

## CONSERVATION OF LUBRICATING OIL.\*

*The following is a report by the Oil Advisory Panel of the Transvaal Chamber of Mines, of which the Chairman is Mr. W. E. Gooday.*

## I. STORAGE AND ISSUE.

(a) *Storage.*

Stocks of oil should not be stored in lean-to shelters, but in sheds providing proper protection.

Stocks in the mine stores should be so arranged that new deliveries can be placed in a position so that oils and greases would be withdrawn for issue in the same rotation as they have been received, thus avoiding any consignment being retained in store for undue time.

Where storage of lubricants is unavoidably out-of-doors, it is necessary to cover containers to protect them from the effects of weather, heat or wet. Drums should always be stored horizontally, and not on end.

In the case of insulating oils (transformer and switch oils), ingress of moisture affects the quality of these materials very seriously, and every effort should be made to store insulating oils under cover.

It is essential to ensure absolute cleanliness in the storage and issue of lubricants, for the most flagrant injury to lubricants is caused by allowing ingress of dust, dirt, moisture, and other impurities. Haphazard storage may detract from the value of lubricants, and possibly render them unfit for service.

Care should be taken to preserve the markings on containers, in order that the contents may always be easily identified, and to minimize risk of confusion in use.

In the storage of greases, care should be taken to maintain as equable a temperature as conditions will permit; for extremes are often the cause of separation of the constituents.

Stocks should be stacked so as to facilitate periodical examination, otherwise damaged containers hidden in a stack may leak slowly for a considerable period without detection of loss.

(b) *Containers.*

Containers that need to be cut open should not be cut more than is necessary, otherwise dirt and dust may enter. The four-gallon tin is becoming increasingly difficult to obtain, thus mines should be prepared for a proportionate increase in drum deliveries.

Before opening a barrel, its exterior should be cleaned thoroughly, to free it from any dirt that may have adhered to it in handling.

Mines should give the suppliers of lubricants an opportunity to accept returned empty containers prior to offering these to dealers.

Importers of lubricants have not usually been interested in the return of empty drums, but local manufacturers of greases are now anxious to obtain them.

Containers should always be handled carefully, so as to avoid damage in

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opening, or otherwise. When unloading drums, arrangements should be made for these to be dropped on to some material to absorb shock.

Where subsidiary distributing containers are used—possibly made on the mines—these should be preferably of sheet steel or tin, and not of material containing either lead or zinc, both of which metals may react with certain classes of lubricants.

Bucket-type containers are often emptied prematurely from time to time in order that the employee concerned can retain the bucket. This practice should cease.

Distributing containers should be examined regularly, kept scrupulously clean, and fitted with dust-proof covers to prevent impurities gaining access to the oil. They should be fitted with spouts of size designed to permit of oil being poured into syphon oilers, ring oil bearings, and other places without spilling.

All containers to be returned to stores, and the lubricant remaining in them to be removed. The idea that drainings are a perquisite available to the employee should be discouraged. It has been calculated that sometimes in four-gallon containers approximately one pint of oil remains and in forty-gallon drums one gallon.

(c) *Issue.*

The official responsible for lubricants should set an economical ration for given purposes; requisitions for amounts exceeding that ration should be accompanied by reasons. Issues of lubricant should be made, as far as possible, to the persons who will apply it to machinery. Where appropriate, issues should be limited to the minimum required for one shift.

Pouring oil from drums through the bung can be wasteful, and, where possible, a faucet should be employed.

Oil for use underground should be distributed in small containers, for the issuing of unnecessarily large quantities of oil tends towards waste, particularly with Natives prone to use the oil for purposes of bodily adornment or for dressing boots.

Rockdrill lubricators that are filled on the surface should be returned to stores with the unused oil intact.

Apart from the reduction of quantity of oil per issue, it may be advisable in some instances, which might be dictated by the size of packing available, to reduce the number of issues in a given time.

## II. APPLICATION.

(a) *Feeds.*

It is recommended that managers and engineers should consider the installation of more economical means of applying lubricants to machinery, such as force-feed mechanical lubricators, wick, drip lubricators, bottle oilers, etc., in place of the open hole into which lubricant is poured.

Feeding should, wherever possible, be automatic, although this may be difficult at the present time, as the automatic devices may not be sufficiently available.

The safety factor employed when adjusting automatic feeds is probably high in normal times—this might be reduced under present conditions. It

