstract No. 622, 1943. A. L.

1380.* Wartime Changes in Petroleum Industry. R. J. Gonzales. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 970–989.—In 1939 there was increasing demand, in 1940 large export markets in Europe were lost, in 1941 tankers were diverted to Great Britain. In 1942 the need for critical petroleum war products greatly increased, transport was dislocated by sea between the Gulf and the East Coast, and materials ran short. The annual rate of well completions fell from 32,150 in 1941 to about half that figure in 1942, while the number of dry holes increased from 22% to 31%.

Total reserves of 13 billion brl. in 1937 had increased to 20 billion at the beginning of 1943. More than 90% of this increase is from the Gulf Coast area, principally in Louisiana and Texas, the latter now representing 82% of the Gulf Coast total and 57·5% of that for the whole U.S.A.

U.S. crude production in 1942 was 3,796,000 brl./day, or 46,000 brl./day less than the record production in 1941. Through the discovery of large gas-condensate fields and expansion in cycling plants, output of natural gasoline and condensate nearly doubled, from a daily level of 141,000 brl. in 1939 to about 245,000 brl. in the first half of 1943. Movement of oil from the Gulf Coast to Mid-Continent rose from less than 50,000 brl./day in 1939 to over 300,000 brl./day at the beginning of 1943. For the East Coast the tank-car has replaced the tanker, and 71,000 tank-cars, or about two-thirds of the total U.S.A. number, have been placed in East Coast service.

In the refining department in 1942 the notable features were requirements for aviation gasoline and tri-nitro-toluene. A. L.

1381.* Developments in South-eastern United States in 1942. Contributed by Mississippi Geological Society. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 990–995.—Forty-nine wildcat tests were drilled, as against forty-four in 1941. Geophysical prospecting was on a large scale, as in the previous year. At the end of 1942, 13 seismographs, 10 gravity meters, 1 magnetometer, and 4 core-drill parties were at work. Most exploration was in west, central, south-west and south Mississippi, south and south-west Alabama, west Florida, and south Georgia. The Humble Oil and Refining Company had in operation core drills, el-tran, gravity meter, magnetometer, and seismograph for a combined total of 230 work weeks. The California Company, using only gravity meter and seismograph, showed 231 work weeks. The Carter Oil

Company, the Pure Oil Company, the Atlantic Refining Company, and the Gulf Refining Company followed in the order named. Many large lease blocks were acquired as a result of this geophysical work.

At widely separated positions in south Mississippi a new prospective producing zone was discovered in the Massive sand of the basal Tuscaloosa (Upper Cretaceous). This stimulated exploration, though no new fields were found during 1942, in spite of penetration of many horizons from Lower Tertiary to Lower Mississippian.

Twelve new producing wells were added to the great Tinsley field, Yazoo County, Mississippi, bringing the total to 337, which have produced since the discovery in August 1939 a cumulative total of 47,632,294 brl. As now defined, this 9500-acre field is expected to yield an ultimate recovery of 90,000,000 brl.

In the Pickens field there were no new wells, and one well was abandoned, the remaining two wells averaging 283 brl./day. Since April 1940, 40 acres have yielded 621,589 brl. An extension of the Pickens fault-line field in Yazoo and Madison Counties has now seven wells averaging 1407 brl./day and has yielded 311,022 brl. since December 1941.

Cary field, Sharkey County, Mississippi, remains a one-well field averaging 11 brl. of oil and 400 brl. of salt-water daily.

Of the wildcats mentioned already, six were in south Alabama, and two each in Florida and Georgia. A promising future for wildcats in Florida is presaged by the acquirement there of more than 700,000 acres of new leases by the major oil companies.

A. L.

1382.* Second-hand Book Dealers. A. I. Levorsen. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 996–997.—A list of geological booksellers in Canada and the U.S.A., who are " known to carry a larger than ordinary supply." A. L.

1383.* Interpretation of Cable-tool Drilling Logs. J. F. Swain. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, **27** (7), 997–1000.—A driller's log is based not so much on visual experience as on sense of touch. For him the words " sand," " lime," and " shale " have a meaning not in terms of composition, structure, and origin, but in terms of penetration time, hardness, and abrasive quality. The " jerk " or " jump " of the drilling line on the immediate upstroke of the beam, if moderate denotes " softness," if severe denotes " hardness," and, as an indication of the effectiveness of the blow, signals by its diminishing intensity the need to lower the bit to keep progress with penetration. Softness may often mean frangibility or shattering under sharp impact, rather than absence of compressive strength. Thus, unless abrasive, a series of thin, hard laminations may be recorded as a shale. Toughness is more obvious to a driller than hardness.

The tools when withdrawn are examined for abrasion or " mushrooming," and small particles of adhering rock may be tested by the forefinger or tongue to determine the presence of abrasive grit.

In colouring the water from the bailer a few inches of soft red or grey clay may mask the true colour of harder rocks many feet thick.

The following is a brief commentary on driller's usage of certain terms :

Shale.—Rapid and regular penetration, moderate " jerk " of the drilling line, and a polished but unworn bit suggest shale. Rock particles rubbed between the fingers are smooth, slightly soapy to the touch.

Lime.—Slow penetration and severe " jerk " indicate a hard formation. If the bit is " headed up " or battered out of gauge, but polished rather than roughened, and if the adhering fragments are neither gritty nor smooth and soapy, the bed is logged as " lime." This may mean limestone, but it may also mean solid siltstone, or very fine sandstone, or even igneous rock.

Sand.—A moderate rate of penetration and moderate " jerk " suggest a medium-hard rock. If the bit is appreciably worn out of gauge, if the bevelled cutting edge is much worn, if the steel feels decidedly roughened or scratched, and if the cuttings feel exceedingly gritty between the fingers, the formation is logged as sand. It is probably sandstone, but could very well be chert or sandy limestone.

Shale and shells.—This may be almost any interstratification of hard and soft bands.

A. L.

1384. Geological "Union Now." C. Croneis. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, 27 (7), 1001–1007.—Carey Croneis continues his campaign for a comprehensive American Geological Association, and criticizes the poor standing of geologists in the National Defence Research Committee, etc. Geological bodies should appoint publicity officers. A. L.

1385.* Origin of the Carolina Bays. D. Johnson. *Bull. Amer. Ass. Petrol. Geol.*, July 1943, 27 (7), 1008–1009.—A further statement of the case that rising artesian water was the initial force in forming the Carolina Bays. A. L.

1386.* Structure of Central Tennessee. C. W. Wilson, Jr., and K. E. Born. *Bull. Amer. Ass. Petrol. Geol.*, August 1943, 27 (8), 1039–1059.—Over 2000 surface and subsurface elevations from several key-horizons in that part of Tennessee between the Cumberland Plateau and the western valley of the Tennessee River have been used in the construction of structural contour maps for the top of the Chattanooga Shale (Lower Mississippian), for the Pencil Cave metabentonite bed near the top of the Black River group (Ordovician), and for the top of the Knox dolomite (Cambro-Ordovician). An isopach map of the interval between Pencil Cave and Chattanooga is also provided.

The Nashville dome is an elliptical swell which has a concave outline on its north-west side and a convex outline on the south-east. It lies at the southern end of the north-east to south-west trending Cincinnati arch where the axis swings west. The eastward and southward dips off the Nashville dome merge into the foreland slope of the Appalachian geosyncline, but locally the vast thickening of sediments, characteristic of the deeps of the geosyncline, is not found. On the west, the Nashville dome is separated by the McNairy–Hardin saddle from the south-eastern extension of the Ozark dome. Towards the north-west in Stewart, Montgomery, Houston Counties, there is a " low " in southward continuation of the Illinois basin. The whole area was characterized by recurrent but moderate subsidence during the Palæozoic, and this was least marked on the line of the Nashville dome.

The Chattanooga transgression truncates stratigraphical units from Middle Devonian down to Trenton (Ordovician). Truncation of Middle Devonian chert and Lower Devonian by the Middle Devonian limestone is also noteworthy. Thinning of the various units towards the Nashville dome is mainly attributed to truncation by erosion, and to a smaller extent to non-deposition.

In south-central Tennessee, especially in Giles and Lincoln Counties, there is anomalous north-west–south-east orientation of folds, apparently due to fractures similarly orientated in the basement complex and re-activated during compression : vertical movement giving asymmetrical folds.

A structural contour map of Nashville and environs plotted with a 10 ft. interval shows predominating north-east–south-west anticlines crossed by others that are more sinuous and run from north-west to south-east. Contouring in this case is based on the Hermitage formation at the base of the Trenton. A. L.

1387.* Bearing of Foraminifera and Ostracoda on Lower Cretaceous Fredericksburg-Washita Boundary of North Texas. F. E. Lozo, Jr. *Bull. Amer. Ass. Petrol. Geol.*, August 1943, 27 (8); 1060–1080.—At the dam site in the Red river, 5 ml. north of Denison, Grayson County,Texas, the complete Kiamichi (about 50 ft.) and part of the overlying Duck Creek are exposed. The former is mainly of fissile black shale with some sand flags and limestone, indicating bottom conditions less saline, more acid, and more stagnant than in the succeeding grey marls and limestones of the Duck Creek.

With the exception of *Gryphæa* beds and the ammonite *Adkinsites*, there are few large fossils in the Kiamichi, while in the Duck Creek, the echinoids (*Macraster, Hemiaster*), pelecypods (*Inoceramus, Gryphæa*), and ammonites (*Adkinsites, Elobiceras, Hamites, Mortoniceras*, and *Desmoceras*) are dominant faunal elements.

In the black shale there is a *Virgulina-Trochammina* assemblage (as well as pelagic Globigerinidæ), and in the grey marls a *Palmula-Tritaxia* assemblage, dominated characteristically by the families Lagenidæ, Lituolidæ, Verneuilinidæ, and Placopsilinidæ. Both faunas have Textulariidæ. Whereas the Foraminifera of the Kiamichi and Duck Creek are distinct, the Ostracoda show an overlap of Kiamichi species into the base of the Duck Creek.

The top of the Middle Albian in Texas may be placed at the highest occurrence of *Adkinsites belknapi* (Marcou), which coincides with the highest horizon of the overlapping Kiamichi ostracods. This is also the boundary between the Fredericksburg group below and the Washita group above, and is taken as corresponding with the boundary in Britain between Lower and Upper Gault.

The Foraminifera *Frankeina acuticarinata* Alexander and Smith, *Lenticulina washitensis* (Carsey), and *Palmula leai* Loeblich and Tappan are specially mentioned as occurring only in marly facies of the Kiamichi. In general, the latter seems to have been brackish with conditions like those in the areas of the Gulf of Mexico region to-day where *Ammobaculites*—not always limited to areas of low salinity—and related genera thrive.

Miss H. J. Plummer's conclusion (*Univ. Texas Bull.*, 1926, 2644), based on Midway (Eocene) Foraminifera, seems to be borne out that with decrease of alkalinity weight of test in relation to volume of protoplasm decreases (*cf.* E. Heron-Allan and A. Earland, *J. R. Micr. Soc.*, 1910, pp. 693–695, and *Phil. Trans.* B, **206**, 1915, 262). Among both calcareous and agglutinated types of Duck Creek Foraminifera there are many twinned specimens and freaks, suggestive of warm, shallow environments (*cf.* Miss H. Tappan, *Bull. Amer. Geol. Soc.*, 1942, **53**, 1833). A. L.

1388.* Ground Water and Relation of Geology to its Occurrence in Houston District, Texas. N. A. Rose. *Bull. Amer. Ass. Petrol. Geol.*, August 1943, **27** (8), 1081–1101.—The geological formations from which the Houston and Pasadena district obtains its water are Upper Miocene, Pliocene, and Pleistocene. The strata dip south-eastwards; hence successively younger formations crop out from north-west to south-east. These were deposited during a number of cycles of continental sedimentation, and are mostly fluviatile, deltaic, or lagoonal. The " sand zones " are made up of extremely irregular and lenticular deposits of sand, gravel, silt, and clay, interbedded and intergraded with thin beds of clay, sandy clay, or gravel. The " clay zones " consist of mottled calcareous clay containing thin beds and lenses of sand. A few of the predominantly clay zones can be traced over a wide area. Seven main zones are distinguished on the basis of electrical logs in a thickness totalling not more than 3000 ft., and these are numbered 1 to 7 from below upwards. Most of the water is got from Zones 5 and 7. Dissolved solids increase at depth to about 569 parts per million at 2000 ft. The main increase is in sodium chloride, and sodium bicarbonate. Water in shallower wells is of calcium bicarbonate type. All supplies compare favourably with those for public, industrial, and irregation uses elsewhere in the U.S.A.

The annual pumpage in the Houston and Pasadena areas was nearly constant—as were the water levels—from 1930 to 1936, but an increase of 60% between 1937 and 1941 caused a marked decline of standing water level. In the Katy rice-growing area pumpage was eased off slightly between 1930 and 1935, increased fully threefold from 1935 to 1940, and decreased by half in 1941. After a general gradual fall of the water-table this led to a rise in the latter year. Any increase over present pumpage will hasten decline, whereas a decrease of considerable magnitude will cause a rise.

Exploratory drilling shows an additional supply of ground water west and south of Houston, and the occurrence of fresh water in the deep sands near South Houston indicates that salt-water encroachment from down dip is not likely to make itself felt for many years. A. L.

1389.* Sub-surface Study of Jennings [=Evangeline] Field, Acadia Parish, Louisiana. C. B. Roach. *Bull. Amer. Ass. Petrol. Geol.*, August 1943, **27** (8), 1102–1122.—The Jennings or Evangeline piercement-type salt plug gives rise to one of the major oil-fields of the Gulf Coast. Ultimate recovery is estimated at 120,000,000 brl. and up to the end of 1941 77,000,000 brl. had been produced. The oil is held in equal proportions in supercap Miocene sands and in flanking Oligocene beds. The field was discovered in 1901 from a seepage on the site of an eroded topographic rise. Possibly oil migration, following break-through of a salt off-shoot in the north-west, is still incomplete.

The oldest formations penetrated are " Vicksburg " and " Hackberry " brought up in faulted blocks or as bits of old sheaths on the salt. Deepest zone fossil noted is *Nodosaria blanpiedi*. In the Oligocene, the Frio with *Marginulina texana* and *Cibicides hazzardi* has oil or gas in the Clement, Lower and Upper Ribira, and Heywood sands, while the succeeding *Marginulina* zone contains the Leckelt and Arnaudel sands. After deposition of the latter, strong upward creep of the salt gave rise to faulting, both radial and tangential, and to a marked unconformity. The eroded surface is buried under *Heterostegina* sediments, including a limestone, and there is probably another unconformity separating the *Discorbis* zone, with one oil-sand, from the *Heterostegina* zone. If the top of the Oligocene is placed as high as this, the succeeding Miocene is readily distinguished as being very much more sandy than the Oligocene. The basal Miocene yields oil on the west flank abutting the salt. The Lower Miocene sands reveal the effects of a number of upward movements of the salt, and one unconformity stretches right round the dome. The chief effect is the thinning of the sands towards the salt core.

At present the salt plug has penetrated as far as the Middle Miocene beds, and it is surmounted by a thick cap rock, which is continuous on the east half of the dome with a mineralized sand section containing much anhydrite, but also cavernous and difficult to drill because of loss of mud. Rise of the salt core was evidently held up for a time by abundant water in the Miocene sands, which leached not only salt, but some of the other compounds that would normally have remained as cap rock. The latter less soluble substances were deposited in the pores of the sand, but as the updip ends of sandy strata were mineralized first, often this shielded downdip layers from complete cementation.

The mineralized and other Middle Miocene beds are conspicuously broken by fairly recent faulting. Apart from M. T. Halbouty's paper (*Bull. Amer. Ass. Petrol. Geol.*, September 1935), there is a poverty of information about the higher beds. The top of the Miocene is based on the first occurrence of *Rangia johnsoni*, and the top of the Pliocene at the point where *Rotalia beccarii* was observed.

The axis of the salt core leans towards the north, but at the very summit where the cap rock firmly bonded to the mineralized sand on the east side has held it back, the break-through has been on the west side, with subsequent tilting of the cap and migration of oil. A. L.

1390.* Anse La Butte Dome, St. Martin Parish, Louisiana. F. W. Bates and J. B. Wharton, Jr. *Bull. Amer. Ass. Petrol. Geol.*, August 1943, 27 (8), 1123–1156.—As at August 1942, 4,269,264 brl. had been produced, with a total ultimate recovery from known sands estimated at about 32,000,000 brl. from 300 acres. Development of flank sands at shallow and intermediate depths is probably complete, and about 95% of the reserves are on the south-east side trapped in sands truncated against a plane, relatively gently dipping surface of the salt. The south side of the salt dome, however, is actually steeper than the north.

The dome is of piercement type reaching within 160 ft. of the surface. It is suggested that the initial intrusion of salt was in the form of a narrow spine which gradually expanded laterally, so that no fragments of older formations are found on top of the dome, and almost everywhere the formational dips, though ranging up to 75°, are notably less than the contiguous surface of the salt mass. There is strong radial faulting, but concentric and tangential faulting is less clear, albeit the latter may have played a decisive part in oil migration into different fault-blocks.

It will be seen that this interpretation of the mode of emplacement differs considerably from the relatively vigorous upward movement *en masse* postulated for the Jennings (Evangeline) dome, situated 40 ml. away to the east, also within the belt of Gulf Coast salt domes.

In the stratigraphical terminology employed by the authors the Nickerson and Voorhies sands reached at between 9000 and 10,000 ft. are referred to as basal Miocene, though probably only a little younger than Vicksburg. They belong to the Chickasawhay. Just above them occurs rare *Cibicides hazzardi*, below which we find the Hackberry assemblage, which includes *Nonion lunatum*, *Gyroidina scalata*, *Pseudoglandulina comatula*, *Uvigerina stephensoni*, *Bolivina mexicana*, scarce *Nodosaria blanpiedi*, and in addition forerunners of the later *Marginulina* associates of the Lower Catahoula, as well as *Pyrgo subsphærica*, *Bulimina sculptilis*, *Saracenaria italica*, *Uvigerina* spp., *Angulogerina* sp., and *Operculinella* sp., the last group being suggestive of the Vicksburg.

The Tortoris and Fournet sands occur in the Lower Catahoula, and the *Discorbis* sand, with *Discorbis candeiana*, towards the top of the Marine Catahoula. Above this may be placed the "base of the Upper Miocene Sand Series," though other authors would put to the top of the *Discorbis* Zone in the Oligocene. Very extensive thick sands occur in the Upper Catahoula, including the Martin and Patin sands, with the exception of Patin A, which falls at the base of the Fleming (Miocene). The Fleming contains the Breaux, Bergeron, and Moresi sands; and above the Moresi lies the top of the *Potamides matsoni* Zone. There is one more thick oil sand before the top of the *Rangia johnsoni* Zone marks the end of Fleming deposition. The Plio-Pleistocene has not been zoned. It contains the Deborah sand and others of a minor nature, medium to coarse, separated by grey to red shales and sands, some of which are calcareous. Pyrites and lignite occur, and occasional fossils include pelycypod fragments, and *Rotalia, Globigerina* spp.

About 82% of the yield comes from the Martin and Patin series. There are future prospects at depth. A. L.

1391. Exploratory Drilling Record Appears Likely for 1944. Anon. *Oil Wkly*, 24.7.44, **114** (8), 37.—Exploratory drilling in U.S.A. is proceeding at a rate which is almost certain to establish a new record for volume, and if no decline in the percentage of discoveries occurs during the last half of the year, more sources of new production should be found this year than ever before. The new interest in the south-eastern States is a significant development from the long-term point of view. This region has possibilities of production from the Eocene, through the Cretaceous, and possibly into the Jurassic. Recent Mississippi discoveries have reserves estimated at 50 million to 100 million brl.

New fields and new pays have been found in East Texas, and recently the first Smackover limestone producer was completed in this area. The deep Tensleep pay in Wyoming has been extended 1 ml. Prolific production has been found in the deep Palæozoic limestone of Central Montana. The opening of Wilcox production in McClain County is expected to stimulate wildcatting in Oklahoma. Intensive prospecting in California in the first half of 1944 has given negligible results. West Texas has a substantial exploration campaign planned for the Ellenburger.

2035 exploratory tests have been completed in the first half of 1944, and if this rate continues, the 1944 total will be 13% greater than the 3599 tests drilled in 1943. Compared with 1943, there has been a 33·3% increase in the number of field and new pay strikes. The discovery ratio has risen from 17·5% to 18·7%. Oil fields opened in 1944 have been 24% more than in the first half of 1943, gas fields 113% more, and distillate fields 30% more.

The discoveries in the different areas are briefly noted, together with the overall results of exploratory drilling. Tables summarize by States and districts the results of exploratory drilling in June 1944, and in the first six months of 1943 and 1944, and analyse the discoveries by types for May and June 1944, and for the first six months of 1943 and 1944. G. D. H.

1392. New Oil- and Gas-Fields and New Pay Horizons Discovered in the United States in June, 1944. Anon. *Oil Wkly*, 24.7.44, **114** (8), 40.—The new discoveries are listed with the name, company, location, date spudded, date completed, depth, completion horizon, name, age and nature of producing horizon, initial production and method, oil gravity, structure and method of discovery, and a tentative evaluation of the discovery or extension. G. D. H.

1393. Well Completions Show 24·3 per cent. Increase. Anon. *Oil Wkly*, 24.7.44, **114** (8), 52.—11,125 wells were completed in U.S. during the first six months of 1944, compared with 8616 in the same period of 1943. The rate of completing wells has increased in recent months, and in May and June was at the highest level since wartime Government restrictions were imposed. It is possible, therefore, that in 1944 the completions will more nearly approach the projected P.A.W. total of 24,000 than the average for the first six months would suggest.

At the beginning of June 3482 rigs were either drilling or rigging, and at the beginning of July the figure was 3811. The steady gain in drilling has been reflected in practically all areas of importance, especially in the more prolific producing states and in the south-eastern States. Texas completed 2945 wells, compared with 1886 wells in the first half of 1943; the corresponding figures for California were 977 and 668. Illinois and Arkansas were the only major districts showing declines in 1944 as compared with 1943, the figures being 4·3% and 28·5%, respectively. Rises of 39%, 29%, and 15% took place in Montana, Wyoming, and Colorado, respectively, as compared with the figures for the first half of 1943.

10,951 of the 11,125 wells completed were new wells; 174 were old wells drilled deeper. Of the new wells, 5941 were oil or distillate producers, 992 gas producers. 849 were water-input, gas-input, and salt-water disposal wells.

Well completions are summarized by States and districts for June 1944, and for the first half of 1944. The weekly average rates of well completion are tabulated for the first six months of 1944 and for every month in 1943, and the number of rigs in operation at the beginning of each of these months is given. G. D. H.

1394. Footage Increases as Average Well Deepens. Anon. *Oil Wkly*, 24.7.44, **114** (8), 55.—Compared with the first half of 1943, 24·3% more wells were completed in U.S.A. in the first half of 1944, and the rise in footage was 42·6%. The average depth of the completions was 3327 ft. in the first half of 1944, and 3047 in the preceding year. The 11,125 wells drilled in the first half of 1944 accounted for 37,017,631 ft., 10¾ million feet more than in the same period of 1943. Texas accounted for 35·6% of this year's footage, the average depth being 4586 ft. The average depth in the South Louisiana was 9490 ft., and in the Texas Upper Gulf Coast region 7477 ft.

The footage and average depth are given by States and districts for the first halves of 1941, 1943, and 1944, new wells being separated from old wells drilled deeper, and the average drilling depths are given yearly from 1925 and for the first halves of 1941, 1942, 1943, and 1944. G. D. H.

1395. Deep Drilling Characterizes 1944 Activity. Anon. *Oil Wkly*, 24.7.44. **114** (8), 56.—During 1944 a wildcat in Pecos County, West Texas, has reached a depth of 15,279 ft., 275 ft. deeper than the previous record well. In Southern Louisiana a producing well has been completed at 13,503 ft. in the same field as that which produced from 13,266 ft., the former record deep producing well.

In 1943 the deepest production in Mississippi was from 6222 ft.; it is now from 10,374 ft. In only ten of the 36 sub-districts of U.S.A. have wells been drilled deeper than 12,000 ft., eight of these being in the southern States of Texas, Louisiana, Mississippi, Alabama, and Florida. New records for production depth have been established in 1944 in Florida (11,626 ft.), West Texas (10,710 ft.), North Louisiana (10,681 ft.), Oklahoma (10,645 ft.), Colorado (8,558 ft.), and Illinois (4,780 ft.).

The U.S.A. drilling depth and producing depth records are tabulated. G. D. H.

1396. Wildcat Discoveries Rate Higher This Year. Anon. *Oil Wkly*, 24.7.44, **114** (8), 57.—During the first half of 1944, 11·3% of the tests completed were productive. The corresponding figure for 1943 is 10·6%, and the average for the past three and a half years is 11·1% (1941, 10·7%; 1942, 11·9%). The above figures do not cover outpost tests.

Five of Wyoming's ten wildcats completed in the first half of 1944 were successful, and during the past three and a half years the percentage of success was 30·9. The four States of District 3 (Texas, Louisiana, Arkansas, and New Mexico), which supply over 50% of the Nation's crude, have had the most active wildcatting. The percentage of success was 14 8 in Oklahoma.

The ratio of success in wildcatting is given by States and districts for 1941, 1942, 1943, and the first half of 1944. G. D. H.

1397.* California's Exploration Covers Wide Range. N. A. D'Arcy. *World Petrol.*, August 1944, **15** (9), 24.—The Salton Sea area of Imperial Valley is one of the large undeveloped and unproven regions of sedimentary rocks left in California. Several years ago a shallow exploratory well was drilled near the Chocolate Mountains, and it is reported to have cored oil sands with oil of about 35°-gravity. Since then geological and geophysical surveys have indicated the existence of good oil structures, and large areas have been leased. Drilling has begun and gas production has been reported. There has been new drilling in the Eureka area of Northern California, near some of the earliest producing wells of the State. Exploratory drilling for gas has been extended into the far northern end of the Sacramento Valley.

The great demand for natural gas has led to the drilling of many exploratory wells, and ten new gas-fields have been found since the beginning of 1943, but unfortunately, for present purposes, many of these are far from commercial pipe-lines. Old gas supplies have been developed.

Many of the heavy oil-fields have been extended. Most of them produce from depths of 800–3500 ft., the shallow drilling permitting rapid completions and the use of very mobile equipment.

Several new oil-producing zones have been found in the Wilmington field. A new discovery has been made at San Miguelito. Offshore drilling is proceeding at Ventura and Elwood, and there is directional offshore drilling at Huntingdon Beach.

A deep test has been drilled in the area of Peru Creek, but, like others in this neighbourhood, the well was a failure. A test in the El Segundo area gives evidence of being a commercial well. At Sunny Hills, midway between the East and West Coyote fields, a well gives promise of considerable development in that area. At Kern Bluff a field has been opened at a depth of a little over 1000 ft. A test in the San Emidio area is near old shafts used in mining pitch. The Bering pool at Del Valle was opened at a depth of 9629 ft. The deep discovery at Pleasant Valley produces from Eocene sands, and some feel that it will rival the Coalinga extensions. A deep test at Montebello has reported an oil showing below 10,000 ft., while the discovery well of the Lanare field came in below 9000 ft.

Tables list the oil and gas discoveries in California during 1943 and to June 1944, giving depth, production, and other data, and curves show the drilling and producing activity since 1936. G. D. H.

1398.* Canadian Oil Search Turns to New Areas. H. G. Cochrane. *World Petrol.*, August 1944, **15** (9), 30.—Three years ago Canada was using nearly 60,000,000 brl. of oil a year. About 17% of this was produced in Canada, mainly at Turner Valley. The Canadian production has risen from 1–2 million barrels in 1936 to a peak of 10·4 million barrels in 1942. At present new discoveries are failing to keep pace with depletion, and tax and other concessions have not encouraged drilling to the required extent. Turner Valley's daily output is declining, and has done so since 1942.

The Taber field now has 6 producers. Vermilion has 34 producers, compared with 13 in 1943, and its current output is nine times greater than a year ago.

1943 was a record year for geological and geophysical activity in Canada, and exploration is still intensive in Alberta and Saskatchewan.

Oil was discovered at Norman in 1919. In 1932 a small refinery was erected to refine the summer output of the 3 wells for use in the gold and radium fields. In 1942 approval was given for the drilling of further wells, the building of a pipe-line to Whitehorse, and the erection of a refinery there. At the close of 1943, 37 wells had been drilled at Norman Wells, 27 of them producing by natural flow. Depths ranged 1025–2700 ft., and bottom-hole pressure 700–900 lb./in.^{2} The oil is of 38·4 gravity, with 0·55% of sulphur. The probable productive area at Norman is 4000 acres, and recovery estimates are between 35 and 100 million barrels.

The Canadian Department of Mines and Resources has opened up 100 million acres of the north-west territories for leasing on generous terms.

Good surface showings are reported at Good Hope, 350 ml. north of Norman Wells, around Fort Simpson, and at Providence near the west end of Slave Lake.

Renewed efforts are being expended on the Athabaska tar sands. Only 2–5% of the 1500 sq. ml. tar-sand area has conditions suitable for the open-cut methods for the removal of overburden, which alone would permit economical production capable of competing with drilling methods elsewhere. Many problems remain to be solved.

G. D. H.

1399.* Significent Features of West Edmond Field. E. G. Dahlgren. *World Petrol.*, August 1944, **15** (9), 40.—The West Edmond field of Oklahoma has been defined on the east and west, and may be 12 ml. long. In the discovery well, completed in April 1943, the First Wilcox was met at 7508 ft., and the Second Wilcox at 7640–7690 ft., without oil. The well was plugged back to the Bois D'Arc section of the Hunton lime and completed for 365 brl. of oil in 12 hr. At the end of 1943 the field had produced 474,000 brl. of 41-gravity crude from 15 producers. On 9th July, 1944, there were 81 Hunton completions and 2 Bartlesville wells. It is estimated that 175 locations will be required to fill in the undrilled areas in the present proved area.

The average drilling time of the wells is about 60 days, and drilling contracts are on the basis of \$6·50 to \$7·50 per foot. Accepted casing practice includes 300–500 ft. of 5½–7-inch flow-strings, cemented with 700–1500 sacks. Careful drilling mud control has overcome various formational hazards.

During May pipe-line runs were 332,099 brl., making the total recovery to the beginning of June 1, 915,475 brl. Gas–oil ratios average about 1000–1200 cu. ft./brl., some wells being considerably higher. The gas appears to be from solution in the oil. Some salt water has been produced along the west edge of the field, indicating the possibility of a water drive. Recovery estimates have been placed 4000–9000 brl./acre. The original bottom-hole pressure was 3130 lb./in.^{2}, and the pressure had fallen to 2920 lb./in.^{2} on 27th April, 1944.

The discovery well log, a cross-section, and a table of the crude-oil characteristics are included. G. D. H.

1400. 1944 Exploration Below Goal, July Record Poor. L. J. Logan. *Oil Wkly*, 21.8.44, **114** (12), 53.—368 exploratory wells were completed in the U.S.A. during July 1944. 17·4% of them were productive, against 19·2% of those drilled during the first seven months of 1944. In general, the July discoveries seem to be below par in quality, for none at present indicates exceptional importance. During the first seven months of 1944 there were 2407 exploratory completions; in the same period of 1943 the figure was 1953. The expansion was less than the 30% expansion in all completions shown by 1944 relative to 1943. In 1944 19·2% of the exploratory tests have succeeded; in the same period of 1943 19% succeeded. New discoveries show an increase of 26% over last year, while extensions show an increase of 18%. Among the discoveries there have been relatively better results in opening new sources of distillate (60%) and gas (83%) than in opening new sources of oil (14·5%).

The booming West Edmond field of Oklahoma has been extended 3 ml. north, 1 ml. east, and 1 ml. north-east. In West Texas, extensions were recorded at Means (Andrews County), North-west Slaughter (Cochran County), Moore and Morita (Howard County). Elk Basin's Tensleep pay (Wyoming) has been extended ½ ml. south. In Illinois, three successful outpost tests in Edwards and Wayne Counties are tentatively classed as extensions, but may prove to be discovery wells of new McClosky limestone pools.

Two shallow pools were found in California in the Puente in a fault-trap on Lucky Baldwin Ranch, North Whittier Heights area, Los Angles County, and in the Olcese sand (Miocene) of the Ant Hill area, north of Edison field, Kern County. Some new fields and new pays were found in Illinois, Indiana, Kentucky, and Michigan. Kansas had three oil discoveries, all expected to be small. A distillate field was found in Arkansas, and two distillate fields in South Louisiana, together with several new pays and an oil-field extension. Texas had a comparatively poor month.

The July discoveries are listed, with pertinent information, and the exploratory drilling results during July and during the first seven months of 1944 are analysed by States and districts. G. D. H.

1401. Wells Completed in the United States in Week Ended 19th August, 1944. Anon. *Oil Wkly*, 21.8.44, **114** (12), 69.—369 fields wells (241 giving oil and 45 giving gas) and 65 wildcats (8 giving oil and 1 giving gas) were completed in U.S.A. in the week ended 19th August, 1944. The 1944 completions to the above date are 14,609.

The field and wildcat completions are analysed by States and districts for the week ended 19th August, 1944, and comparative totals are given for 1944 and 1943 for the lapsed part of each year to this date. G. D. H.

1402.* Wildcat Completions and Discoveries. Anon. *Oil Gas J.*, 26.8.44, **43** (16), 157. —9 oil-wells and 3 gas-wells were among the 77 wildcats completed in U.S.A. in the week ended 19th August, 1944.

A table summarizes the results of the completions by States and districts. G. D. H.

1403.* Summary of July Completions. Anon. *Oil Gas J.*, 26.8.44, **43** (16), 162.— During the four weeks ended 29th July, 1944, 2162 wells were completed in U.S.A. 1099 found oil and 259 found gas.

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

1404. Crude Oil Production Below Recent Peak. Anon. *Oil Wkly*, 28.8.44, **114** (13), 15.—During the week ended 26th August, 1944, the U.S. oil production averaged 4,676,585 brl./day, 13,600 brl./day less than the all-time record of the previous week. The aggregate output daily of Illinois, Kansas, Michigan, Montana, New York, and Wyoming fell by 20,000 brl. as compared with the week ended 19th August. Texas gave 2,108,900 brl./day, Oklahoma 342,000 brl./day, and the output of California rose by 8000 brl./day to 867,000 brl.

A table gives by States and districts the average daily outputs during the weeks ended 19th and 26th August, 1944. G. D. H.

1405. Sakhalin Island Has Good Possibilities. D. L. Carroll. *Oil Wkly*, 28.8.44, **114** (13), 28.—Sakhalin has an area of about 25,000 sq. ml., with oil resources in the northern half, in a belt along the east coast. This belt is some 20 ml. wide and about 250 ml. long, with oil in Miocene and Pliocene beds, the maximum thickness of which may be 30,000 ft. The belt is bounded on the west by metamorphosed Palæozoic rocks.

During 1943 the Sakhalin fields are said to have produced over 5 million brl. of oil, an estimate which is probably conservative.

The belt of Tertiary beds represents the uplift and folding of a relatively small segment of a geosyncline which has been receiving marine sediments continuously since Oligocene times. The Miocene and Pliocene sandstones, shales and sandy shales are folded and faulted along north–south trends, and all the oil occurrences found have been associated with anticlines. Seeps occur along fault-lines, and give rise to extensive areas of asphalt-cemented gravels. There is a basal Miocene conglomerate resting on an easterly-dipping Palæozoic surface. Oil is present in a thick shale series lying almost immediately above the basal conglomerate. Intercalated in the shale are lenses of sandstone and several extensive beds of pumiceous sandstone which are well-saturated with oil where penetrated by wells or seen in outcrops. The shale is probably of Middle Miocene age, and is likely to be the main source of the oil in this and higher formations of the Upper Miocene and Pliocene. Except in the northern half of the area, beds below the Pliocene have not been tested. The Pliocene has more than a dozen pays in its 10,000 ft. of sandstones, conglomerates, and shales. The bulk of the oil has come from Miocene beds overlying the Middle Miocene source rock, and has been obtained from Okha, Ehabi, Nutovo, and Katanguri, four of the largest fields.

The diplomatic history of the Sakhalin concessions is briefly described.

G. D. H.

1406. Colombia's Tibu Area Has Ten Producing Wells. Anon. *Oil Wkly*, 28.8.44, **114** (13), 50.—On 15th August, there were 8 shallow Tertiary producing wells and 2 deep Cretaceous producing wells in the Tibu area of the Colombia Petroleum Company's Barco concession. It lies 25–30 ml. north-west of the Petrolia field, and includes the former wildcatting areas of Tres Bocas and Socuavo. The deepest Tertiary wells are 5000 ft. deep, and average about 500 brl./day of 30–31-gravity oil.

The Cretaceous wells are 9228 ft. and 9850 ft. deep, giving distillate with very high gas–oil ratios.

Currently, Petrolia and Tibu are giving 13,500 brl./day. G. D. H.

1407. Wells Completed in the United States in Week Ended 26th August, 1944. Anon. *Oil Wkly*, 28.8.44, **114** (13), 55.—450 field wells (310 producing oil and 50 producing gas) and 90 wildcats (15 producing oil and 4 producing gas) were completed in U.S.A. in the week ended 26th August, 1944. During 1944, 15,168 wells have been drilled, compared with 11,784 in the corresponding period of 1943.

The completions are analysed by States and districts for the above week.

G. D. H.

1408.* Creole's Venezuelan Production Increased 86 per cent. Anon. *Oil Gas J.*, 2.9.44, **43** (17), 23.—At present Creole is producing over 400,000 brl./day in Venezuela.

The daily average production in the first half of 1944 was 351,000 brl., compared with 215,000 brl. in the first half of 1943. If the war continues, Creole expects further increases in production following completion of the Jusepin-Puerto La Cruz pipe-line towards the end of 1944, and the delivery of three new tankers in the spring of 1945.

Creole's income in the first half of 1944 was $31,800,000; in the first half of 1943 the income was $10,600,000. A large part of the income will be re-invested in Venezuela.

Income tax and royalty payments in the first half of 1944 were $16,000,000.

G. D. H.

1409.* Wildcat Completions and Discoveries. Anon. *Oil Gas J.*, 2.9.44, **43** (17), 87.—During the week ended 26th August, 1944, 50 wildcats were completed in U.S.A. 8 found oil and 2 found gas. 2451 wildcats have been drilled during 1944 to the above date.

The completions are analysed by States and districts for the week ended 26th August, 1944, and during 1944. G. D. H.

1410. Wells Completed in United States in Week Ended 2nd September, 1944. Anon. *Oil Wkly*, 4.9.44, **115** (1), 77.—375 field wells (263 giving oil and 34 giving gas) and 96 wildcats (18 giving oil and 2 giving gas) were completed in U.S.A. in the week ended 2nd September, 1944. The field and wildcat completion results are summarized by States and districts for the above week, and cumulative totals to date for this year and for the corresponding period of 1943 are given. G. D. H.

1411.* Colombian Production Declines Slightly. Anon. *Oil Gas J.*, 9.9.44, **43** (18), 40.—The June crude production in Colombia was 1,916,800 brl., compared with 2,086,000 brl. in May. The total for the first half of 1944 was 10,834,998 brl., the corresponding figure for 1943 being 3,561,442 brl. G. D. H.

1412.* West Edmond Field Presents Paradox. C. J. Deegan. *Oil Gas J.*, 9.9.44, **43** (18), 44.—The West Edmond field of Oklahoma is a simple stratigraphic trap. Its limits can be approximately determined in a general east–west direction. Production is from the Hunton limestone.

123 wells have been drilled over an area 9 ml. long and about 3 ml. wide. Most have had initial outputs of 25–100 brl./hr. Estimates of the producing area range 25,000–33,000 acres, and from May 1943 to September 1944 the production was 3,470,000 brl. Development is on a 40-acre spacing.

Examination of the Hunton producing areas of Oklahoma gives ultimate yields ranging 1700 brl./day to 10,000 brl./acre, mostly on 10-acre spacing.

The West Edmond field is deeper and of a different type from most other Hunton pools. Estimates of the ultimate yield per acre range 4000–9000 brl., and most of them are 5000–8000 brl. Hence the ultimate recovery estimates range 125 million to 210 million brl. With a 5000-brl./acre recovery it seems that the field will pay its way.

The oil is in the Bois d'Arc section of the Hunton at the tip end of a pinch-out. The pre-Pennsylvanian beds on the west flank of the Nemaha granite-ridge were bevelled, so giving the wedge-out below the Pennsylvanian. A stream-bed seems to have run east–west and completely eroded the Bois d'Arc along its channel, so that there are several dry holes in the heart of the field. It is possible that there is a fault in the same area. There are indications of greater porosity in the south than in the north.

The oil is highly paraffinic, and gives 32·3% of motor fuel fractions. It is high in lubricating fractions.

Stratum contour and isopach maps are included, together with production data and the crude-oil analyses. G. D. H.

1413.* Wildcat Completions and Discoveries. Anon. *Oil Gas J.*, 9.9.44, **43** (18), 123.—82 wildcats, 16 giving oil and 5 giving gas, were completed in U.S.A. in the week ended 2nd September, 1944. The completions are summarized by States and districts.

G. D. H.

1414. New Oil-Sand Discovered in Gebo Pool, Wyoming. Anon. *Oil Wkly*, 11.9.44, **115** (2), 13.—Tensleep production from 4880 to 4983 ft. has been found in the Gebo pool, Hot Springs County, Wyoming. Two wells had previously obtained oil from the Embar at 4680–4968 ft. G. D. H.

1415. U.S. Oil Production Hits Peak of 4,701,085 Barrels. Anon. *Oil Wkly*, 11.9.44, **115** (2), 16.—In the week ended 9th September, 1944, the U.S.A. oil production averaged 4,701,085 brl./day, a new record. The Texas average rose to 2,156,050 brl./day. Increases in output also took place in Illinois, Wyoming, Ohio, Pennsylvania, and Oklahoma, but these were offset by decreases in Kansas and California.

The daily average production is given by States and districts for the above week and the previous week. G. D. H.

1416. Creole's Venezuela Output Shows 86 per cent. Gain. Anon. *Oil Wkly*, 11.9.44, **115** (2), 46. See Abstract No. 1408. G. D. H.

1417. Drilling is Under Way in Dominican Republic. Anon. *Oil Wkly*, 11.9.44, **115** (2), 47.—At Commendador a well has reached 5200 ft., and another is at 4300 ft. Both are in the Oligocene. A 7000-ft. dry hole has been drilled in Haiti.

G. D. H.

1418. Wells Completed in United States in Week Ended 9th September, 1944. Anon. *Oil Wkly*, 11.9.44, **115** (2), 49.—384 field wells (249 giving oil and 48 giving gas) and 74 wildcats (12 giving oil and 1 giving gas) were completed in U.S.A. during the week ended 9th September, 1944.

The completion data are summarized by States and districts for the above week, with cumulative totals for 1944 to that data. G. D. H.

1419.* Wildcat Completions and Discoveries. Anon. *Oil Gas J.*, 16.9.44, **43** (19), 137.—During the week ended 9th September, 1944, 71 wildcats were completed in U.S.A. 13 found oil and 1 found gas.

A table summarizes the completions by States and districts. G. D. H.

1420.* Wildcat Completions and Discoveries. Anon. *Oil Gas J.*, 23.9.44, **43** (20), 317.—89 wildcats (13 giving oil and 3 giving gas) were completed in U.S.A. during the week ended 16th September, 1944. 2693 wildcats had been completed during 1944 to the above date.

The completions are summarized by States and districts. G. D. H.

1421.* Summary of August Completions. Anon. *Oil Gas J.*, 23.9.44, **43** (20), 318.—During the four weeks ended 26th August, 2305 wells were completed in U.S.A. 1200 produced oil and 191 gas, and there were 250 service wells. The total footage was 7,333,328 ft.

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

Geophysics.

1422. An Empirical Method of Interpretation of Earth-Resistivity Measurements. R. W. Moore. *Petrol. Tech.*, July 1944, 7 (4), A.I.M.M.E. Tech. Pub. No. 1743, 1–18.—A graphical method of analysing the data obtained from shallow earth-resistivity tests is presented. The method is based on empirical results, and has no theoretical basis. The usual apparent resistivity–electrode spacing curve is used together with a cumulative resistivity–electrode spacing curve plotted on the same sheet. The greatly reduced scale required for plotting the cumulative values of resistivity, together with the effect of the summation of the individual resistivity values, serves to minimize the effect of purely local surface anomalies and inadvertent errors of measurement. The point of intersection of tangents or straight lines drawn to intersect at zones of maximum curvature in the sumulative curve indicates the depth to the underlying material. Numerous figures are presented, in which data from published reports and from recent field studies are analysed, and the results compared with actual depths established by borings or with the depth value obtained by the use of theoretical methods of analysis. Smoothly rounded curves of apparent resistivity such as are often obtained in the field, and which have been a serious drawback to attempts to analyse the data empirically heretofore appear to be susceptible to rather accurate analysis by the method described.

The method is best suited to analyses involving shallow two-layer formations. It has, however, been successfully applied, in analysing the data obtained from tests made over shallow three-layer formations. As with most empirical methods, its chief advantage is its simplicity and ease of application. G. D. H.

1423.* Distant Offshore Seismic Survey Conducted in Gulf of Mexico. E. H. Short, *Oil Gas J.*, 26.8.44, **43** (16), 87.—Considerable geophysical work was begun close to the Gulf Coast shoreline in 1932 and led to the development of offshore production. In 1938 a field was established about 1 ml. offshore from Cameron Parish, Louisiana, and in 1941 a well was completed 1¾ ml. offshore from Jefferson County. The early geophysical work was within about 3 ml. of the shore. Now, seismic work has been extended to 26 ml. offshore. The equipment consisted of seven boats—recording boat, survey boat, two shooting boats, a back-sight boat, a utility boat for recovering the geophones, and an emergency boat.

The work is frequently in rough water, and requires men of excellent physique. Watch must be kept for sudden squalls.

The profiles were started from shore south of Cameron, Louisiana, and projected out into the Gulf.

The design of buoys to prevent the overnight shift of markers presented an important problem, in order to avoid the need for reshooting profiles. At the distant offshore stations the maximum depth of water was 44 ft. Floating backsights were designed. Ordinarily the backsights were set 1000–1500 ft. apart.

The survey boat works ahead of the recording and shooting boats. Each time the recording boat is anchored, two spreads are shot, one ahead of the recording boat and the other behind. The shooting boats come alongside the recording boat. One of the shooting boats plants the geophones, marking their locations by means of cork buoys. The two shooting boats then proceed to their location 2000 ft. from the recording boat. Telephone lines are strung. First one shooting boat fires its shot; then the other. Before the boats move the observer makes certain that good records have been obtained.

The usual explosive charge is 10 lb.

In shallow water geophones with long spikes were used; in deeper water the geophones were set in a truncated cement cone with a 14-in. base. The survey tower was constructed of airplane tubing, and had an overall height of 34 ft. It was built in sections to permit ease of transport. This tower was used when the water was calm and did not exceed 30 ft. in depth. G. D. H.

Production.

1424. A Series of Enthalpy-Entropy Charts for Natural Gases. G. G. Brown. *Petrol. Tech.*, July 1944, **7** (4), A.I.M.M.E. Tech. Pub. No. 1747, 1–12.—A series of enthalpy-entropy charts are presented for natural gases of 0·6, 0·7, 0·8, 0·9, and 1·0 gravity over the pressure range of 5000–10,000 lb./in.^{2}, and the temperature range of 32–700 F. These charts indicate directly the work requirement and temperature rise for adiabatic compression or temperature change for free expansion of natural gases. The mode of computation and the uses of the charts are described. G. D. H.

1425. Prediction of Conditions for Hydrate Formation in Natural Gases. D. L. Katz. *Petrol. Tech.*, July 1944, **7** (4), A.I.M.M.E. Tech. Pub. No. 1748, 1–10.—Each natural gas under a given pressure will form solid hydrates at a certain temperature, provided sufficient water is present. The temperature of natural gases below about 5000 lb./in.^{2} decreases when the gases are expanded freely. This decrease in temperature may cause the expanding gas to enter the region of temperature and pressure at which hydrates will form. The final pressure to which a natural gas may be expanded without hydrate formation depends on the initial temperature and pressure and the gas composition.

Charts for predicting the pressure to which natural gases may be expanded without hydrate formation have been prepared for gases of even gravity. Pressure-temperature curves for hydrate formation were established for gases having gravities from 0·6 to 1·0. These curves and the thermal behaviour of the gases during free and adiabatic expansion were used to prepare the charts for estimating the permissible expansion of natural gases without hydrate formation.

A number of examples of the use of the charts are given. G. D. H.

1426. Patents on Drilling and Production. W. M. Zaikowsky, assignor, by mesne assignments, to Consolidated Engineering Corporation. U.S.P. 2,346,203, 11.4.44. Appl. 7.12.40. Well logging method.

E. F. Raymond. U.S.P. 2,346,233, 11.4.44. Appl. 24.4.42. Gun perforation in wells.

W. Brauer. U.S.P. 2,346,248, 11.4.44. Appl. 29.5.41. Means for flowing liquid from wells.

F. W. Harris, assignor to Patco, Inc. U.S.P. 2,346,301, 11.4.44. Appl. 5.9.39. Apparatus for expanding drill pipe protectors.

E. J. Protin and J. E. Simonin. U.S.P. 2,346,392, 11.4.44. Appl. 15.11.41. Well-casing and method of making it.

A. D. Garrison, assignor to Texaco Development Corporation. U.S.P. 2,346,481, 11.4.44. Appl. 27.11.40. Determination of underground strata.

W. A. O'Bannon. U.S.P. 2,346,602, 11.4.44. Appl. 17.2.41. Separator for well pumps.

E. W. Bennison, assignor to E. E. Johnson, Incorporated. U.S.P. 2,346,647, 18.4.44. Appl. 28.11.40. Well-screen.

R. E. Millican, assignor of fifty-four and one-half per cent. to Carlton Meredith. U.S.P. 2,346,777, 18.4.44. Appl. 16.2.42. Flow device.

E. E. Roper, assignor to Stanolind Oil and Gas Company. U.S.P. 2,346,789, 18.4.344. Appl. 15.6.42. Well logging.

H. O. Williams and A. A. Jens, assignors to E. E. Johnson Inc. U.S.P. 2,346,885, 18.4.44. Appl. 15.4.40. Deep-well screen.

T. B. Lewis, assignor of one-third to James C. Davis, Jr., and one-third to F. N. Lewis. U.S.P. 2,347,115, 18.4.44. Appl. 18.11.41. Derrick construction.

O. L. Bishop. U.S.P. 2,347,240, 25.4.44. Appl. 10.6.41. Well-pump.

G. A. Raynor, assignor of one-half to C. L. Staub. U.S.P. 2,347,281. 25.4.44. Appl. 3.9.44. Oil-well testing device.

O. E. Barstow, assignor to the Dow Chemical Company. U.S.P. 2,347,589, 25.4.44. Appl. 2.9.41. Liquid level indicating system for use in treating wells.

P. G. Shelley, assignor to the Dow Chemical Company. U.S.P. 2,347,615, 25.4.44. Appl. 2.3.42. Apparatus for treating wells.

R. G. Taylor, assignor to the Guiberson Corporation. U.S.P. 2,347,620, 25.4.44. Appl. 2.4.41. Surface-operated flowing means for wells.

D. W. Auld and L. J. Weber, assignors to Phillips Petroleum Company. U.S.P. 2,347,726, 2.5.44. Appl. 29.8.39. Wire-line pressure-retaining core-barrel.

L. W. Benz, assignor to Phillips Petroleum Company. U.S.P. 2,347,729, 2.5.44. Appl. 24.6.41. Well-tool.

L. L. MacWilliams, assignor to Phillips Petroleum Company. U.S.P. 2,347,746, 2.5.44. Appl. 17.1.41. Method of measuring fluid flow.

T. C. Wherry, assignor to Phillips Petroleum Company. U.S.P. 2,347,759, 2.5.44. Appl. 29.3.41. Fishing tool.

W. J. Crites, assignor to Phillips Petroleum Company. U.S.P. 2,347,768, 2.5.44. Appl. 4.4.41. Apparatus for producing wells.

W. J. Crites, assignor to Phillips Petroleum Company. U.S.P. 2,347,769, 2.5.44. Appl. 27.9.41. Secondary recovery apparatus.

W. A. Heath, assignor to Phillips Petroleum Company. U.S.P. 2,347,778, 2.5.44. Appl. 10.11.41. Method of recovering hydrocarbons.

W. A. Heath, assignor to Phillips Petroleum Company. U.S.P. 2,347,779, 2.5.44. Appl. 7.4.42. Well apparatus.

R. G. Piety, assignor to Phillips Petroleum Company. U.S.P. 2,347,794, 2.5.44. Appl. 15.3.41. Well-surveying device.

W. J. Crites, assignor to Phillips Petroleum Company. U.S.P. 2,347,812, 2.5.44. Appl. 15.3.41. Drivehead.

W. E. Cummins. U.S.P. 2,347,887. 2.5.44. Appl. 18.1.43. Dual pump.

F. A. Gruetjen, assignor to A. O. Smith Corporation. U.S.P. 2,348,004, 2.5.44. Appl. 28.4.41. Oil-well pumping outfit.

L. Yost, assignor to A. O. Smith Corporation. U.S.P. 2,348,046, 2.5.44. Appl. 1.5.41. Ball-thrust bearing for well-drilling units.

L. Yost, assignor to A. O. Smith Corporation. U.S.P. 2,348,047, 2.5.44. Appl. 1.5.41. Mud turbine and method of assembling the same.

L. S. Chambers. U.S.P. 2,348,192. 9.5.44. Appl. 13.1.40. Method for evaluating flow characteristics of wells.

C. E. Bridwell. U.S.P. 2,348,241, 9.5.44. Appl. 26.8.41. Oil-well pumping means.

H. C. Lawton, assignor to Shell Development Company. U.S.P. 2,348,484, 9.5.44. Appl. 31.10.41. Method of sealing off porous formations.

H. C. Otis. U.S.P. 2,348,563, 9.5.44. Appl. 2.8.40. Well-tool.

H. C. Otis. U.S.P. 2,348,564, 9.5.44. Appl. 2.8.40. Well-device.

W. L. Church. U.S.P. 2,348,959, 16.5.44. Appl. 5.7.41. Well-pump.

D. G. C. Hare, assignor, by mesne assignment to the Texas Company. U.S.P. 2,340,041, 16.5.44. Appl. 29.8.41. Signalling device for gun perforators.

E. A. Means, assignor to Lubri-Gel Products Company. U.S.P. 2,349,049, 16.5.44. Appl. 4.8.40. Salt-water drilling mud.

E. A. Means. U.S.P. 2,349,050, 16.5.44. Appl. 28.2.42. Control and prevention of caving and sliding in drilling oil- and gas-wells.

L. C. Uren, assignor to The Texas Company. U.S.P. 2,349,062, 16.5.44. Appl. 27.3.42. Method and apparatus for gravelling wells.

W. E. Gilbert, assignor to Shell Development Company. U.S.P. 2,349,164, 16.5.44. Appl. 20.7.42. Bottom-hole intermitter for pumping wells.

W. B. Lerch and E. J. Gatchell, assignors to Phillips Petroleum Company. U.S.P. 2,349,181, 16.5.44. Appl. 19.5.38. Method of sealing or fixing casing tubes in wells.

S. A. Scherbatskoy, R. E. Fearon and J. Neufeld, assignors to Well Surveys Incorporated. U.S.P. 2,349,225, 16.5.44. Appl. 15.9.41. Well-logging instrument.

C. A. Moon, assignor to Socony-Vacuum Oil Company. U.S.P. 2,349,366. 23.5.44. Appl. 12.3.42. Method for geophysical prospecting.

C. C. Bancroft. U.S.P. 2,349,536, 23.5.44. Appl. 7.11.41. Apparatus for preventing clogging of oil-wells.

R. L. Chenault, assignor to Gulf Research and Development Company. U.S.P. 2,349,649, 23.5.44. Appl. 21.2.41. Oil-well pump and the like.

I. J. McCullough. U.S.P. 2,349,666. 23.5.44. Appl. 10.2.40. Perforator gun with improved projectile restraining means.

B. Pontecorvo, assignor to Well Surveys, Incorporated. U.S.P. 2,349,753. 23.5.44. Appl. 5.2.42. Method and apparatus for geophysical exploration.

R. D. Dawson and C. F. Blankenhorn, assignors to Shell Development Company. U.S.P. 2,350,154. 30.5.44. Appl. 5.5.43. Non-aqueous drilling fluid.

J. W. Menhall. U.S.P. 2,350,364. 6.6.44. Appl. 17.3.41. Deep well drilling apparatus.

G. A. Smith, assignor to Sperry-Sun Well Surveying Company. U.S.P. 2,350,371. 6.6.44. Appl. 23.7.40. Borehole logging apparatus.

C. M. O'Leary. U.S.P. 2,350,472. 6.6.44. Appl. 7.2.42. Intermitter.

F. M. Milek, assignor of fifty per cent. to Alexander Healy, Jr., U.S.P. 2,350,692. 6.6.44. Appl. 28.12.43. Fishing tool.

E. C. Brumleu and W. E. Gilbert; said Gilbert assignor to Shell Development Company. U.S.P. 2,350,973. 6.6.44. Appl. 30.10.43. Pressure-actuated tubing anchor.

C. P. Collins, assignor of one-half to Eastman Oil Well Survey Company, and one-half to Eastman Oil Well Survey Corporation. U.S.P. 2,350,986. 13.6.44. Appl. 4.5.43. Deflecting drill bit.

M. De Groote and B. Keiser, assignors to Petrolite Corporation Ltd. U.S.P. 2,351,017. 13.6.44. Appl. 26.10.42. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser, assignors to Petrolite Corporation Ltd. U.S.P. 2,351,018. 13.6.44. Appl. 20.11.42. Process for breaking petroleum emulsions.

R. E. Fearon, assignor to Well Surveys Incorporated. U.S.P. 2,351,028. 13.6.44. Appl. 17.9.41. Well surveying method and apparatus.

M. F. Aloi. U.S.P. 2,351,179. 13.6.44. Appl. 22.2.43. Well casing perforator.

L. A. Blackburn. U.S.P. 2,351,183. 13.6.44. Appl. 25.11.41. Long stroke deep oil well pumping jack unit.

C. C. Brown and J. J. Hastik, assignors to Brown Oil Tools Incorporated. U.S.P. 2,351,187. 13.6.44. Appl. 5.6.41. Pipe cutter.

W. L. Childs, J. F. Shaw and W. B. Noble, assignors to Reed Roller Bit Company. U.S.P. 2,351,320. 13.6.44. Appl. 12.10.39. Rock bit.

W. St. Maur E. Crake, assignor to Shell Development Company. U.S.P. 2,351,322. 13.6.44. Appl. 13.1.42. Bottom hole regulator.

E. L. Miller and R. W. Brown, assignors to Chicago Pneumatic Tool Company. U.S.P. 2,351,357. 13.9.44. Appl. 30.9.42. Bearing for rock bits.

F. W. Jessen and J. L. Battle, assignors to Standard Oil Development Company. U.S.P. 2,351,434. 13.6.44. Appl. 5.1.43. Use of pecan hulls for treating muds.

T. T. Thigpen, assignor to Shell Development Company. U.S.P. 2,351,576. 13.6.44. Appl. 28.1.43. Polished rod pumper jack.

R. O. Anderson. U.S.P. 2,351,654. 20.6.44. Appl. 7.4.41. Draw works.

L. W. Blau and G. E. Cannon, assignors to Standard Oil Development Company. U.S.P. 2,352,247. 27.6.44. Appl. 4.6.38. Thermal well-logging.

R. L. Carruthers. U.S.P. 2,352,370. 27.6.44. Appl. 6.12.40. Derrick support for underwater drilling.

W. L. Church, assignor of one-half to C. Ware. U.S.P. 2,352,423. 27.6.44. Appl. 2.12.40. Packer assembly.

G. Herzog, assignor to the Texas Company. U.S.P. 2,352,433. 27.6.44. Appl. 12.2.43. Well logging.

H. P. Salverda, assignor of one-half to F. J. McCarron and A. McCarron Loftus. U.S.P. 2,352,453. 27.6.44. Appl. 29.4.42. Well tool extracting device.

T. W. Burnam. U.S.P. 2,352,468. 27.6.44. Appl. 24.11.41. Drilling fluid.

A. H. N.

Transport and Storage.

1427. Possibility of Converting the Large-Diameter War Emergency Pipe-Lines to Natural Gas Service After the War. S. A. Swensrud. *Petrol. Tech.*, July 1944, 7 (4), A.I.M.M.E., Summary of contribution No. 135, 1–2.—The 24-in. crude-oil line and the 20-in. petroleum-products line, built as a war emergency, and running from Texas to the New York–New Jersey–Philadelphia area, raise many complications as regards keeping them in crude-oil or petroleum products service. A probable surplus of tankers after the war causes most companies to feel that they can attain lower costs and more satisfactory results from the resumption of tanker movements to the East Coast rather than by trying to take over or to utilize the capacity in the large pipe-lines under some tariff-rate structure.

At or near the source of the lines lies one of the greatest developed gas reserves in the world, for much of which there is at present no satisfactory market outlet; at the other end of the lines lies one of the greatest concentrations of population in the world, which is not now served by natural gas. An analysis of the market potentialities and comparison with other areas where natural gas is being distributed, and where it has displaced manufactured gas, makes it seem clear beyond question that the full capacity of both of the large-diameter lines could be fully utilized in this service, and this without creating any undue drain upon the gas reserves of the nation. On the basis of an estimated capacity of 100–120 billion cubic feet per year, the gas that might be marketed through these lines would amount to only 3–4% of the total consumption of natural gas in U.S.A.; it would be less than one-eighth of the quantity of gas used annually in Texas for industrial purposes other than oil refining.

The direct cost of putting gas through the lines would be only about 5 c. per M. cu. ft. The main costs would be the indirect items of taxes, depreciation, and return on investment, which, together with reasonable allowances for gas-storage costs, contingencies, etc., are estimated to bring the total throughput cost up to about 20 c. per M. cu. ft., on the basis of a 75% load factor. It seems reasonable to assume that the cost of gas at the source would be approximately 5 c. per M. cu. ft. On the basis of these costs it is undoubted that attractive rates to customers could be established, comparable with rates in other central eastern areas where conversion to natural gas has occurred.

The use of both lines would be a safeguard against emergency interruptions. Gas compressor stations would have to be installed. G. D. H.

Gas.

1428.* Oriskany Natural Gas. A. J. S. Headlee and J. L. Hall. *Industr. Engng Chem.*, 1944, **36** (4), 299.—Several natural gas-wells have been discovered in the Oriskany sand, and one of these fields has produced 600 billion cubic feet of gas since January 1944. The composition of the gas from the Oriskany sand varies from almost pure methane to gases consisting of 85% methane associated with 12–15% ethane. From some wells retrograde condensate is produced which consists of C_3–C_8 hydrocarbons. A yield of 1500 gallons of distillate per million cubic feet of gas is obtained. J. W. H.

Cracking.

1429. Effect of Catalytic Cracking on the Postwar Supply of Motor Gasolines and Distillate and Residual Fuels. W. G. Moore and T. G. Elder. *Petrol. Tech.*, July 1944, **7** (4), A. I.M.M.E. Tech. Pub. No. 1731, 1–8.—See Abstract No. 880.

1430.* Thermal Reforming for Olefin Production. G. Egloff. *Oil Gas. J.*, 29.7.44, **43** (10), 157.—Thermal reforming operations were carried out on straight-run gasolines and naphthas and blends in a single-coil pilot plant under varying pressures, temperatures, and charging rates to determine the effects of these variables upon the yields of olefins and on the yields and octane numbers of the gasolines produced. The yields of olefin polymers obtainable from the C_2–C_5 olefins have been calculated on the basis of plant data from H_3PO_4 catalytic polymerization to produce *iso*-octenes which are hydrogenated to *iso*-octanes, and codimers which are converted into hydrocodimers. The alkylates producible from the olefins by HF or H_2SO_4 alkylation with *iso*butane have been calculated on the assumption that (1) all were used for alkylation and none for polymerization, (2) any additional *iso*butane requirements were available from other sources.

Seven tables give the data from reforming operations on Californian and Mid-continent straight-run gasolines and naphthas under increasing temperatures, pressures, and charging rates; and their effects are discussed in each case. Marked increases of gaseous olefins for use in subsequent syntheses can be obtained by increasing the intensity of reforming conditions employed on gasolines and naphthas. Optimum yields of butylenes correspond to temperatures ranging from 1100 to 1200° F., and pressures from 100 to 300 p.s.i., depending on the composition and boiling range of the charging stocks. At the present time such stepped-up operations are well worth while, in view of the increased yields of olefins and the higher octane numbers of the gasolines. The aromatic contents of the liquid products are also higher, although apparently maximum aromatic production is obtained at somewhat higher pressures than those giving the best yields of olefins. W. H. C.

1431.* Improvement of Octane Rating of Gasoline by Isomerization. A. V. Frost. *Oil Gas J.*, 29.7.44, **43** (10), 165.—In this paper, the thermodynamics of catalytic isomerization of hydrocarbons—butane to octane, and *cyclo*hexane to methyl*cyclo*pentane—is discussed. Data on the equilibrium constants of isomerization, entropies, and the octane numbers of these hydrocarbons, recorded and calculated by the author, are correlated. Literature references are quoted which establish that the effect of catalysts of the $AlCl_3$ type in isomerization consist of partial conversion of straight-chain paraffins into *iso*paraffins. Isomerization reactions are reversible, the conversion of a paraffin hydrocarbon into an *iso*paraffin proceeds until a definite equilibrium of the hydrocarbon mixture is established for a given temperature. As isomerization in the presence of $AlCl_3$ type catalysts does not form isomers containing quaternary carbon atoms (gem substitutes), octane numbers were calculated for mixtures in which all the isomers are at equilibrium, with the exception of those containing quaternary carbon atoms; in addition, octane numbers were calculated consisting of equal amounts of pentanes, hexanes, heptanes, and octanes, the isomers of which are in equilibrium. These are shown in the tables and in graphs. The data indicate that octane numbers of equilibrium mixtures of paraffins decrease with rise of temperature the more rapidly the higher is the molecular weight of the hydrocarbon. For the mixtures of methyl*cyclo*pentane with *cyclo*hexane the octane numbers of which are close, practically no change of the octane number with temperature occurs. The presence of hydrocarbons with quaternary carbon atoms greatly affects the octane number of the equilibrium of the hydrocarbons. From the data presented, it follows that to obtain saturated gasolines with octane numbers above 70, by isomerization of low-octane charge stocks: (1) isomerization with catalysts that are unable to form gem-substitutes should be carried out at temperatures below 170°; (2) isomerization with catalysts that are able to form gem-substituted paraffins can be carried out at temperatures of 200–300°. W. H. C.

1432.* Cracking of Latin American Crude Oils No. 3.—Colon (Venezuela). G. Egloff. *Oil Gas J.*, 12.8.44, **43** (14), 76.—The producing areas of the Colon oil-fields are those of Tarra, Los Manueles, El Cubo, and Las Cruces, which are about 65 miles south-west of Lake Maracaibo. This paper gives the results of cracking: (1) the residue of, and (2) a distillate obtained from, the same residue from the primary distillation, (3) the reforming of the gasoline produced in the primary distillation.

Colon crude oil is paraffinic in character, it has a specific gravity of 0·8686, and a sulphur content of 0·89%, and yields 22·2% gasoline of 400° F.E.P. and 49·0 N.; 13·6% kerosine; 21·9% gas oil, of 60 C.N.; and 42·1% residue.

The residue (sp. gr. 0·9421) was cracked in a two-coil pilot plant by recycle operation. Two runs were made at different charging rates to obtain 375° F.E.P. gasolines, and (1) a normal fuel residue; (2) a heavy residue. The temperatures and pressures maintained were 890° F. at 140 p.s.i. and 950° F. at 30 p.s.i., at the heavy and light coil exits, respectively. The yields were 35·1% gasoline and 59·2% residue for operation (1), and 48·9% gasoline and 35·0% residue for operation (2). The octane numbers of the gasolines were around 70.

The gasoline from the less intense cracking, (1) was treated with 2 lb. H_2SO_4/brl. neutralized with caustic soda and then re-run with steam to a maximum temperature of 350° F. and sweetened by plumbite, giving a satisfactory product of gum content, without inhibitor of 3 mg.; and an induction period, with 0·025% No. 1 inhibitor of 576 minutes. A 65% distillate from the distillation residue was cracked in the pilot plant described, without recycling. Three runs were made under the following conditions : at 910–950° F., and 150 p.s.i. and 350 p.s.i., respectively, for the light and heavy coil outlets, but with different cracking intensities by reducing the charge rate. The yields were :

Yield vol.-% of charging stock.	1.	2.	3.
Gasoline	53·0	58·6	59·4
Residue	37·9	32·8	31·9

The octane number of the three gasolines were around 70, the viscosities of the residues (2) and (3) conformed to the No. 6 A.S.T.M. fuel specification. The gasoline from operation (2) was refined with acid and caustic soda and re-run as described earlier, giving a similar product.

The straight-run gasoline was reformed in a pilot plant operated so that all cracking and reforming reactions took place in the heating coil, quenching being employed in the transfer line. Two runs were made at 1000° F. and 500 and 750 p.s.i., respectively, to produce gasolines of different octane numbers, the lower yield being obtained at the highest pressure. The yields were :

Yield vol.-% of charging stock.	1.	2.
Gasoline	86·8	82·2
Residue	1·4	1·3
Liquid volume loss	11·8	15·9

The reformed gasolines had octane numbers of 64 and 69, and the residues contained 13·5% and 27%, respectively, of 400° F. end point materials. The 69 octane gasoline was refined with 1 and 2 lb./brl. of 43% acid, neutralized, and redistilled in the manner already noted. The properties of the untreated and treated reformed gasolines were :

	Treatment.		
	None.	1 lb. acid.	2 lb. acid.
Sulphur, %	0·3	0·01	0·01
Gum, mgr./100 ml. copper dish—			
with inhibitor	10	1	1
with 0·025% No. 1 inhibitor	2	2	1
Reid vapour pressure, p.s.i.	9	9	—
Induction period, minutes—			
without inhibitor	265	275	730
with 0·025% No. 1 inhibitor	490	1000	1000
Octane number (A.S.T.M.)	69	68	67

W. H. C.

1433. Patents on Cracking. J. D. Danforth. U.S.P. 2,339,247, 18.1.44. Appl. 8.1.40. A hydrocarbon oil is contacted with a catalyst consisting of silica and small proportions of zirconia and boric oxide to effect conversion.

J. D. Danforth. U.S.P. 2,339,250, 18.1.44. Appl. 30.9.40. Hydrocarbons are subjected under conversion conditions to contact with a catalyst produced by impregnating calcined particles of silica, alumina, and zirconia with a boron compound and decomposing the boron compound into boric oxide.

G. C. Connolly. U.S.P. 2,339,838, 25.1.44. Appl. 9.1.42. Hydrocarbon oils are heated to cracking temperature and afterwards contacted with a catalyst consisting essentially of titania gel containing boria.

W. J. Mattox. U.S.P. 2,340,007, 25.1.44. Appl. 26.12.42. A normally liquid olefinic hydrocarbon may be converted into substantial yields of normally gaseous olefinic hydrocarbons, including propylene and butylene, by subjection to cracking conditions in the presence of a catalyst composed essentially of aluminium sulphate and alumina.

J. C. Baillie and M. J. See. U.S.P. 2,343,295, 7.3.44. Appl. 26.4.41. Hydrocarbon oils are contacted at conversion temperatures with a catalyst consisting essentially of active magnesia and active silica. The catalyst contains more than 15% and less than 30% of magnesia, and is prepared by intimately admixing finely divided magnesia with silica hydrogel, and afterwards drying and igniting the resulting mixture.

G. Egloff. U.S.P. 2,343,649, 7.3.43. Appl. 31.7.40. In a process for the conversion of hydrocarbon oil a naphtha is catalytically reformed in the presence of a powdered dehydrogenating catalyst. At the same time a gas oil is catalytically cracked, and afterwards conversion products containing catalysts are combined. The mixture is further converted in a reaction chamber, and the resulting products are separated into liquid residue containing the catalysts, and cracked vapours. The cracked vapours are fractionated to form light and heavy reflux condensates. Fractionated vapours are recovered, and the heavy reflux condensate is returned to the reforming stage of the process. The light reflux is thermally cracked, and the products are passed to the reaction chamber.

J. C. Baillie and M. J. See. U.S.P. 2,343,731, 7.3.44. Appl. 5.2.40. Hydrocarbon oils are converted by contacting their vapours at conversion temperatures with a catalyst consisting essentially of a physical mixture of magnesia and silica. To prepare the catalyst, magnesia is intimately mixed with finely pulverized silicon dioxide, and the mixed oxides are made wet with water. In this way particles are cemented at their points of contact with an intergranular material. Finally the resulting product is dried and ignited.

J. M. Barron. U.S.P. 2,343,848, 7.3.44. Appl. 31.12.40. In a process for cracking and coking hydrocarbon oils, cycle condensate is passed to a heating zone and heated to cracking temperature. The resultant heated products are combined with the oil which is to be cracked in a reaction zone in which vapours are separated from liquid residue, and in which cracking conditions of temperature and pressure are maintained. Liquid residue is withdrawn from the zone, together with a portion of the vapours, and passed to a coking zone, in which conversion into coke residue takes place. The proportion of vapours withdrawn is sufficient to effect autogenous coking of the mixture. Vapours evolved from the coking zone are passed to a dephlegmating zone, and thence to a second dephlegmating zone. Vapours withdrawn from the reaction zone are delivered to the second dephlegmating zone, and a charging stock is introduced. The resulting mixture of reflux condensate and unvaporized charging stock is passed to the first dephlegmating zone to dephlegmate vapours. Reflux condensate and unvaporized charging stock are withdrawn, and a portion is cycled back to the first dephlegmating zone to increase the liquid flow therein and prevent coking. Vapours from the second dephlegmating zone are further fractionated to separate a reflux condensate fom lighter products, and this condensate is passed to the initial heating zone.

A. V. Grosse and J. C. Morrell. U.S.P. 2,343,851, 7.3.44. Appl. 29.11.39. To produce low-boiling aromatic hydrocarbons from hydrocarbon oils heavier than gasoline and containing aromatics, the initial material is subjected to a non-hydrogenating cracking and dehydrocyclization treatment in the presence of an oxide of an element from the left-hand column of Group V of the Periodic Table admixed with a cracking catalyst. The catalyst consists of a major proportion of silica and a smaller proportion of alumina.

A. V. Grosse and J. C. Morrell. U.S.P. 2,343,852, 7.3.44. Appl. 29.11.39. To produce low-boiling aromatic hydrocarbons from hydrocarbon oils heavier than gasoline and containing aliphatics, the latter are subjected to a non-hydrogenating cracking and dehydrocyclization treatment in the presence of an oxide of an element from the left-hand column of Group VI of the Periodic Table, admixed with a cracking catalyst consisting of a major proportion of silica and a minor proportion of alumina.

H. B. M.

Hydrogenation.

1434.* Catalysis of the Liquid-Phase Stage of Coal Hydrogenation. N. Booth. *J. Soc. Chem. Ind.*, 1944, **63**, 1–3.—The most effective catalyst in the liquid phase hydrogenation of coal is tin. Evidence is discussed supporting the hypothesis that the tin compound catalyst is first reduced to the metal which alloys with the iron of the converter walls and then catalyses the reaction. This hypothesis had led to an investigation, by the Fuel Research Station, of the catalytic efficiency of tin/iron alloys, and it has been found that they can be better, and possibly more economical, than a good standard catalyst such as stannous hydroxide. Increasing the surface area or porosity of the alloy by treatment with 15% sulphuric acid results in an increased catalytic efficiency. T. C. G. T.

1435. Patent on Hydrogenation. W. Kroenig, W. V. Fuener, and G. Grassl. U.S.P. 2,338,119, 4.1.44. Appl. 21.1.41.—In the production of a hydrocarbon oil from a high-boiling carbonaceous substance by catalytic destructive hydrogenation, the conversion is carried out in the presence of a catalyst containing iron. The catalyst is prepared from a carrier substance and a titanium salt which is soluble in water and dilute acid. It is selected from the group consisting of titanium sulphates and complex organic titanium salts. H. B. M.

Polymerization and Alkylation.

1436. Patent on Polymerization and Alkylation. L. S. Kassel. U.S.P. 2,338,248, 4.1.44. Appl. 29.12.41. In a process for synthesizing hydrocarbons, an *iso*paraffin is alkylated with an olefin in the presence of a mixture of hydrogen fluoride and sulphur dioxide. H. B. M.

Refining and Refinery Plant.

1437.* Caustic Embrittlement in Boilers. P. Hamer and E. W. Colbeck. *Chem. and Ind.*, 1944, 163.—For the incidence of caustic embrittlement of steel it is necessary to have caustic soda in concentrations between 15% and 50% and at temperatures in excess of 70° C. Caustic embrittlement of steam raising boilers will therefore occur only if caustic alkalinity is present and can be concentrated by evaporation of seepage through, for instance, rivet holes. Such leakage, in addition to allowing the caustic alkalinity to concentrate, permits this to happen at a point of metallic stress which favours the process. So far there is no recorded case of embrittlement of an all welded or solid forged boiler drum.

A short discussion on inhibitors concludes that Na_2SO_4 is still the most reliable additive, and that embrittlement does not occur when the ratio $Na_2SO_4/NaOH$ is maintained above 2·5. The authors are not completely satisfied with evidence in support of $NaNO_3$ though acknowledgment is made of American claims for this salt and for tannins and lignins.

The article concludes with a warning that serious notice should be taken of small leaks from boilers. T. C. G. T.

1438.* An Automatic Control for Lime-Soda Water Softening. F. A. Champion. *J. Soc. Chem. Ind.*, 1944, **63**, 204–208.—It has been shown by laboratory experiments that a conductivity cell can be used to measure simultaneously the hardness and rate of flow of certain variable waters, and hence the quantity of reagents required for softening these waters. Possible methods are suggested for using the variation in resistance of a suitably designed conductivity cell for the operation of the dosing gear through a thermionic relay. No actual water-softening experiments or large-scale trials of the proposed method have been made. C. F. M.

1439.* Automatic Detection and Control of Hydrogen Sulphide. J. Clough. *J. Soc. Chem. Ind.*, 1944, **63**, 210–213.—Discoloration by hydrogen sulphide of a paper screen impregnated with a solution of lead salt interrupts a beam of light falling on a photoelectric cell, and a relay is brought into action which operates the alarm bells and/or gas absorption plant. C. F. M.

1440.* Eddy Diffusion. A. A. Kalinske and C. L. Pien. *Industr. Engng. Chem.*, 1944, **36** (3), 220.—The mathematical theory of eddy diffusion developed by G. I. Taylor is confirmed by experiments on the turbulent flow of water in channels. The experimental technique employed was the injection of hydrochloric acid/alcohol solutions of density 1·0 into the stream, and the determination of the chloride concentration of samples taken at various selected points. The investigation covered the effect of various degrees of surface roughness and stream velocity. It is shown that the scale of turbulence enters directly into the eddy diffusion relationship. To predict diffusion in turbulent flow, it is necessary to know the eddy diffusion coefficient and the scale of turbulence. If direct determinations of these factors cannot be made, they may be estimated from the equations given. J. W. H.

1441.* Designing Condensers. R. E. Peck and L. A. Bromley. *Industr. Engng Chem.*, 1944, **36** (4) 312.—Conventional methods for condenser design involve tedious trial and error methods and the authors present a nomogram based on fundamental equations which permit the rapid solution of these problems. The derivation of the fundamental equations is discussed, and the use of the nomogram is illustrated in detail by the solution of two calculations, one for a vertical and one for a horizontal condenser. J. W. H.

1442.* Analysis of Filtration Data. D. R. Sperry. *Industr. Engng. Chem.*, 1944, **36** (4), 223.—A bibliography of filtration data is given and the derivation of the rate of flow formulæ discussed. The application of filtration formulæ to a design problem first requires a filtration analysis of the slurry, and experimental methods of making this examination are described and illustrated by actual data for a tungstic acid slurry. A simple method is given of finding the latus-rectum of the parabolic time-discharge curve. Analyses are given for twenty widely different slurries which include fuel oil and cutting oil. J. W. H.

1443.* Practical Refinery Engineering. No. 7. Heat Transfer Film Coefficients—Steam Condensing on Outside of Horizontal Tubes. M. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 5.8.44, **5** (13), 76.—The film coefficient of a one-component vapour condensing on the outside of horizontal tubes can be computed by the Nusselt equation. As the film temperature cannot be measured practically, a value for the temperature drop through the steam film must be assumed, and the thermal resistance obtained by the method of trial and error. The solution by trial and error can be rapidly made by the use of the chart given. Two examples and their solution illustrate the use of the chart.

This paper also discusses the more complex problem of mixed vapours that are usually met with in refinery operations. W. H. C.

1444.* Practical Refinery Engineering. No. 8. Heat Transfer Film Coefficients. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 12.8.44, **43** (14), 92.—In the calculation of the heat-transfer film coefficient for steam condensation on the inside or outside of tubes in horizontal or vertical exchangers two distinct types of condensations are differentiated—the film type, and dropwise condensations which give entirely different values for the film coefficient. The Nusselt derived equation used for the purpose is conservative, and gives values for the steam film coefficient which can ordinarily be attained in actual practice. As in some instances experimental work on vertical tubes has given results 30–50% greater than would be indicated by the Nusselt equation; in using this formula it is necessary to assume a value for the temperature drop through the steam film and evaluate for the thermal resistance by trial and error methods. Since thermal resistances are proportional to the temperature drops, this fact may be utilised to check the assumed value for the temperature drop through the steam film.

By the use of the chart presented these calculations are facilitated. Examples of the use of the chart and their solution are given. W. H. C.

1445.* Fischer–Tropsch Synthesis May Prove a Major Refining Process. Part I. A. L. Foster. *Oil Gas J.*, 19.8.44, **43** (15), 99.—A survey is given of the literature describing (*a*) the preparation of the basic reactants CO and H_2 by the water-gas and methane-steam reactions, (*b*) the method of synthesis, (*c*) theories advanced to explain the synthesis reaction, (*d*) chemical composition of the light fractions distilling up to 100° C., (*e*) methods employed to increase the yield of mono-olefins in Kogasin I (naphtha fraction), which include variation in the ratio of CO to H_2 in the feed and variation of catalyst, (*f*) the preparation of synthetic lubricating oils from the mono-olefins in Kogasin I and also from Kogasin II (gas oil fraction). A bibliography is appended. R. A. E.

1446.* The Refiners Notebook. No. 5. Eliminating Vapour Space in Storage Tanks. W. L. Nelson. *Oil Gas J.*, 19.8.44, 43 (15), 101.—Tank designs that nearly eliminate vapour space above the surface of the oil are of the following types: (1) Water-displacement tanks, (2) Floating roof, (3) Piston-type roof, (4) Wiggins floating roof, (5) Graver expansion roof.

Type (1) tanks are stated to be much used for naval fuel oil storage; some underground tanks are of this type.

Type (2)—a simple floating roof (pan-type roof) is shown by a diagram. The roof only covers the surface of the liquid; it has no space for the accumulation of vapour, and does not keep the vapour from escaping.

The Wiggons pontoon roof consists of a round, air-tight float in which the outer cover slopes towards the centre for draining water from rain or snow; the inner surface of the float slopes upwards to the centre, and so provides a space for the accumulation of any vapour. Diagrams of the sealing devices at the perimeter are shown: (1) for rivetted or lap welded tanks; (2) for butt-welded tanks. The seals are effective in eliminating vapour loss, except during a high wind.

A diagram of the seal of the Graver expansion roof is given. In this type of tank the roof rests in a separate oil-seal compartment rather than in the oil in the tank.

In gauging floating-roof tanks a correction must be included for the oil displaced by the roof—the volume of oil to be subtracted from the gauge reading may be computed by dividing the weight of the roof (plus any water or snow on it) by the density of the liquid without correction for temperature. The weight of each roof is stamped on the manhole. An example of such a correction is given. W. H. C.

1447.* Practical Refinery Engineering. No. 9. Heat Transfer Film Coefficients. Petroleum Gases and Vapours. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 19.8.44, 43 (15), 103.—The heat-transfer film coefficient for gases or vapour flowing inside tube or pipes is usually calculated by the Dittus–Boelter equation. A chart is given from which the thermal resistance of methane at 14·7 p.s.i. absolute pressure may be obtained. To use the chart it is necessary to know the mass velocity, average gas temperature, and the pipe diameter. Correction factors for hydrogen, ammonia, air, and carbon dioxide are given in a chart. For hydrocarbon gases at various temperatures and pressures the correction factors are given in a table. It is noted that for these conditions the calculated film resistances is only approximate, and consequently a safety factor should probably be provided for in actual design. The use of the chart and correction factors is shown by examples. W. H. C.

1448.* Fischer–Tropsch Synthesis May Prove a Major Refining Process. Part 2. Methods of Operation. A. L. Foster. *Oil Gas J.*, 2.9.44, 43 (17), 46.—A review is given of information on the Fischer–Tropsch synthesis based on sixty-five patents and twenty literature references on the subject. The ratio of CO : H_2, and particularly temperature control, are important factors in the three or four vital factors in any commercial application of the synthesis. An important advance appears to have been made in one patent—by the use of a "carried powdered catalyst" and with a heat remover, circulating through, or around the walls of the reaction chamber to remove the heat of reaction, and thus aiding the temperature control. Dispersion of gases in the liquid suspension catalyst must be very fine to maintain the required speed of the reaction. This requirement, however, increases the cost of pumping and handling over that in which the gases are passed through a solid catalyst bed. Sulphur in the gases should be limited to 0·1 g. per 3500 cu. ft. The catalysts employed include many metals of Group 8, mixed with other metals or their oxides of Series 4, Groups 1, 6, and 7, as promoters or activators. From the data it appears that nickel is not suitable for producing liquid hydrocarbons, as it gives mainly CH_4, and forms a carbonyl at high pressures which volatilizes. Cobalt does not form carbonyls at 750 p.s.i., but does so at 1470 p.s.i. Iron as metal produces hydrocarbons entirely and does not give oxygenated compounds, but with iron carbonyl or carbide some oxygenated material is formed. The product formed with iron catalyst is more unsaturated and of higher octane number than when other catalysts are used. The best results for synthesis with iron catalysts are obtained with a CO : H_2 ratio of 1 : 2. High-melting-point paraffin waxes (up to 134° C.) have been produced with a ruthenium catalyst. The synthesis of high anti-knock hydrocarbons, which has recently received much attention, and the conversion of natural gas is reviewed in relation to the references indicated. The operating conditions and catalysts are surveyed. The products formed vary greatly depending on the temperature and pressure used, and by varying the catalyst and operating conditions the products obtained may be mainly CH_4 to liquid hydrocarbons of wide or narrow range, or high-melting-point waxes. W. H. C.

1449.* Practical Refinery Engineering. No. 11. Pressure Drop through Heat Exchangers. P. Buthod and E. W. Whiteley. *Oil Gas J.*, 2.9.44, **43** (17), 56.—High fluid velocity through an exchanger produces the most efficient heat-transmission rates, but also increases the pressure loss. As the velocity of liquids through exchangers may vary according to whether gravity flow or pumping is operating, in calculating the heat-transfer rate, the pressure drop on both sides of the tubes must be considered. The total pressure drop of a tubular heat exchanger not only includes the friction loss in the tubes, but the header-box pressure losses which are caused by a combination of contraction, enlargement, and reversal of flow in each pass. Equations are shown for these functions. The data necessary for the calculations are the velocity (linear) and specific gravity of the liquid, and these are evaluated at the average fluid temperature between the two ends of the exchanger.

To facilitate calculations a chart is given, and its use is explained by two problems and their solution. W. H. C.

1450.* The Refiners Notebook. No. 7. Volatile-Liquids Storage. W. L. Nelson. *Oil Gas J.*, 2.9.44, **43** (17), 61.—Pressure storage and low-temperature storage are surveyed; high pressure requires heavy and costly construction; refrigeration entails expensive insulation and high cost maintenance. Economical storage lies between the two extremes. Five types of storage are outlined: (1) at atmospheric pressure, refrigeration being necessary; (2) at 2½–20 p.s.i.—spherical shapes and double-wall insulated tanks; (3) at 25–100 p.s.i.—spheres and horizontal or vertical cylindrical tanks; (4) 100 p.s.i. and upwards—horizontal cylindrical tanks (small or refrigerated) and cylinders; (5) 500 p.s.i. and upwards—cylinders and small heavy spheres. Refrigeration may also be employed with any of the types.

Selection of tanks is discussed, and a chart is given showing temperature °F./absolute pressure, curves for gasolines and natural gasolines of different vapour pressure; bottled gases; butadiene; the butanes; and propane. The chart also indicates the class of vessel suitable for storage of different products. Their economies of construction and the use of spherical tanks are briefly discussed.

W. H. C.

1451.* Practical Refinery Engineering. No. 12. Pressure Loss in Tubes of Heat Exchangers. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 9.9.44, **43** (18), 83.—Well-defined temperature gradients exist along the cross-sectional area of a fluid stream in a heat exchanger. This variation affects the viscosity, and therefore the velocity, and has to be considered in calculating the pressure loss. The type of fluid motion greatly affects both the pressure loss and the heat-transfer rates. Streamline and turbulent flow as designated by their Reynolds numbers are discussed, the former occurring in the range below Reynolds values of 2100. Turbulent flow which functions in the Reynolds range above 2100 permits greater heat-transfer rates; therefore exchangers are designed to work in the turbulent range of flow. The pressure loss on the tube side of exchangers consists of the header-box losses plus the friction losses through the tubes. A modified Fanning type of equation is shown and explained for the evaluation of the pressure loss. The calculation is, however, facilitated by the use of a chart based on the equation given. Two examples are shown to demonstrate its application. W. H. C.

1452.* Practical Refinery Engineering. No. 13. Pressure Drop—Shell Side of Tubular Heat Exchangers. P. Buthod and B. M. Whiteley. *Oil Gas J.*, 16.9.44, **43** (19), 91.—Calculation of the shell-side pressure drop is complicated by a number of factors which vary according to the particular design and method of fabrication used by the manufacturer. A modified form of the Fanning equation can be used for correlating the pressure loss. This involves specific gravities, baffle factor, number of tubes, the friction loss, and the equivalent linear velocity. Therefore, a mass velocity term is used for obtaining the two last factors. An equation is given for this purpose which corrects for the flow area of the varying cross-sections, the leakage between the baffles and the shell, and the leakage through the tube holes. A 15–25% safety factor should also be applied for other factors which affect the pressure loss. By the use of two charts—(1) friction factor; (2) pressure drop, constructed for flows through the shell-side of tubular exchangers—the pressure drop can be very easily obtained. Two practical examples are given. W. H. C.

1453.* Practical Refinery Engineering. No. 14. Heat Balances. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 23.9.44, 43 (20), 289.—In the computation of the heat load on exchangers and other heating equipment a knowledge of the specific heat of liquids or vapours at mean temperatures is required. A chart is presented from which the specific heats (at atmospheric pressure) over the temperature range 0–1000° F. can be directly read from the curves of (1) liquids of varying A.P.I. gravities, and (2) vapours of varying specific gravities (Air = 1) or A.P.I. gravities. This chart is constructed for an oil of characterization factor 11·8, but can be used for other oils by means of the characterization factor correction curves which are included. Characterization factors for some typical oils are shown. In the case of vapours the factor refers to the liquid before vaporization. Specific heats of liquids are little affected by pressure, but for gases and vapours at high pressures a correction must be applied. A chart, based on pseudo-reduced temperatures and pressures, is given from which the necessary correction can be obtained; and where the analysis of the gas is not available the pseudo-critical conditions can be estimated from a third chart by the equations shown. The procedure of using the charts is shown by two examples and their solution. W. H. C.

1454. Patents on Refining and Refinery Plant. A. R. Workman. U.S.P. 2,338,371, 4.1.44. Appl. 17.6.42.—Petroleum oils containing mercaptans are sweetened by intimate contact with a catalyst consisting essentially of cupric orthophosphate in the presence of free oxygen at a temperature between 100° and 200° F.

H. G. M. Fischer. U.S.P. 2,338,579, 4.1.44. Appl. 22.3.41. To remove mercaptan compounds from petroleum oils they are contacted with a solution prepared by removing lead from a spent doctor solution.

C. K. Jones and R. C. Brandon. U.S.P. 2,338,585, 4.1.44. Appl. 29.10.44. In a process for sweetening hydrocarbon oils involving dispersion of metal sulphides in the sweetened distillate, the last traces of metal sulphides are separated from the oils by washing with a small amount of a high-molecular-weight protein having affinity for water, mucilaginous colloid forming characteristics, and oil-insolubility.

R. D. Howard. U.S.P. 2,338,941, 11.1.44. Appl. 22.6.40. To refine relatively low-boiling petroleum distillates containing deleterious contaminants, including sulphur compounds, the hot vapours are subjected to the joint action of small proportions of oxygen and water vapour without the addition of any active reagent. Heavy reaction products are separated from the vapours while being contacted with reflux liquid comprising condensed components of the vapours. The vapours while still hot are passed through a permeable mass containing oxidized metal to effect sweetening. A refined, relatively low-boiling product is condensed from the treated vapours.

J. Q. Cope and W. H. Claussen. U.S.P. 2,343,611, 7.3.44. Appl. 17.8.37. A process is described for separating components of a complex mixture containing aromatic and non-aromatic compounds having overlapping boiling ranges. The mixture is passed through an extraction zone together with a liquid phase selective solvent in intimate contact at a temperature not less than the boiling point of the mixture. A vapour phase non-aromatic raffinate is separated from the liquid phase solvent, which is then removed from the extraction zone. The solvent, together with its dissolved aromatic hydrocarbons, is passed to a separate stripping zone, and a seal is maintained between the solvent extraction and stripping zones to prevent return of vaporized products. Conditions in the extraction zone are altered by returning to it amounts of vapour-phase hydrocarbons stripped from the solvent phase in the stripping zone.

H. C. Paulsen. U.S.P. 2,343,794, 7.3.44. Appl. 24.4.41. Mercaptan compounds are removed from mineral oils by contacting them with a treating agent comprising an alkali metal hydroxide solution and morpholine. H. B. M.

Fire Prevention.

1455.* Industrial Fire Risks. W. F. Cooper and F. H. Mann. *J. Inst. Elec. Engrs*, 1944, **91** (1), 267–285.—In Section 1 the authors first describe the classification of buildings and structural materials in relation to fire resistance, and then deal with the hazard from various industrial materials and processes and special precautions which should be adopted in providing and operating electrical installations in view of these risks. Flame-proof and intrinsically safe constructions are briefly described.

The matter discussed in Section 1 is applied in Section 2 to various special cases. The authors consider the petroleum industry to be one of the most straightforward applications of flame-proof electrical equipment with considerable scope for intrinsically safe telephones, bells, and inspection torches. Particular attention is called to the danger from stray earth-currents.

In considering inherent fire risks from electrical equipment the authors state that "the use of oil for insulation and cooling in transformers, condensers, control gear and circuit-breakers introduces the most serious fire risk in the electrical industry," and in the ensuing discussion the view is expressed that after the war the development of oil-less equipment will make rapid progress. C. F. M.

1456.* Fireproofing of Wood. N. C. Jones. *Chem. and Ind.*, 1944, 98.—Present-day techniques and processes for fireproofing wood are outlined. Surface treatments are : (*a*) linseed-oil-base paint in which borax replaces part of the pigment ; (*b*) sodium silicate solution containing kaolin and/or asbestos ; (*c*) whitewash and salt or cement wash ; (*d*) urea-formaldehyde resins containing ammonium phosphate ; (*e*) sodium alginate gels containing borax or ammonium phosphates, etc. Impregnation processes usually utilize ammonium sulphate, but ammonium phosphates are very good. The U.S. Forest Service record sixty chemicals or preparations, and a few of these are reported. Of the few organic substances tried are hexachlorbenzene in *O*-dichlorobenzene.

A brief description is given of methods for testing fire resistance. T. C. G. T.

Chemistry and Physics of Hydrocarbons.

1457.* Chart for Distillation of Binary Mixtures. J. W. Faassen. *Industr. Engng Chem.*, 1944, 36 (3), 248.—A chart is presented which enables the number of theoretical plates at any reflux ratio to be determined for the separation of a binary mixture by distillation. This chart is used in conjunction with the Smoker nomogram for determining the number of plates at minimum reflux ratio, and is based on the Fenske equation and the Gilliland correction for solving the number of theoretical plates at finite reflux ratios. J. W. H.

1458.* Correlation of Physical Properties of Higher Paraffin Hydrocarbons. A. W. Francis. *Industr. Engng Chem.*, 1944, **36** (3), 256.—The observed densities, refractive indices, and boiling points of eighty-three paraffin hydrocarbons above C_{11} have been correlated by the use of functions of the form $A - (B/n)$, where n is the number of carbon atoms ; the constants A and B are dependent on the molecular structure. Ten per cent. of the calculated refractive indices and densities are so discordant with the experimental values as to indicate inaccuracies in the observations, but the average discrepancy of the remainder is $\pm 0{\cdot}0009$. The average discrepancy of the boiling point data is $\pm 6{\cdot}4°$ C., which is probably due to the poorness of the determinations. J. W. H.

1459.* Volumetric Behaviour of *n*-Butane. R. H. Olds, H. H. Reamer, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1944, **36** (3), 282.—The volumetric behaviour of butane has been investigated over the temperature range 100–460° F. and at pressures up to 10,000 p.s.i. The data obtained were found to be in agreement with that published by other workers within the experimental range previously determined, but the present work extends the range of data available. J. W. H.

1460.* *Bicyclo*(2 : 2 : 1)heptane and *Bicyclo*(2 : 2 : 1)-2-heptene. C. L. Thomas. *Industr. Engng Chem.*, 1944, **36** (4), 310.—*Bicyclo*(2 : 2 : 1)-2-heptene was prepared by heating *dicyclo*pentadiene with ethylene at 200° C. and 120 atmos., a yield of 46% of the theoretical being obtained. The *bicyclo*(2 : 2 : 1)-heptane was prepared by hydrogenating the *bicyclo*(2 : 2 : 1)-2-heptene at 50° C. and 100 atmos. with U.O.P. hydrogenation catalyst. The blending octane number was 95 ± 5 and 56 ± 5 for the saturated and unsaturated compound, respectively. J. W. H.

1461.* Optical Rotation of Pennsylvanian Lubricants. F. L. Carnahan, R. E. Hirsch, and M. R. Fenske. *Industr. Engng Chem.*, 1944, **36** (4), 333.—Optical rotations have been determined for distillates from seventy-six commercially refined Pennsylvanian oils. In most cases nine fractions were obtained from each oil, and the range of samples investigated covered all known producers of Pennsylvanian oil. The highest rotation for any fraction was +0·26, which is considerably lower than that for oils from other fields, and these data may be used to identify oils of Pennsylvanian origin. J. W. H.

1462.* Graphical Solution of Ternary Distillation Problems. L. H. Corn. *Industr. Engng Chem.*, 1944, **36** (4), 378.—A graphical solution of ternary distillation problems is presented in which the equilibrium graph is constructed from the data on the three limiting binary systems. The construction and use of this type of graph are fully illustrated by a problem on the separation of benzene, toluene, and xylene. J. W. H.

1463.* Composition of the Coexisting Phases of *n*-Butane-Water System in the Three Phase Region. H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1944, **36** (4), 381.—Equilibrium data are given for the above system over the temperature range 100–303·7° F. The critical temperature and pressure of the liquid phase of lesser density were found to be 305·6° F. and 637·5 p.s.i., respectively. J. W. H.

1464.* The Hydrogen Bond. L. Hunter. *Chem. and Ind.*, 1944, 155–157.—Current trends of hydrogen-bond theory are discussed and examples given of bonds involving the atoms F, O, N, and S. An account is given of the evidence pointing to hydrogen bonds involving carbon. C. F. M.

1465.* Petroleum Refining—A Chemical Industry. F. Kind. *Chem. and Ind.*, 1944, 170–172, 182–184.—A lecture covering present-day developments in the petroleum industry, with particular reference to the production of chemicals, and concluding with an appeal to encourage petroleum refining in this country.

The necessity for greatly increased scientific staff is stressed. T. C. G. T.

1466.* Carcinogenic Hydrocarbons and Synthetic Oestrogens. R. H. Martin. *Chem. and Ind.*, 1944, 94.—A letter suggesting that the carbon skeleton of the potent oestrogenic substance, β, δ-di-(γ-hydroxyphenyl)-γ-ethylhexane, discovered by Blanchard, Stuart, and Tallman (*Endocrinol*, 1943, **32**, 307), can be arranged to coincide with that of 9 : 10-dimethyl-1 : 2-benzanthracene, which is one of the most active carcinogenic hydrocarbons. This and other considerations suggests that the compound should be examined for carcinogenicity. T. C. G. T.

1467.* The Action of Ultra-Violet Light on Liquid Benzene. C. B. Allsopp and B. Szigeti. *J. Soc. chem. Ind.*, 1944, **63**, 30–31.—Five different substances have been separated from liquid benzene irradiated in the presence of air with ultra-violet light of wave-length 2537 A. Preliminary attempts at identification show one to contain a carbonyl group and another to resemble a diphenyl. C. F. M.

1468.* The Reactions of *Cyclo*hexane and Decahydronaphthalene under Hydrogenation-Cracking Conditions. C. M. Cawley and C. C. Hall. *J. Soc. chem. Ind.*, 1944, **63**, 33–39.—The hydrogenation-cracking of *cyclo*hexane and decahydronaphthalene in the presence of molybdenum disulphide or tungsten disulphide at temperatures of 350–510° C. has been investigated in some detail. *cyclo*Hexane is isomerised to methyl-*cyclo*pentane, and both compounds then undergo ring-opening, followed by the isomerization of the paraffins thus produced. The reactions of decahydronaphthalene are analogous; isomerization to di*cyclo*-nonanes and -octanes occurs, and is followed in a similar way by ring-opening to decanes, which undergo further isomerization and degradation. These reactions take place at temperatures about 50° lower than the corresponding reactions for *cyclo*hexane. C. F. M.

1469.* Some Rheological Properties of Polyvinyl Chloride. L. Bilmes. *J. Soc. chem. Ind.*, 1944, **63**, 182–185.—The rheological properties of plasticized polyvinyl chloride have been studied in a specially constructed torsion apparatus over the temperature range −70° to 100° C. The results obtained have been analysed by means of the Nutting equation, and their significance is related to considerations of molecular structure. On raising the temperature from −70° to 140° C., the material passes through four states—the glassy, leathery, rubbery, and plastic states—and it has been found possible to characterize these states by values of the constants of the Nutting equation. C. F. M.

1470. On the 1 : 3-Rearrangement of a Phenyl Group. C. F. H. Allen and J. Van Allen. *J. Amer. chem. Soc.*, 1944, **66**, 7–8.—An example of the shift of a phenyl group in an unsaturated five-carbon ring system is described and a proof is given that a 1 : 3-rearrangement of the phenyl group has occurred. E. H. W.

1471. Heat Capacity, Heats of Transition, Fusion and Vaporization, Vapour Pressure and Entropy of 1 : 1 : 1 : -tri-fluoroethane. H. Russell, Jr., D. R. V. Golding, and D. M. Yost. *J. Amer. chem. Soc.*, 1944, **66**, 16–20.—Results are presented of the measurement of the heat capacity, heats of transition, fusion and vaporization, and vapour pressure of 1 : 1 · 1-trifluoroethane, in the temperature range 13–226° K. The calorimetric entropy was calculated from these data. A slight revision of previously published Raman spectrum data is given, and from this and other molecular data the entropy of the compound is calculated statistically. A barrier of 3450 ± 400 cal./mole is indicated from a comparison of calculated and observed entropies. E. H. W.

1472. Anomalous Oxidation of an Ethylene Derivative by Perbenzoic Acid. C. K. Bradsher. *J. Amer. chem. Soc.*, 1944, **66**, 45–46.—An example is given of the oxidation of an ethylene derivative using perbenzoic acid where there has been an addition of two atoms of oxygen to one mole of an olefin. E. H. W.

1473. Spectroscopic Evidence for Conjugation in *cyclo*Propane Systems. I. M. Klotz. *J. Amer. chem. Soc.*, 1944, **66**, 88–91.—The presence of resonance due to hyperconjugation in systems containing a *cyclo*propane ring adjacent to an olefinic or carbonyl group has been confirmed by the examination of the ultra-violet absorption spectra of several of these compounds. E. H. W.

1474. Preparation of *cyclo*Hexanols by Catalytic Reduction of Phenols. H. E. Ungnade and A. D. McLaren. *J. Amer. chem. Soc.*, 1944, **66**, 118–122.—Alkyl*cyclo*hexanols have been prepared from alkyl-, alkenyl-, and acyl-phenols by catalytic hydrogenation in the presence of Raney nickel. Hydrogenation of di-*ortho*-substituted phenols was promoted by the presence of a small amount of aqueous alkali.

At low temperatures hydrogenation of alkenyl-, and acyl-phenols gave good yields of alkylphenols. At higher temperatures acyl-phenols gave alkyl*cyclo*hexanols. In the presence of alkali, at low temperatures acyl-phenols gave a mixture of alkyl-phenol and hydroxyalkyl*cyclo*hexanol, while at higher temperatures a mixture of alkyl*cyclo*hexanol and hydroxyalkyl*cyclo*hexanol was produced. E. H. W.

1475. Alkylation of *o*- and *p*-Xylene. Note by D. Nightingale and J. R. Janes. *J. Amer. chem. Soc.*, 1944, **66**, 154–155.—Following previous work using various catalysts for the alkylation of *m*-xylene, a study has been made of the alkylation of *o*- and *p*-xylene. Using anhydrous ferric chloride and boron trifluoride as catalysts, *o*-xylene readily alkylated with *t*-butyl compounds, but with *p*-xylene a successful reaction was not accomplished. E. H. W.

1476. Preparation of Ketones from Nitro-olefins. D. R. Nightingale and J. R. Janes. *J. Amer. chem. Soc.*, 1944, **66**, 352–354.—Aliphatic nitro-olefins have been prepared by refluxing the acetates of nitro-alcohols with an aqueous methanol solution of sodium bicarbonate. The physical constants of the nitro-olefins so prepared are listed. The corresponding ketoximes were obtained from suitable nitro-olefins by reduction with zinc and acetic acid. Hydrolysis of the ketoximes with dilute sulphuric acid in the presence of formalin gave the ketones. E. H. W.

1477. Diolefins from Allylic Chlorides, II. A. L. Henne and H. H. Chanan. *J. Amer. chem. Soc.*, 1944, **66**, 392–394.—A series of 1 : 5-diolefins have been synthesized by the condensation of five allylic chlorides in six different pairs. Proof of the structure of the compounds produced, and their constants are given. E. H. W.

1478. Conjugated Diolefins by Double Bond. Displacement. II. A. L. Henne and H. H. Chanan. *J. Amer. chem. Soc.*, 1944, **66**, 395–396.—Twelve 1 : 5-diolefins (whose synthesis is reported in the previous abstract) were passed over a catalyst of chromia and alumina at 250° C. A double-bond shift occurred in seven cases forming conjugated diolefins, but the remainder failed to show any measurable rearrangement. Constants and yields of the products are listed. E. H. W.

1479. Dissociation of Hexa-arylethanes. XV. Methoxyl Substituents. C. S. Marvel, J. Whitson, and H. W. Johnston. *J. Amer. chem. Soc.*, 1944, **66**, 415–417.—The degrees of dissociation of six methoxyl substituted hexa-arylethanes have been re-determined by the magnetic susceptibility method. The values obtained were much lower than those in the literature obtained by cryoscopic molecular-weight methods, instability of the ethanes causing the latter results to be too high. The present results indicate that the methoxyl group is less effective than the methyl group in causing dissociation. E. H. W.

1480. Solubility of Aluminium Bromide in *n*-Butane. J. D. Heldman and C. D. Thurmond. *J. Amer. chem. Soc.*, 1944, **66**, 427–431.—The solubility of aluminium bromide in *n*-butane is reported from 28·3 C. to the melting point of the salt, 97·5° C. No convincing evidence for the phase transformation at 70° C. as reported by other workers, was noted. Hildebrand's equation relating solubility to internal pressure differences predicts the difference between the actual and ideal solubility of aluminium bromide in *n*-butane, and the system is regular in the Hildebrand sense. Solubility relationships of aluminium bromide in other solvents are briefly discussed. E. H. W.

1481. Osmotic Pressures for Mixed Solvents. F. T. Wall. *J. Amer. chem. Soc.*, 1944, **66**, 446–449.—A thermodynamical treatment of the problem of osmotic pressures of systems with mixed solvents is given. The significance of experimental measurements is discussed. E. H. W.

1482. An Optically Active Styrene Derivative and its Polymer. C. S. Marvel and C. G. Overberger. *J. Amer. chem. Soc.*, 1944, **66**, 475–477.—Optically active vinyl monomers are useful in studying the kinetics of polymerization, and *p*-vinylbenzyl *d*-*s*-butyl ether was prepared and polymerized for this purpose. The change in specific rotation was not great, and an accurate study of the progress of the polymerization was not possible, but the indications were that the reaction followed first-order kinetics. The synthesis of the optically active styrene derivative and the preparation by new methods, or, for the first time, of some methyl ether derivatives related to the intermediates, are described. E. H. W.

1483. Factors Determining the Course and Mechanism of Grignard Reactions. XIV. Replacement of Halogen Atom of Aromatic Halides with Hydrogen Atoms by the Action

of Grignard Reagents and Cobaltous Chloride. M. S. Kharash, D. C. Sayles and E. K. Fields. *J. Amer. chem. Soc.*, 1944, **66**, 481–482.—Grignard reagents in the presence of cobaltous chloride reduced dihalogenated aromatic compounds to monohalogenated derivatives, *o*-bromotoluene to toluene and polycyclic aromatic halides to the corresponding hydrocarbons. Polymeric materials were also obtained in each reaction. A possible mechanism for these reactions is given. E. H. W.

1484. Action of Sulphuric Acid on 1-Phenyl-2-alkyl-*cyclo*propanes. D. Davidson and J. Feldman. *J. Amer. chem. Soc.*, 1944, **66**, 488–489.—Treatment of 1-phenyl-2-alkyl*cyclo*propane with 90% sulphuric acid produced 1 : 1 : 2-trimethylindan, while under similar conditions 1-phenyl-, 2-methyl-, and 1-phenyl-2-ethyl*cyclo*propane yielded gummy polymers. A possible series of changes for the first reaction are suggested. E. H. W.

1485. The Fluorescence of Phenylated Anthracenes. Y. Hirshberg and L. Haskelberg. *Trans. Faraday Soc.*, 1943, **39**, 45–48.—The fluorescence of a number of phenylated anthracenes has been measured, and the influence of substituents on the number, position, and intensity of the bands is discussed. C. F. M.

1486. Thermodynamic Properties of *cis*-2-Butene from 15° to 1500° K. R. B. Scott, W. J. Ferguson, and F. G. Brickwedde. *Nat. Bureau of Standards*, July 1944, **33** (1), 1–20.—The following properties of a sample of *cis*-2-butene, 99·94% pure, were measured : (1) the specific heat of solid and of liquid from 15° to 300° K., (2) heat of fusion at the triple point (130·25 int. joule $g.^{-1}$), (3) triple-point temperature ($-138{\cdot}900 \pm 0{\cdot}008°$ C.), (4) heats of vaporization at several temperatures between 246° and 293° K., and (5) vapour pressure from 200° to 296° K. With these experimental data, calculations were made of (1) the normal boiling temperature (3·718° C.), (2) volume of the saturated vapour, (3) enthalpy and entropy of the solid and the liquid from 0° to 300° K., and (4) entropy, enthalpy, and specific heat of the vapour in the ideal gas state from 245° to 300° K. Thermodynamic functions for *cis*-2-butene in the ideal gas state from 300° to 1500° K. were calculated from spectroscopic data. Thermodynamic data for the *cis–trans* isomerization of 2-butene are included. R. A. E.

1487. Volume Correction Factors for C_4 Hydrocarbon Mixtures. S. Cragoe. *Nat. Bureau of Standard Letter Circular*, 757, 27.7.44.—Volume correction factors in this circular were compiled at the request of Rubber Reserve Co., mainly in order to facilitate accurate determination of quantities of C_4 hydrocarbons bought and sold in commercial transactions. Existing tables are based upon, and presuppose, mixtures which are predominantly paraffins, and so do not apply with sufficient accuracy to mixtures containing other types of hydrocarbons.

The tables are intended to apply only to mixtures consisting entirely of C_4 hydrocarbons, or those containing limited amounts of C_3 and C_5 hydrocarbons which come within the range 40–80 p.s.i. absolute V.P. at 100° F. and 0·56–0·63 sp. gr. at 60–60 F. Plots of coefficient of expansion at 60° F. for all C_3, C_4, C_5 hydrocarbons against (1) specific gravity at 60° F., (2) normal boiling point in °F., and (3) V.P. at 100° F. in p.s.i. absolute show that (2) and (3) give much better correlation than (1). The V.P. correlation is used in the tables provided. These tables comprise (*a*) V.P. of C_4 hydrocarbon mixtures at various temperatures corresponding to indicated values at 100° F., (*b*) lb. per gallon corresponding to designated specific gravity at 60–60° F., (*c*) liquid volume correction factor for C_4 hydrocarbon mixtures, related to V.P. at 100° F. and temperature, (*d*) vapour volume correction factors also related to V.P. and temperature.

Thus to apply the tables a knowledge is required of the V.P. at 100° F. and the specific gravity at 60–60° F. of the product. These properties should preferably be directly determined, but allowable methods of estimation from knowledge of these properties at other temperatures, or of composition, are provided. R. A. E.

Analysis and Testing.

1488.* A Portable Aspirator for Gas Sampling. H. C. Stephenson. *Chem. and Ind.*, 1944, 3–4.—A conveniently portable version of the double aspirator is described which incorporates a water seal unit ensuring unidirectional flow of air. C. F. M.

1489.* A Simple Gasometric Apparatus for Estimation of Carbon Dioxide. T. A. Oxley. *Chem. and Ind.*, 1944, 24–25.—An apparatus of 5 c.c. capacity for the rapid estimation of carbon dioxide in samples of air is described. An accuracy of ±0·2% CO_2 is claimed. C. F. M.

1490.* Glass Immersion Heaters. J. E. Still. *Chem. and Ind.*, 1944, 294.—A description of a simple method for making electric immersion heaters by fitting nichrome wire into glass tubes (Pyrex or Hysil) and bending the tubes to any desired size or shape. The nichrome is kept in contact with the cooled glass surface, and the loading so arranged that the wire heating element does not glow visibly, as if it does the life of the glass is shortened. T. C. G. T.

1491.* Determination of Benzole and Toluene in Coal Gas. W. J. Gooderham. *J. Soc. chem. Ind.*, 1944, **63**, 65–67.—In an earlier paper (*J. Soc. chem. Ind.*, 1935, **54**, 297T) a vacuum-jacketed, Dufton fractionating column and a modified Manning–Shepherd apparatus for the analysis of benzoles were described. The present paper gives the full method of freezing the benzole and toluene out of the gas, describes a small fractionating column (a simpler version of the more accurate vacuum-jacketed column), and shows how toluene can be determined approximately from the specific gravity of the toluole fraction. C. F. M.

1492. A New Laboratory Method of Evaluating Ring Sticking Tendencies of Aircraft Oils. L. W. Griffith, V. E. Yust, and M. E. Schramm. *J. Soc. aut. Engrs.*, 1944, **52** (4), 137–141.—The increase in power of aircraft engines has produced lubricating problems which vary with different engines. Research connected with ring sticking led to the development of a comparative test fulfilling the requirements of being quick, sensitive, reproducible, needing the minimum of materials, and correlating with full-scale performance.

It was considered that the current methods of recognizing ring sticking were unreliable in view of the variety of ways in which rings can stick, whereas dismantling the engine took time and gave little indication of the behaviour of rings under operating conditions.

A test method was evolved, using a CFR " L " head fixed compression engine with a cast-iron piston and crankshaft cooling jet to vary piston temperatures. An opening was cut in the side of the cylinder giving access to the rings, which were prepared to receive a special tool, with which the force required to rotate the rings could be measured. During running, the window was plugged and could be quickly opened to inspect the condition of the rings, when the engine was stationary at B.D.C. Jacket, oil, and air intake temperatures and spark advance could be readily varied to assess their effect on ring sticking.

Results showed that for reproducibility, the rings had to be carefully prepared and air/fuel ratio and jacket temperature closely controlled.

Oils were rated by the hours run to give the same degree of sticking in terms of a reference oil, and gave a very good indication of likely performance. A. T. L.

1493.* The Spectrometric Analysis of Gases. L. J. Brady. *Oil Gas J.*, 1.8.44, **43** (14), 87.—Spectrometry in the ultra-violet and infra-red range of the spectrum is discussed. Provided a component of a mixture has at least one absorption band at a wave-length where the other components are relatively transparent, the concentration can be determined from the absorption measurements made on the spectrometer. The absorption measurement is corrected for scattered light and for the width of the slits employed, and then, by the application of Beer's law, the amount present is obtained.

In the ultra-violet range, paraffins and mono-olefins do not give characteristic spectra at much above 200 $m\mu$, but hydrocarbons with conjugated double bonds show definite absorption bands. This permits the identification and determination of aromatic and diolefin hydrocarbons in the presence of the former.

A Beckman quartz spectrophotometer, which operates from 220 $m\mu$ in the ultra-violet, to over 1000 $m\mu$ in the infra-red, is described, and a diagram shows its constituents and optical path. It can be used for both gases and liquids. An infra-red spectrometer (Perkins-Elmer) is described and discussed, its construction and optical paths are shown in a diagram. This instrument can be operated over a range of from 1 to 15 μ and will analyse gases, liquids, or solids.

Infra-red spectrometers can analyse gases containing up to seven components, with an accuracy of 1–2% of the total; minor impurities in concentrations below 0·1% cannot be determined with accuracy.

The use of the ultra-violet spectrometer is to some extent limited by the fact that only mixtures with up to three components can be determined. The accuracy is about 0·5%, but under favourable conditions very low concentrations of impurities can be determined. W. H. C.

1494.* Time-Saving Computing Instruments Designed for Spectroscopic Analysis. T. D. Morgan and F. W. Crawford. *Oil Gas J.*, 26.8.44, **43** (16), 100.—In spectroscopic analysis a large proportion of the time is taken up with the computation of the results. Two instruments are described which enable the results to be electrically calculated in a very short period. Illustrations and electrical diagrams of the two instruments are shown.

(1) An instrument which will solve seven equations with seven unknowns for computing spectrometer readings to extinctions. The data from the infra-red spectrophotometer consist of galvanometer deflection readings. These deflections are caused by the rays falling on a thermocouple. Two deflections are read at each preselected wave length, (1) via an evacuated cell and (2) after traversing the same cell containing the mixture. The extinction (K) of the absorbing gas is defined as log $I./I$. With the computing instrument the log I_0/I is divided by a constant; this converts I_0/I readings into K_1/A_1 and K_2/B_2 of the equation given, and is accomplished by two linear voltage dividers with logarithmetic scales arranged so that the potential of one is subtracted from the potential of the other. To set the computer for a given value of A, it is necessary only to set potentiometers I_0 and I at typical values, then set potentiometer $\frac{K_2}{A_1} = \frac{\log I_0 - \log I}{A_1}$ and adjust potentiometer A until the galvanometer reads zero.

(2) This computer solves the simultaneous equations resulting from (1) or the data from the mass spectrometer. This instrument will compute four such equations with four unknowns, but it can be easily expanded for a larger number of components.

To illustrate the calculations, the equations necessary, a set of simultaneous equations and the method of computing by successive approximation are shown and explained. The details of setting coefficient potentiometers and the operations of the computers are described. W. H. C.

1495.* Practical Refinery Engineering. No. 10. Shell-Side Film Coefficients. P. Buthod and B. W. Whiteley. *Oil Gas J.*, 26.8.44, **43** (16), 129.—Several complicating factors arise in calculating the fluid heat resistance of the shell-side of an exchanger, not the least being the determination of the true average mass velocity. Equations are given, which give good correlation with actual practice, in which the mass velocity must be corrected for any leakage past the baffles. Factors are given for single-pass and double-pass circuits.

To simplify the calculations of the film coefficient, two charts are given from which: (1) the several resistances related to dimensions and configuration on the shell-side, can be read; (2) the film coefficient can be obtained. It is necessary to know the mass velocity, viscosity, outside diameter of tube, and A.P.I. gravity.

Two examples and their solutions explain the use of the charts. The charts can be used for exchangers with staggered tubes, and also when water is the liquid on the shell-side of the exchanger; the procedure for these cases is given. W. H. C.

Motor Fuels.

1496. Patent on Motor Fuels. G. D. Creelman. U.S.P. 2,338,573, 4.1.44. Appl. 13.9.39.—To aromatize petroleum naphtha it is first fractionated into lighter and heavier fractions, which are separately heated to a temperature above 875° F. The lighter fractions are contacted with a solid aromatizing catalyst in the presence of hydrogen under non-hydrogenating conditions in an elongated conversion zone. Vapours of both heavier and lighter fractions are mixed in this zone, and the conversion process is continued. Finally liquid motor fuel products are condensed and separated from hydrogen gases associated with them on withdrawal from the conversion zone.

G. Free and W. V. Füner. U.S.P. 2,343,450, 7.3.44. Appl. 14.5.40. A liquid hydrocarbon oil, completely vaporized, is passed at a temperature between 300° and 500° C. in the presence of a gas having an oxidizing action over a stationary hydrosilicate catalyst under conditions designed to effect substantial conversion into motor fuel.

M. Pier and G. Free. U.S.P. 2,343,472, 7.3.44. Appl. 6.5.41. An anti-knock motor fuel is produced by passing a hydrocarbon fluid boiling substantially above 250° C. at a cracking temperature through more than one reaction zone. The feed material is introduced at a pressure not higher than 25 atmospheres, and the pressure between at least two of the reaction zones is reduced by at least 5 atmospheres without substantially reducing the temperature. The final reaction zone contains a synthetic magnesium silicate as a cracking catalyst, and thus has a greater catalytic cracking effect than any of the previous reaction zones.

P. J. Gaylor. U.S.P. 2,343,766, 7.3.44. Appl. 2.4.43. A hydrocarbon liquid fuel base is blended with a small proportion of a soluble ester amide of carbonic acids to lower the surface tension of the fuel. H. B. M.

Gas, Diesel and Fuel Oils.

1497.* Outlook for Post-war Diesel Fuels. Refiners Must Avoid Overemphasis of Products Specifications. A. L. Foster. *Oil Gas J.*, 25.5.44, **43** (3), 93.—Many consumers of diesel oil demand far higher ratings for ignition qualities than is needed, and, as a consequence, this both limits the amounts available and sets the price for the quality demanded. It is considered that less restrictive specifications for diesel oils will much augment the supplies available. Observations by many authorities have shown that engine consumption of a fuel of high cetane number is frequently greater than that of a lower-cetane-number fuel.

The average cetane number of fuels specified by twenty different engine makers is 46·6; this compares well with the Co-ordinating Research Council's recommended figure of 47.

A comparison of maximum power and fuel consumptions of high, medium and low cetane number diesel fuels are given :

	High C.N.			Medium C.N.			Low C.N.		
Fuel of engine.	C.N.	B.H.P. and r.p.m.	Lb./B.H.P./hr.	C.N.	B.H.P. and r.p.m.	Lb./B.H.P./hr.	C.N.	B.H.P. and r.p.m.	Lb./B.H.P./hr.
Open-chamber automotive	63	94 at 1200	0·436	56	94 at 1200	0·434	39	94 at 1200	0·444
Open-chamber industrial	63	75 at 750	0·413	56	75 at 750	0·417	39	75 at 750	0·427
High-turbulence automotive	63	110 at 1375	0·544	56	110 at 1375	0·542	39	110 at 1375	0·561

The data show an increase of 1·8% in fuel consumption between fuels of 39 cetane number and 63 cetane number in engine 1; engine 2 shows 3·4% increase for the same drop in ignition quality, with about the same difference with engine 3.

Discussion is made on the data obtained by Blackwood and Cloud (*J. Soc. aut. Engrs*, Feb. 1943, p. 51) on the characteristics of diesel-fuel consumption/engine speed, on oils of mid-boiling points of 700° F. and 500° F., from the same source.

Their data plotted show that with the heavier oil, fuel consumption rate for speeds below 1900 r.p.m. is lower for the fuels of lower cetane number than for the higher-cetane-value fuels with about equal consumptions at 1900 r.p.m. Above this speed the fuel of higher cetane number shows the better results. The curves for the lighter (more volatile) fuels shows the same characteristics as those of the heavier fuels, with the position of equal fuel consumptions for the different cetane value fuels at about 2100 r.p.m.

All available data indicate that as engine speeds increase, the engine becomes more critical of ignition qualities in the upper speeds only, apparently the lower-cetane-value fuels showing better economy when engines are working under part loads. The curves for the less volatile, presumably heavier gravity fuels show several per cent. lower average fuel consumption for the heavier fractions.

Future post-war diesel fuels are surveyed, the properties of thermally cracked gas oils and catalytic recycle gas oils, and the virgin stocks from different U.S. fields from which they are made are given. The data presented afford evidence of the degradation of the original oils by cracking, the catalytic recycle oils having cetane numbers lower than the virgin oils, but higher than the thermally cracked gas oils. Catalytic cracking for aviation purposes is more severe than for motor gasoline, therefore in post-war days it is expected that diesel fuels will presumably be of better ignition quality, storage stability, and have less tendency to deposition.

Typical yields of gas oils from paraffinic, mixed, and naphthenic base oils are given and discussed.

Improvement of diesel oils by solvent refining and by hydrogenation is discussed. The properties of fuels so treated are given. Such methods, however, are costly, and for the present are not likely to be used. W. H. C.

Lubricants and Lubrication.

1498.* Some Factors Affecting the Control of Oxidative Rancidity. T. P. Hilditch. *Chem. and Ind.*, 1944, 67.—The article is primarily intended for the interest of the food chemists.

Naturally occurring anti-oxidants in seed oils may be of different types, but all have one feature in common—namely, the presence of one or more polyhydroxyphenyl residues or ring systems forming part of a more complex molecular structure. These anti-oxidants do not display the same efficiency when isolated as when occurring in their natural place within the seed.

A brief summary of methods for the measurement of oxidative rancidity as applied to edible fats is followed by a survey of the relative efficiencies of various anti-oxidants in different fat systems. Some practical applications of anti-oxidants in foodstuffs is given. T. C. G. T.

1499.* Experiments on the Use of Anti-oxidants in Dry, Edible Fats. C. H. Lea. *J. Soc. chem. Ind.*, 1944, **63**, 107–112.—Pyrogallol, quinol, 1 : 5-dihydroxylnaphthalene, pyrogallolacetone condensation product, gallic acid and its esters, pyrocatechol, and hæmatoxylin are effective anti-oxidants in butter-fat. Of these the lower esters of gallic acid, *e.g.*, ethyl gallate, which are particularly useful inhibitors for butter-fat, have also been shown to inhibit the oxidation of lard, cottonseed, arachis, and palm oils. Approximately 0·01% ethyl gallate is effective as an anti-oxidant.

T. C. G. T.

1500.* Recovery of Grease from Sewage Sludge. T. W. Brandon. *J. Soc. chem. Ind.*, 1944, **63**, 185–186.—The Water Pollution Research Laboratory have carried out a brief investigation of the possibilities of recovering grease from sewage sludge. Samples of fresh and dried sludge and of skimmings from sedimentation tanks have been extracted. The material obtained varies considerably, as is indicated by the following extremes of tests applied on samples extracted by a light petroleum solvent: ash, 0·3–14·1%; saponification value, 50–171 mgms. KOH per gm.; acidity, 19–126 mgms. KOH per gm.; unsaponifiable matter, 5·6–57·3%; iodine value, 26–101. The grease is valued at £10 per ton, the low price being due to the impurities which limit its use. A possible use is the manufacture of soaps for incorporation in greases.

The total possible yield for this country would be 100,000–120,000 tons per year.

T. C. G. T.

1501. Patents on Lubricants and Lubrication. J. C. Zimmer. U.S.P. 2,338,613, 4.1.44. Appl. 2.12.41. A lubricant is prepared from a mineral lubricating oil, 5–20% by weight of an oil-soluble lead soap, and 0 05–3% of an oil-soluble aluminium soap.

R. Rosen and R. M. Thomas. U.S.P. 2,338,669, 4.1.44. Appl. 21.7.42. A small amount of an organic polysulphide prepared by sulphurizing an unsaturated organic oil is added to a viscous hydrocarbon oil to increase its resistance to oxidation at high temperatures. The quantity of addition agent is less than 1%.

A. H. Riesmeyer. U.S.P. 2,339,520, 18.1.44. Appl. 27.6.40. Lubricants consisting principally of refined mineral oils and used in the working of light metal can be reclaimed by treating with sulphuric acid. The acid is used in an amount substantially equal to the stoichiometrical amount which will combine with all the light metal in the oil to form light metal sulphate. Subsequently solid impurities are separated from the oil.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,339,710, 18.1.44. Appl. 1.6.42. A mineral lubricating oil has incorporated in it a small amount of a sulphur-containing organic-phosphorus compound containing at least one nitrogen-phosphorus double bond.

R. W. McOmie and H. A. Woods. U.S.P. 2,339,715, 18.1.44. Appl. 13.7.42. A low-temperature grease consists of 10–20% by weight of a calcium soap, 1·5–5% by weight of an aqueous solution containing glycerin and a water-soluble glycol of not more than four carbon atoms, and mineral oil. The mineral oil has a pour point below 50° F. and Saybolt Universal viscosities at 100° F. of 40–75 seconds and at 60° F. of less than 250,000 seconds. The ratio of glycerin to water in the solution used ranges between 1 : 2 and 2 : 1, and the ratio of aqueous glycerin to glycol ranges between 10 : 1 and 5 : 1. The final product has an A.S.T.M. consistency between 200 and 390 at 77° F.

G. G. Oberfell. U.S.P. 2,339,717, 18.1.44. Appl. 28.4.42. Used and partly oxidized lubricating oils are subjected to low-temperature distillation to remove materials boiling lower than lubricating oil. The residue is filtered to remove suspended tars and gums and to leave the major part of any true colloidal matter. The filtered oil is then subjected to the action of hydrogen, in the presence of an oxide selected from the group consisting of the oxides of molybdenum, chromium, tungsten, and uranium, for a time such that 60–80% of combined oxygen in the oil is converted into water and organic compounds of the phenol type are produced. Finally, the oil is treated to remove water.

S. Musher. U.S.P. 2,339,796, 25.1.44. Appl. 30.9.40. To decrease sludge formation and corrosion tendencies to metal surfaces, lubricating oils are treated at a high temperature with a relatively small amount of a combination of a crude glyceride oil and an aromatic compound selected from the group consisting of the alkylated hydroxylated aranes, alkylated amino-aranes, polyhydroxy aranes, polyamina aranes, aminohydroxy aranes, and monoamino-poly-nuclear aranes.

S. Musher. U.S.P. 2,339,797, 25.1.44. Appl. 30.9.40. Lubricating oils, consisting substantially of the non-volatile high-molecular-weight aliphatic hydrocarbons, are treated at a high temperature with a small amount of a combination of lecithin and *p*-cresol to decrease sludge formation and corrosion tendencies.

S. Musher. U.S.P. 2,339,798, 25.1.44. Appl. 1.10.40. Hydrocarbon oils are treated with a relatively small amount of a combination of soya oil and a phosphite ester to decrease sludge formation and corrosion tendencies. The treatment is carried out at a temperature above 350° F.

D. E. Bergen. U.S.P. 2,343,393, 7.3.44. Appl. 19.12.40. A mineral lubricating oil has incorporated in it a small quantity of piperazine dithiocarbamate to increase its stability against oxidation and sludge formation at crank-case temperatures.

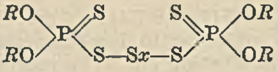
J. S. Yule. U.S.P. 2,343,608, 7.3.44. Appl. 17.10.41. A pour-point depressor for lubricating oils containing wax is prepared by heating a material selected from the group consisting of prime lard oil, No. 1 lard oil, edible lard oil, neat's foot oil, acidless tallow, olive oil, peanut oil and rape-seed oil, with 3–9% of sulphur to a temperature between 250° and 500° F. Heating is carried out for a sufficient length of time for the reaction product to reach its maximum pour depressing capacity, and the product is afterwards cooled. It is claimed that the depressor can lower the pour point of Pennsylvania neutral oil having a viscosity of 180 seconds Saybolt at 100° F. and a pour point of 30° F., more than 50° F. when added in amounts of 1% by volume.

A. Beerbower and A. E. Calkins. U.S.P. 2,343,736, 7.3.44. Appl. 28.8.42. In the manufacture of an aluminium soap grease, 90–95% of mineral lubricating oil and 5–10% of an aluminium soap of high-molecular-weight carboxylic acid are heated to a temperature of 280–300° F. The mixture is then cooled nearly to its transition temperature (90–180° F.) and passed to a vertical tower-shaped transition zone, where it remains undisturbed and at a substantially constant temperature for a period of ½–6 hours to acquire the desired grease structure. Finally the grease is filtered.

A. Beerbower and R. E. Darley. U.S.P. 2,343,737, 7.3.44. Appl. 5.9.42. To prepare a lime-soap lubricating grease, all the fatty materials are first dissolved in a mineral-oil-base stock. Hydrated lime is then dispersed in a mineral oil and 10–50% of the lime dispersion is added. The resultant mixture is treated until the lime is substantially completely reacted and until the foam originally formed has completely broken. Thereafter the remainder of the lime dispersion is added and the mixture is heated and stirred until saponification is complete. The whole of the reaction is carried out at a temperature not exceeding 170–200° F.

F. B. Downing and H. M. Fitch. U.S.P. 2,343,756, 7.3.44. Appl. 23.4.42. A petroleum lubricating oil has dissolved in it 50–500 P.P.M. of copper in the form of an oil-soluble compound and 0·1–0·5% of sulphur in the form of oil-soluble sulphur compounds.

J. L. Osborne. U.S.P. 2,343,831, 7.3.44. Appl. 26.6.41. An extreme pressure lubricant consists of a mineral lubricating oil and a small amount of a compound of the general formula :—



R is a member of the group consisting of alkyl and aryl radicals and x is zero or a small whole number. H. B. M.

Asphalt and Bitumen.

1502. Patents on Asphalt and Bitumen. C. M. Baskin. U.S.P. 2,343,735, 7.3.44. Appl. 26.5.39. A bituminous waterproofing material is prepared from a fibrous pulpy material, a mineral flux oil, a 20–50 penetration cracking coal-tar asphalt, a distillate having an end point of approximately 420° F., and a brittle asphalt having a softening point between 250° and 375° F. which has been oxidized from 200° F.

K. G. Morris. U.S.P. 2,343,789, 7.3.44. Appl. 8.1.41. To produce an asphalt having a softening point of 218–222° F. and a penetration of 18–22 at 77° F., 15–70% of oil, such as could be obtained as overhead distillate from a petroleum reduced crude, is blended with 85–30% of asphalt. The oil has a flash point between 350° and 460° F. and the asphalt has a softening point borween 150° and 290° F. After blending, the product is oxidized and an improved coating asphalt is obtained. H. B. M.

Special Products.

1503.* Internal Discharges in Dielectrics; Their Observation and Analysis. A. E. W. Austen and W. Hackett. *J. Inst. elec. Engr*, 1944, **91** (1), 298–322.—Methods for the observation of discharge phenomena are described and the results analysed. Application of the h.f. discharge detector to the study of discharges in impregnated-paper capacitators and paper-insulated cables is discussed. In reply to a statement made during the discussion that maximum ionization extinction occurs more rapidly in a low-pressure, gas-filled cable with a rosin-blended, paraffinic-base oil impregnant than with a straight naphthenic base oil, the authors suggest that this may be due to the formation of conducting films of carbon around the voids. C. F. M.

1504.* The Industry of Polymers and Macromolecules. F. J. Brisslee. *Chem. and Ind.*, 1944, 38.—A brief review of the developments and uses of synthetic plastics and/or polymers, with particular reference to synthetic rubbers, concluding with a suggestion that it would be preferable to encourage and develop the natural products rather than synthesize them from irreplaceable raw materials such as petroleum.

T. C. G. T.

1505.* Chemical Raw Material Potential and Its Relation to the Trend of Synthetic Resin Development. W. D. Scott. *Chem. and Ind.*, 1944, 274–278.—The potential rapid development of the synthetic resins calls for a large cheap supply of raw materials if the U.K. is to compete favourably in the foreign market. A comparison between U.K. and U.S.A. prices for a number of raw materials is given which shows that the U.K. produces cresylic acid, naphthalene, phthalic anhydride, formalin, and ethyl alcohol at favourable costs, but that she may be forced to import, presumably from the U.S.A., acetic anhydride, acetone, calcium carbide, and certain alcohols. British phenol is very high in cost, probably influenced by the price of the synthetic product. This follows on the high cost of benzene.

It is suggested that the U.K. should utilize petroleum as the basis for the synthesis of the raw materials, but it is claimed that before this can be done economically the hydrocarbon duty would have to be repealed. The author illustrates how removal of the hydrocarbon duty would tend to reduce the price of U.K. benzene to a figure below that prevailing in the U.S.A.

The rest of the article reviews the possibilities of the three alternative sources of raw material available to this country—*i.e.*, petroleum, coal, and chemurgic. A series of tables indicates the vast possibilities of petroleum as a source of raw materials, and shows that coal, although capable of similar achievement, is not at present in a position to compete favourably or economically with oil. In the chemurgic field, where ethyl alcohol may be regarded as the chief product, the U.K. has favourable production costs compared with the U.S.A., but the latter has a vast potential domestic production, whilst the U.K. has to import the bulk of her raw materials.

The author concludes with a call for a general plan of policy and suggests the following steps :—

(1) Revocation of the hydrocarbon duty, particularly in so far as it affects the chemical industry.

(2) Development of gasification processes to supply methane, while exploiting other available sources of this gas.

(3) Importation, free of duty, of specially selected petroleum cuts for chemical utilization, pending the wider development of petroleum refining in this country.

(4) Exploitation of petroleum aromatization processes to augment coal-tar chemicals, and to make available the lower olefines for chemical syntheses.

(5) Investigation of the economic and political factors involved in the setting-up of chemical industries near the Middle East petroleum fields.

(6) Institution of short term researches seeking to improve the yield of aromatic chemicals from coal, such work preferably being undertaken by a rationalized coal-tar refining industry.

(7) Development of our colonial chemurgic resources.

(8) Long-term investigations on the production of oil from coal by hydrogenation and Fischer–Tropsch processes, the researches and pilot plant work being subsidized, but commercialization being postponed until world economic conditions are favourable. T. C. G. T.

1506.* Pyrethrins and the Rôle of Pyrethrum in Anti-Pest Measures. Part I. T. F. West. *Chem. and Ind.*, 1944, 290–294.—A very complete and up-to-date review of the history of pyrethrum growing, the chemistry of pyrethins, and the applications of pyrethrum as an insecticide. 67 references to the literature are made, most of the references being later than 1940. T. C. G. T.

1507.* Notes on D.D.T. G. A. Campbell and T. F. West. *Chem. and Ind.*, 1944, 319.—A brief summary of the discovery and utilization of D.D.T., *i.e.*, *aa-bis-*(*para*-chlorophenyl)-$\beta\beta\beta$-trichloroethane. D.D.T. acts as a contact and as a stomach poison, but in the concentration used it is not dangerous to warm-blooded animals. It controls a wide group of insects, varying from household pests to horticultural and agricultural pests. It is a white solid, possessing little odour, and is soluble in most organic solvents. It is insoluble in water, but can be emulsified with the latter without loss of activity.

At present the bulk of D.D.T. supplies is directed to the use of the armed forces, where its main function is lice control. D.D.T. is not an ovicide. It has the remarkable property of being adsorbed on a surface which remains toxic for prolonged periods, but although it has prolonged contact action, D.D.T.'s knockdown effect is small in comparison with pyrethrum, and it is probable that if used for fly sprays D.D.T. will have to be combined with pyrethrum extracts.

America is at present producing about 300,000 lb. per month, and expects this figure to be 1,700,000 lb. per month early in 1945. T. C. G. T.

1508.* Rôle of Carbon Black in Rubber Manufacture. D. Parkinson. *Chem. and Ind.*, 1944, 325–327.—British made experimental blacks are being submitted to the rubber industry as substitutes for standard American types. The author directs attention to the resemblances and differences between various grades of colloidal carbon, and indicates the uses to which they can be put in the rubber industry, and particularly in the manufacture of tyres. Attention is directed to the fact that the use of carbon black is increasing, as more is required in the compounding of synthetic than in the case of natural rubber.

Up to the present the rubber industry only accepts as satisfactory a black that has been manufactured by some kind of thermal decomposition or smoke-producing process. Carbon blacks prepared by grinding processes do not possess the desirable spherical shapes characteristic of carbon smokes.

Carbon blacks fall into three main groups : (1) non-reinforcing ; (2) semi-reinforcing ; and (3) fully reinforcing. The main point of difference is particle size, which varies from about 300 mμ for the non-reinforcing to 25 mμ for the fully reinforcing blacks. Thermal or soft blacks fall into the first group, furnace black in the second, and channel black in the third. Channel black, as the fully reinforcing black, is of course the main black used in tyre manufacture, and is prepared from natural gas.

It is indicated that the very fine blacks, such as channel, have disadvantages which can be reduced or avoided by judicious blending with the other grades. The effect of carbon blacks on various rubber compounds is reviewed both with regard to natural and synthetic rubbers. The demand for the non-reinforcing—*i.e.*, the coarse grade is likely to decrease, whilst the use of the other two grades will increase.

T. C. G. T.

1509.* New Synthetic Detergent from Petroleum. Anon. *Chem. and Ind.*, 1944, 327.—A brief note on the manufacture, nature, properties, and uses of the sodium alkyl sulphates marketed by the Shell interests as " Teepol." T. C. G. T.

1510.* Observations on the Testing of Pyrethrum Extracts. Part II. The Use of Absorption Spectra. A. E. Gillam and T. F. West. *J. Soc. chem. Ind.*, 1944, **63**, 23–25.—As chemical methods of evaluating pyrethrins I and II in pyrethrum extracts have led to discrepancies, a spectrographic method has been investigated, but found to offer very little advantage. During the investigation, no evidence was found of the third active substance which some recent publications have suggested exist in pyrethrum extracts. T. C. G. T.

1511.* Effect of Aviation Gasolines on Low Temperature Flexibility of Synthetic Elastomers. G. J. Wilson, R. G. Chollar and B. K. Green. *Industr. Engng Chem.*, 1944, **36** (4), 357.—The du Noüy type tensiometer normally used for the measurement of surface tension has been modified, and used to determine the modulus change in rubber stocks by measuring the force required to bend a thin sample acting as a cantilever beam through a calculated deflection. The effect of two different aviation fuels on compounds made up from Hycar OR15, Perbunan 26, and Neoprene FR and GN has been determined over the temperature range −60° C. to +80° C. The data are presented in the form of graphs relating stiffness with temperature for elastomers before and after immersion in the fuel. J. W. H.

1512. Organo-Silicon Compounds Emerge from Laboratory. Anon. *Chem. Ind.*, August 1944, **55** (2), 222.—A group of organo-silicon compounds are now in commercial production by the Dow Corning Corporation. They are oils, resins, and greases of unique stability to heat and chemical action, and are particularly useful in electrical insulation, as hydraulic fluids, pump packings, waterproofing materials for paper and textiles, in the treatment of ceramics to reduce surface conductivity and as chemically resistant lubricants. They are produced by reacting an alkyl magnesium chloride solution with an ether solution of silicon tetrachloride, forming alkyl silicon chlorides, from which the silicones are obtained on the addition of water. On polymerization the silicones may form straight chains or cyclic compounds with or without cross linkage, depending on the starting material and reaction conditions. Silicones of the types $RSi(OH)_3$ and $R_2Si(OH)_2$ produce baking lacquers, varnishes and resins and those of the type $R_3Si(OH)$, the liquids and greases. C. L. G.

1513. Production of Synthetic Resins in 1943. Anon. *Modern Plastics*, Sept. 1944, **22** (1), 116.—A tabulation is given showing the production, sales, value per pound, and total value of synthetic resins of different types in the U.S. with total figures for the years 1940–43. Overall production has increased from 276,814,363 lb. in 1940 to 651,511,000 lb. in 1943, coal tar derivatives being 378,846,000 lb. The quantities produced of the different types were as follows : Phenolic, cresylic, and mixed phenolic resins, 164,307,000 lb. ; alkyd resins (from coal-tar products), 154,385,000 lb. ; urea resins, 53,859,000 lb. ; alkyd resins (non coal-tar), 49,644,000 lb. ; polyvinyl alcohol-aldehyde resins, 14,435,000 lb. ; polystyrene, 6,737,000 lb. ; alcohol polymerization resins (including allyl and furfural), 522,000 lb. ; the balance being made up of other non-cyclic resins 154,205,000 lb., and other cyclic resins, including petroleum-derived cylic resins, 53,416,000 lb. For the more important types the quantities used for different purposes are shown. Thus alkyd resins are used mainly for protective coatings, phenolic, mainly for plastics and adhesives, and urea-formaldehyde mainly for adhesives. C. L. G.

1514.* Aliphatic Hydrocarbon Derivatives Available in Quantity. Anon. *Oil Gas J.*, 2.9.44, **43** (17), 55.—Research in connection with synthetic rubber by the Connecticut Hard Rubber Co., New Haven, has lead to the production of aliphatic normal hydrocarbons, and their derivatives, in the even series of carbon atoms C_8 to C_{18}, and the corresponding olefins, alcohols, ethers, mercaptans, thioethers, disulphides, and sulphonic acids, most of which are available in commercial quantities and various grades. Sulphones in limited quantities can also be purchased. Suggested uses for the various types of compounds are outlined. W. H. C.

1515. Anhydrous Ketones. Anon. *Chem. Tr. J.*, 15.9.44, **115**, 273.—E.P. 563,164 of 1943 issued to Shell Development, G. J. Pierrotti, and C. L. Dunn covers the production of anhydrous ketones by distillation of the crude materials with entrainers or auxiliary reflux materials which increase the relative volatility of the ketone, have higher boiling temperatures than any of the components, and do not form azeotropic mixtures with them, and are chemically and thermally stable at the operating temperatures. The specific entrainers claimed are liquid polyhydric alcohols (*e.g.*, ethylene glycol), polyhydric alcohol ethers (*e.g.*, aryl glycerol ethers) and hydroxyalkylamines. An example is given of the dehydration of a methyl ethyl ketone-water constant-boiling mixture containing 11·7% of the former by the introduction of 110% of ethylene glycol at 90° C. into the fractionating column at a point about a quarter of the column height from the top. On distillation the top product recovered consisted of 99·8% M.E.K., and the bottom product 89·5% glycol, 8·9% water, and 1·6% M.E.K., from which pure glycol can be recovered by redistillation for re-use in the process. C. L. G.

1516. D.D.T. Trials. Anon. *Chem. Tr. J.*, 29.9.42, **115**, 332.—A summary is given of an article in the *Market Grower* by V. H. Chambers, G. L. Hey, and N. K. Smitt, describing preliminary trials of D.D.T. as an agricultural and horticultural insecticide. A suspension of D.D.T. in water gave a highly promising degree of control of apple-blossom weevil. Laboratory tests on Tomato Moth Caterpillar gave results as good as, or better than, lead arsenate. Small-scale tests on plums and apples to compare D.D.T. emulsion with lead arsenate against winter moth caterpillar gave good results. Apple sawfly tests indicated that the most satisfactory service was performed by nicotine. D.D.T. sprays and dusts appeared effective under laboratory conditions in the control of sitones weevils. For red spider control it is doubtful if D.D.T. will prove superior to derris or lonchocarpus, unless its persistence is of practical value. C. L. G.

1517. Some Industrial Applications of Surface Active Agents. E. S. Paice. *J. Oil Colour Chem. Assoc.*, Oct. 1944, **27** (292), 189.—Following a brief review of the mechanism of wetting and detergency, and of the nature of surface active agents, a description is given of the industrial applications of these products, with particular respect to the secondary alkyl sulphates manufactured in this country. These include raw wool scouring; worsted yarn and piece goods scouring; in dyeing operations to improve levelling, wetting, and penetration; in anti-shrink chlorination treatment of wool; in the kier boiling of raw cotton to remove wax and other impurities; in the degumming of natural silk; in the scouring, washing, and dyeing of artificial silk; in the impregnation of fibres with synthetic resins to produce waterproof, creaseless materials; in the scouring and dyeing of leather and furs; in the laundry industry, in ore flotation; in the dispersion of pigments in paints, etc.; as components of emulsifiers; as wetting agents in the plastics industry; as wetting agent, mould lubricant, and reclamation agent in the rubber industry; in the aqueous degreasing of metals and as wetting agent in the electroplating, acid pickling, soldering, and brightening of metals. C. L. G.

1518. Toxicity to Flies of Derivatives of Eugenol and *cis*- and *trans*- *cis*-Eugenol. T. F. West. *Nature*, 14.10.44, **154**, 488.—It has previously been shown (see Abstract No. 152) that alteration of the pentadienyl side-chain in the pyrethrum molecule reduces its toxicity. In view of the fact that it is not certain whether the terminal group is allyl or propenyl, the toxicities of derivatives of the isomeric phenols, eugenol, which contains the allyl group and *iso*eugenol, which contains the propenyl group, have been compared. The former were, in general, found to be more toxic, and an extension of the work into the comparison of the *cis* and *trans* forms of *iso*-eugenol showed that the *cis* form of *iso*eugenol was of similar toxicity to eugenol, whereas the *trans* form is less toxic. This may be compared with conclusions reached on the synergistic action of sesamin, *iso*sesamin and asarinin, in which spatial considerations were regarded as of little or no importance, the nature of the substituents in the benzene ring being the determining factor. C. L. G.

1519. Persistence of D.D.T. in Oil-Bound Water Paint. G. A. Campbell and T. F. West. *Nature*, 21.10.44, **154**, 512.—It has been found that oil-bound water paints containing D.D.T. are toxic to flies coming into contact with them, and remain so after two months. Tests were carried out in cages of zinc mesh which had floors and part of the walls and lid made of plywood and painted with an oil-bound water paint containing 5% of D.D.T. 100 housefly pupæ were introduced into the cage with food and examined daily. None was alive after 6 days, whereas in another cage painted with a similar paint but not containing D.D.T. none died. Tests in a small room painted with a paint containing only 0·5% D.D.T. gave a 90% kill overnight, and there were indications of a tendency of the flies to avoid contact with the D.D.T. painted surface. With oil and resin paints the insecticide is strongly adsorbed and has no toxic effect, but there is some evidence that it may exert toxicity in certain continuous film forming media. The laboratory results are supported by practical behaviour in a factory canteen. C. L. G.

1520. Insecticidal Action of D.D.T. H. Martin and R. L. Wain. *Nature*, 21.10.44, **154**, 512.—A study has been made of the insecticidal properties of D.D.T. ($\alpha\alpha$-bis-(4-chlorphenyl)-$\beta\beta\beta$-trichloroethane) and its analogues, leading to a working hypothesis of their mode of action. D.D.T. is chemically unreactive and stable to boiling with water, but loses HCl to alcoholic alkali or on heating to form $\alpha\alpha$-bis-(4-chlorphenyl)-$\beta\beta$-dichloroethylene, which has no toxicity. The chemical inertness of D.D.T. suggests that its toxicity is not due to chemisorption at vital centres. It is considered that the formation of HCl by intracellular decomposition of D.D.T. is responsible for its toxicity, and it has been confirmed that some related compounds from which HCl can be eliminated are also toxic, whereas those from which it cannot be eliminated are not toxic. This is not the only consideration, however, as the molecule must have sufficient lipoid solubility, this being conferred by the chlorphenyl groups. Thus the dihydroxy derivative is less toxic than the dimethoxy derivative.

C. L. G.

1521. Petroleum Sulphonic Acids. New Products for British Industry. Anon. *Chem. Tr. J.*, 3.11.44, **115**, 459.—A description is given of the methods of production of Petroleum Sulphonates at the Manchester Oil Refinery, with the specification of the present product (Petromor 276), and of the industrial applications of oil soluble sulphonates.

The sulphonates are derived from the oleum treatment of selected solvent extracted raffinates for the production of transformer, technical, and pharmaceutical white oils. The treated oil, freed of acid sludge by centrifuging, is neutralized with aqueous soda in the presence of industrial methylated spirits. The separated mixture of alcohol, water, mineral oil, petroleum sulphonates, and sodium sulphate is treated to remove alcohol and salts which can be completely removed. A variety of grades can be produced, but at present one utility grade is made containing minimum 60% sodium sulphonates and maximum 10% water, the balance being mineral oil. The production of water-soluble sulphonates from acid sludge is also being studied. Industrial uses for petroleum sulphonates include : manufacture of soluble cutting oils, to which they impart anti-corrosion properties, leather and wool oils, wetting agents, detergents, and dyeing assistants in the textile industry, polishes, disinfectants, cleansing materials, printing inks, and paints. C. L. G.

Detonation and Engines.

1522.* The Electrical Equipment of American Automobiles. (Progress Review.) R. M. Critchfield and W. H. Crouse. *J. Inst. elec. Engr*, 1944, **91** (1), 158–161.—The electrical system of the 1942 American car is considered in detail. C. F. M.

Coal and Shale.

1523.* Heating Services in a Small House. L. C. C. Rayner. *Chem. and Ind.*, 1944, 363.—The heating requirements of a small house are reviewed. The use of solid fuel is assumed, and modern trends in the development of burning appliances are indicated. A short reference is made to the district heating systems adopted in America and Russia. T. C. G. T.

1524. Low-Temperature Distillation Yields of Primary Tar and Light Oil from Coals of Various Ranks and Types. W. H. Ode and W. A. Selvig. U.S. Bur. Mines. Report of Investigations No. 3748, March 1944.—Yields of primary tar and light oils obtainable from various types of coals are important both from the point of view of combustion and carbonization. It is generally accepted that the principal cause of smoke produced by burning coal is incomplete combustion of tar and light-oil, and that the greater the yield of these, the greater is the potential smoke-producing property of the coal. As an alternative source of liquid fuels, tar and light-oil obtained by low-temperature carbonization of coal are widely used both in England and in Germany.

This paper gives information on the relation of tar and light-oil yields to analyses of samples of coal of various ranks and varieties. Data obtained indicate that yields increase regularly with increase in volatile matter of the coal up to about 37%. Above this figure the relation of yields to volatile matter is very poor, and in general the volatile matter percentage is not a good index when coals of all ranks are considered. If, however, the percentage of volatile matter is reduced by an amount equal to 1·3 times the oxygen content of the coal, a good correlation with tar and light-oil yields is obtained, and the type or variety of coal appears to have little effect on this relationship. Yields can also be correlated with the hydrogen content of the coal, but in this case the type of coal has small but significant effect. Correlation of yields of the common-banded (bright) and splint coals with hydrogen content is not quite as good as that with the volatile matter reduced by an amount equal to 1·3 times the oxygen content. H. B. M.

1525.* Hydrogenation of Coal. H. H. Storch *et al. Industr. Engng Chem.*, 1944, **36** (4), 291.—A verbatim report is given of the round table conference on the hydrogenation of coal held under the auspices of the American Chemical Society. The discussion was limited to the fundamental chemistry of the hydrogenation process, and centred round the solution of coal in various solvents and the structure of the coal molecules. J. W. H.

Economics and Statistics.

1526.* The Haplolepidæ, A New Family of Late Carboniferous Bony Fishes. T. S. Westoll. *Bull. Amer. Mus. Nat. Hist.*, July 1944, **83** (1), 1–121. Bibliography of 138 items.—The Haplolepidæ are a family of small fishes from the Upper Carboniferous found in (1) cannel coals, Linton, Ohio, and Nýřany, Czechoslovakia; (2) impure cannel or parrot shales, Newsham, Northumberland, Longton, Staffordshire, Cannelton, Pennsylvania; (3) ironstone nodules, Mazon Creek, Illinois. There are two genera *Haplolepis* Miller (syn. *Mecolepis* Newberry, *Eurylepis* Newberry) and *Pyritocephalus* Fritsch (syn. *Teleopterina* Berg.)

In all cases the beds seem to have been deposited in shallow, stagnant waters, such as those of sluggish or abandoned drainage ways of coal swamps. The debris was organic (mainly plant). For a picture of the general conditions one may go to G. H. Ashley (*U.S. Geol. Surv. Bull.*, 659, 1918) or to T. Hallissy (*Proc. Geol. Assoc. London*, 1939, **50**, 330–334). It is specially noticeable that it is only in carbonaceous facies that an association of Haplolepidæ and the Tetrapod groups Aistopoda and Nectridia is found. The Haplolepidæ no doubt formed part of the food of rapacious larger fishes and Amphibia, but while *Haplolepis corrugata*, with small conical teeth, may have been able to deal with larvæ and small invertebrates, the very slender, tiny and low rounded teeth on the bones of the palate of other haplolepids suggest that they fed on planktonic life, eggs, young forms, and possible subaerial organisms from the margins of the cannel pools—though most of the insects found in such an environment to-day have no known representatives in the Carboniferous.

The physiological environment was a very special one: low oxygenation, high CO_2 content, pH probably <7, so that the very distinctive haplolepid-nectridian-aistopodan assemblage could not have migrated between Bohemia and Ohio by sea. The highly vascular auxiliary respiratory structures which seem to have been present in Haplolepidæ would make osmotic regulation alone an insurmountable barrier to marine migration. If then distribution of the group was by way of braided streams and standing coal swamps, the non-existence of the North Atlantic basin during late Carboniferous times must be assumed, as by F. Nopcsa (*Quart. J. geol. Soc. Lond.*, 1934, **90**).

Other evidence pointing in this direction may be derived from the fact that the continental Old Red Sandstone fishes of Europe have remarkable links with Canada and Greenland (*e.g.*, the distribution of *Phlyctænaspis, Cheirolepis*, and *Eusthenopteron*), while in late Carboniferous and early Permian times near relatives of some characteristic tetrapods of Texan " Red Beds " occur also in Europe.

When the Coal Measures swamps began to disappear, the change appeared in Europe north of the Hercynian-Armorican (*i.e.*, Variscan *sensu lato*) front before it affected the intermontane basins of France and Bohemia, so that it is not remarkable that stragglers of the Nectridia and Aisopoda are found in the Stephanian and early Permian of these regions. In North America a few Amphibia (Nectridia such as *Crossotelos* and *Diplocaulus*) persisted into the true red beds. But there is no evidence that haplolepids survived beyond early Stephanian. The Amphibia, such as *Diplocaulus*, which were contemporaneous with the red beds, were almost certainly semi-aquatic creatures able to withstand changes insupportable to Haplolepidæ. A. L.

1527.* Benzole Recovery. W. H. Hoffert and G. Claxton. *Chem. and Ind.*, 1944, 328.—A letter denying implications made by W. D. Scott (*c.f.* Abstract No. 1505) that they have discussed the revocation of hydrocarbon duty and its effect upon benzole costs and benzole recovery.

W. D. Scott, *Chem. and Ind.*, 1944, 351. A letter replying to Hoffert and Claxton and agreeing that the latter have not discussed the impact of hydrocarbon duty on benzole recovery. T. C. G. T.

1528. Estimated Consumption of Petroleum Products in the United States After the War. C. L. Burrill. *Petrol. Tech.*, July 1944, **7** (4), A.I.M.M.E., Tech. Pub. No. 1730, 1–13.—An attempt has been made to predict the pattern of the consumption of petroleum products in the U.S.A. during the period of transition from war to peace, the arguments and assumptions being set out in some detail.

According to the estimates, the total demand for crude and products which was 1,594,542,000 brl. in 1941 will reach a peak of 1,748,400,000 brl. in 1944, decline to 1,540,700,000 brl. in 1946, and reach 1,872,800,000 brl. in 1950. Exports of crude and products are expected to decline steadily from 101,027,000 brl. in 1941 to 46,900,000 brol. in 1950. The domestic demand for gasoline was 670,577,000 brl. in 1941, and is estimated at 620,000,000 brl. in 1946 and 850,000 brl. in 1950. The demands for residual and distillate fuel oil were respectively 383,339,000 brl. and 174,034,000 brl. in 1941, while the estimates for 1946 are 353,000,000 brl. and 190,000,000 brl., and for 1950 413,000,000 brl. and 252,000,000 brl. The kerosine and lubricating oil demands were 70,023,000 brl. and 31,400,000 brl., respectively, in 1941, with estimates of 72,000,000 brl. and 27,800,000 brl. in 1946 and 80,000,000 brl. and 35,900,000 brl. in 1950.

The paper is concerned only with the demand for petroleum products and crude, not with the supply necessary to meet the projected demands. In addition to the crude oil produced in U.S.A., the total supply of petroleum products available to meet requirements includes a substantial amount of natural gasoline and some imports of residual fuel oil and heavy crude. Also, it is generally believed that one important effect of the substantial construction of catalytic cracking plants during the war will be to increase the yields of light products at the expense of the yields of residual fuel oil, thereby making it possible to produce the light product requirements with less crude oil than would be necessary with the older thermal cracking processes. To the extent that these developments are effective, domestic crude-oil requirements will be reduced relative to total product requirements, and imports of residual fuel, or heavy crude, will be increased. It also follows that the drop in domestic crude-oil requirements from the war-time peak to the post-war low should be greater than the drop in demand for crude and products. G. D. H.

BOOK REVIEW.

The Efficient Use of Fuel. 34 Chapters, viii + 807 pp., 303 illustrations. H.M. Stationery Office. Price 12*s.* 6*d.* net; 13*s.* post free.

The drive for fuel economy is of major importance to the war effort, and will be of equal importance for the reduction of cost of production after the war. The progress which the Fuel Efficiency campaign has made has aroused in the minds of those engaged in industry a desire to know more of the subject. Lectures, works visits, etc., which have been held in all parts of the country under the auspices of the Ministry of Fuel and Power, have been attended by some 20,000 engineers, works managers, boiler and furnace operatives, and others. The desire has been repeatedly expressed at these meetings that an authoritative textbook should be made available containing a permanent record of the subject matter of those discussions and lectures. This book, "The Efficient Use of Fuel," has now been issued as a comprehensive work to meet this need, and has been designed to give the whole story of the practice and principles of fuel utilization. In preparing it the Fuel Efficiency Committee has had the co-operation of over 200 experts, comprising most of the leading authorities on fuel utilization in the country.

In undertaking this task the committee realized that no single existing textbook covers both the fundamental principles and the essential operating features necessary to obtain satisfactory results. The result is unique, in that for the first time there has been gathered into one volume material for which previously it would have been necessary to consult perhaps twenty or more standard books. It is written in a form easily understandable, and is equally suitable for students of all ages and for the busy man in the works. The Minister of Fuel and Power in his foreword says: "This book, in which has been assembled a very great deal of information not readily available, will not only serve the present urgent need, but will be of permanent value to all those concerned with the industrial use of fuel."

Each of the thirty-four chapters into which the book is divided has been submitted for approval or criticism to a panel of experts in that particular branch of the subject. The nature and properties of all industrial fuels, solid, liquid, and gaseous are discussed, together with the effects of combustion. Information is given on such important matters as draught and chimney design, combustion technique, air supply and flue-gas composition, clinker formation and prevention. The transmission of heat and the calculation of fluid flow are explained at some length; an important section published for the first time is the complete analysis from first principles of the flow of gases in a furnace system. Steam production, including boiler practice and testing, and steam utilisation are comprehensively treated. The measurement of fuels (solid, liquid, and gaseous) and of steam is described, and particulars are given of how to make measurements on the works. Six chapters are devoted to furnaces, including gas producers, furnace management and technique, the application of fuel to special industries, electric furnaces, waste heat boilers, and refractory and insulating materials.

The remainder of the book consists of information on a variety of subjects that are of the highest importance in fuel utilization, such as central heating, the technique of drying and thermostatic control. Plant used for town gas (such as governors, burners, thermostats, valves and meters) is described. Petroleum and its utilization as a fuel and the important subject of graphical heat balances are allotted chapters, while others are devoted to instruments, the sampling of solid and gaseous fuels, the analysis of coal (in which the meaning of coal analysis is explained simply for the practical man). The final chapter discusses the selection of the various fuels for industrial purposes. Three short appendices deal with the Fuel Research Board's Coal Survey, with steam tables and with entropy.

A. E. D.

INSTITUTE NOTES.

December, 1944.

FORTHCOMING MEETINGS.

Wednesday, 10th January, 1945, at 4.30 p.m. **"Spectrographic Methods Applied to the Petroleum Industry,"** by G. B. B. M. Sutherland, Ph.D., and H. W. Thompson, D.Phil.

Wednesday, 14th February, 1945, at 4.30 p.m. **"Secondary Recovery of Oil."** (Further particulars to be announced.)

Wednesday, 14th March, 1945, at 5.30 p.m. **Original Papers by Sub-Committees of the Standardization Committee.** (Further particulars to be announced.)

Wednesday, 18th April, 1945. **Joint Meeting with the British Rheologists' Club.** (Further particulars to be announced.)

Wednesday, 9th May, 1945, at 5.30 p.m. **"Code of Electrical Practice for the Petroleum Industry,"** by Alan D. Maclean, A.I.E.E. (Fellow).

Wednesday, 13th June, 1945, at 5.30 p.m. **"H.D. Lubricating Oils,"** by Special Sub-Committee of the Standardization Committee.

All the above meetings will be held at 26, Portland Place, W.1.

Stanlow Branch.

Wednesday, 24th January, 1945. **"Development in Lubricating Oil Production,"** by S. J. M. Auld, O.B.E., D.Sc.

Wednesday, 14th February, 1945. **"Pumping and Transportation,"** by T. Brookbank.

Wednesday, 7th March, 1945. **"Spectrographic Methods applied to the Petroleum Industry,"** by G. B. B. M. Sutherland, Ph.D., and H. W. Thompson, D.Phil.

Wednesday, 28th March, 1945. **"Education for the Industry,"** by F. H. Garner, O.B.E., Ph.D.

Wednesday, 18th April, 1945. **Film Show and Annual General Meeting.**

BRANCHES ACTIVITIES.

Branches Committee.

A meeting of the Branches Committee was held at Manchester on Tuesday, 21st November, 1944, with Mr. J. A. Oriel in the Chair. There were also present: Messrs. C. A. P. Southwell, G. H. Thornley and E. A. Dunstan (Northern Branch), J. S. Parker and J. C. Wood-Mallock (Stanlow Branch), E. Thornton (South Wales Branch) and F. H. Coe (Secretary).

Northern Branch.

A meeting of the Northern Branch was held at the Grand Hotel, Manchester, on Tuesday, 21st November, 1944, when Mr. C. A. P. Southwell (Fellow), gave a talk on "The Oil Fields of England," illustrated by a film.

The audience, which was a large one, included visitors from the

Manchester branches of the Institution of Automobile Engineers, Mechanical Engineers and Civil Engineers.

PERSONAL NOTES.

Sir William Fraser, C.B.E., Chairman of the Anglo-Iranian Oil Co., Ltd., has been elected a director of the Great Western Railway.

Mr. L. G. Gabriel (Fellow) has been elected a member of the Council of the Society of Chemical Industry.

Mr. J. A. Oriel (Fellow) has been elected a member of the Council of the Society of Chemical Industry. He has also been elected a member of the General Council of the British Standards Institution.

Dr. H. R. Ricardo (Hon. Member) has been awarded the Rumford Medal by the Royal Society " in recognition of his important contributions to research on the internal combustion engine."

APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

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

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

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

Membership.

BAXENDELL, Peter Brian, Student, Royal School of Mines. (*V. C. Illing.*)

BOYLE, Russell Ignatius, Student, Birmingham University. (*F. H. Garner.*)

CASTON, John Ernest Frederick, Student, Royal School of Mines. (*V. C. Illing.*)

CREE, John Aitchison Cook, Mechanical Engineer, National Oil Refineries, Ltd. (*R. B. Southall; E. Thornton.*)

DAVIES, Edward Sydney, Lecturer i/c Chemistry. Mining & Technical Institute, Neath. (*R. B. Southall; S. W. Cooke.*)

FARMER, Michael Henry, Assistant Chemist, Anglo-Iranian Oil Co., Ltd. (*H. Lambourne.*)

GRIFFITHS, Reginald St. Aubyn, Chief Engineer and Storage Manager, Cleveland Petroleum Co., Ltd. (*E. Evans-Jones; A. Harland.*)

HARDMAN, Eric, Petroleum Research Chemisty, Anglo-Iranian Oil Co., Ltd. (*A. E. Dunstan; D. A. Howes.*)

JACQUES, David Frank, Student, Birmingham University. (*F. H. Garner.*)

MALPAS, William Ewart, Student, Birmingham University. (*F. H. Garner.*)

PEARSON, Peter Dennis, Student, Royal School of Mines. (*V. C. Illing.*)

ROGERS, Derek Allan Joseph, Student, Birmingham University. (*F. H. Garner.*)

TADAYYON, Jamal, Student, Birmingham University. (*F. H. Garner; A. H. Nissan.*)

Tennant, Frank Edward, Student, Royal School of Mines. (*V. C. Illing.*)

Thomas, Maelgwyn Emlyn, Oil Accountant, National Oil Refineries, Ltd. (*R. B. Southall ; E. Thornton.*)

Tompkins, Dennis Gordon, Works Manager, Ayrton & Co. (*J. S. Parker ; V. Biske.*)

Wall, Colin Gulliver, Student, Birmingham University. (*F. H. Garner.*)

Transfers.

Barrett, James, Analytical and Research Chemist (Member). (*Harold Moore ; J. E. M. Haslam.*)

Hawkes, John Cecil, Lt., R.E.M.E. (Student). (*T. G. Hunter ; A. H. Nissan.*)

Lees, George Martin, Chief Geologist (Associate Member). (*G. H. Coxon ; C. A. P. Southwell.*)

Smith, Norman Wilson, Analytical Chemist (Associate Member). (*James Smith ; W. F. Jelffs.*)

Thompson, Francis Eric Austin, Petroleum Chemist (Member). (*G. H. Coxon ; F. B. Thole.*)

TRANSACTIONS AUTHOR AND TITLE INDEX.

An author and title index to the Transactions (1914–1944) has been prepared and will be published shortly.

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

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The Institute has published a brochure " Instructions for the Guidance of Authors " containing details of recommended practice in the preparation of Papers for publication. Copies of this brochure will be supplied on request.

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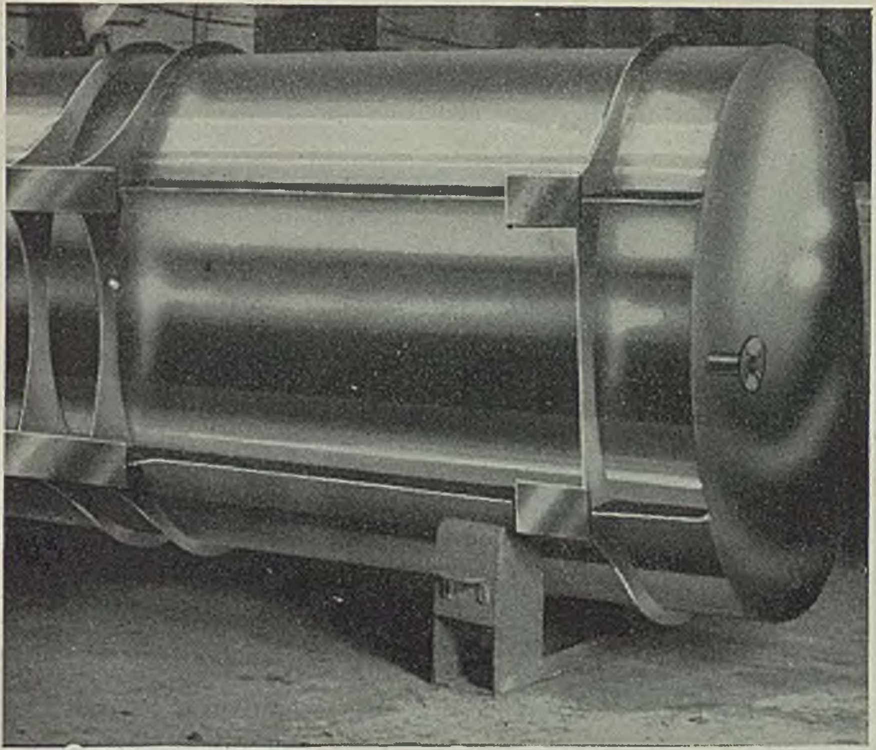

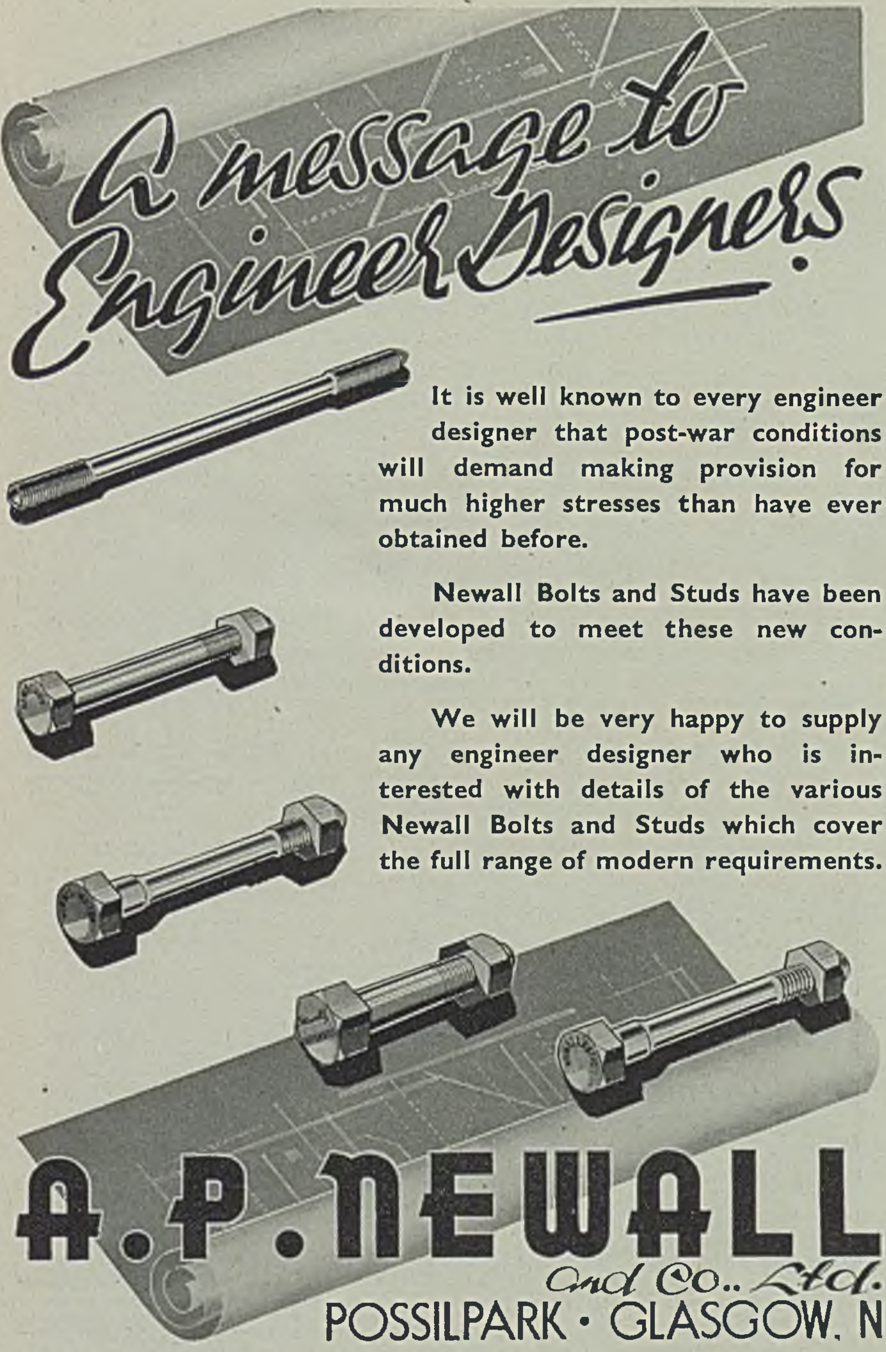

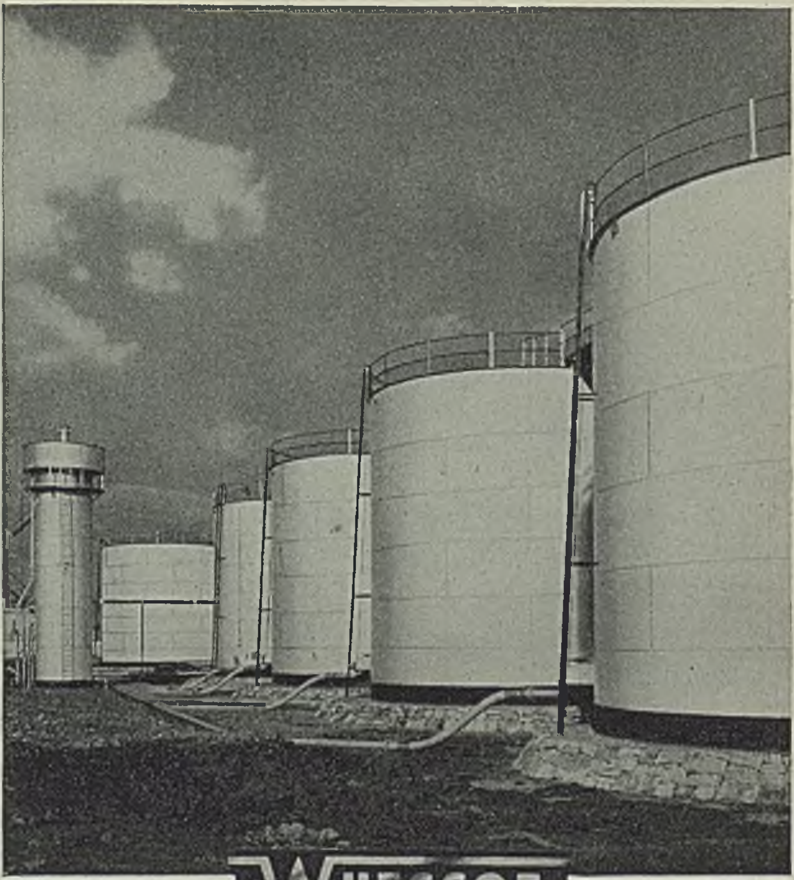


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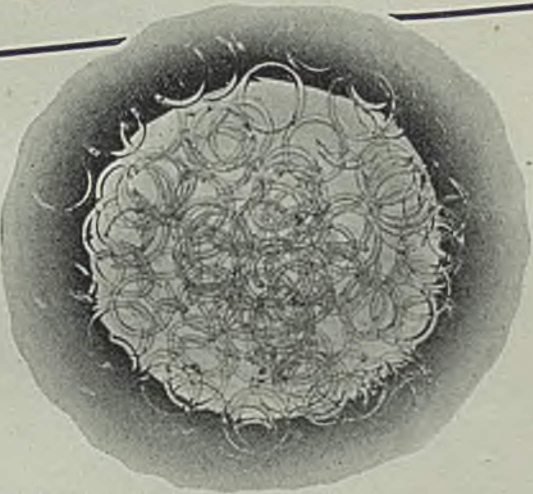

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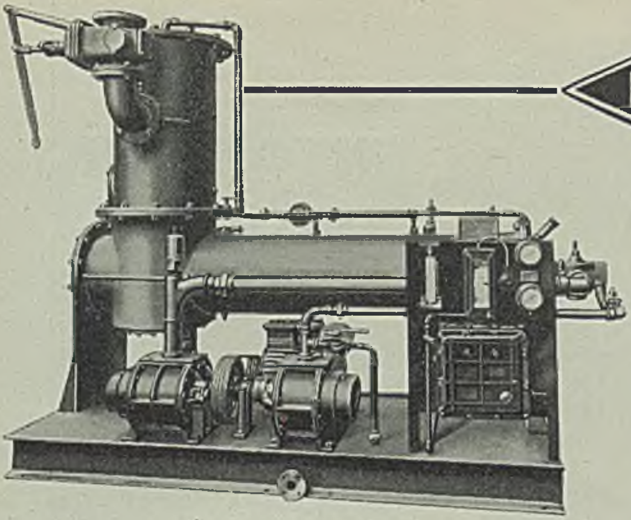

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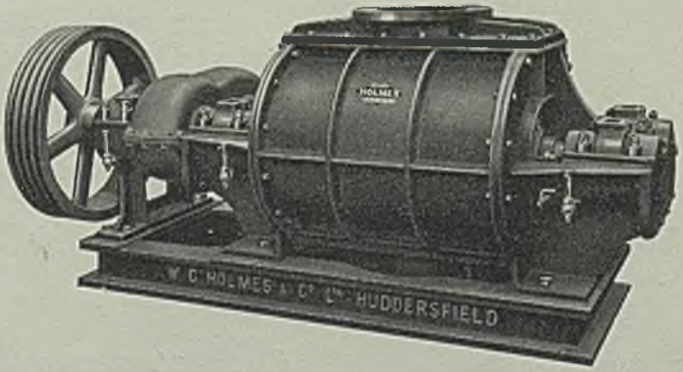

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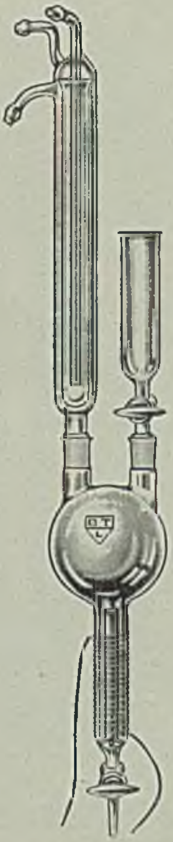

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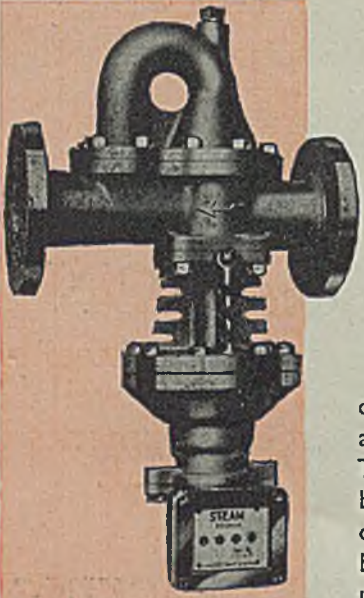
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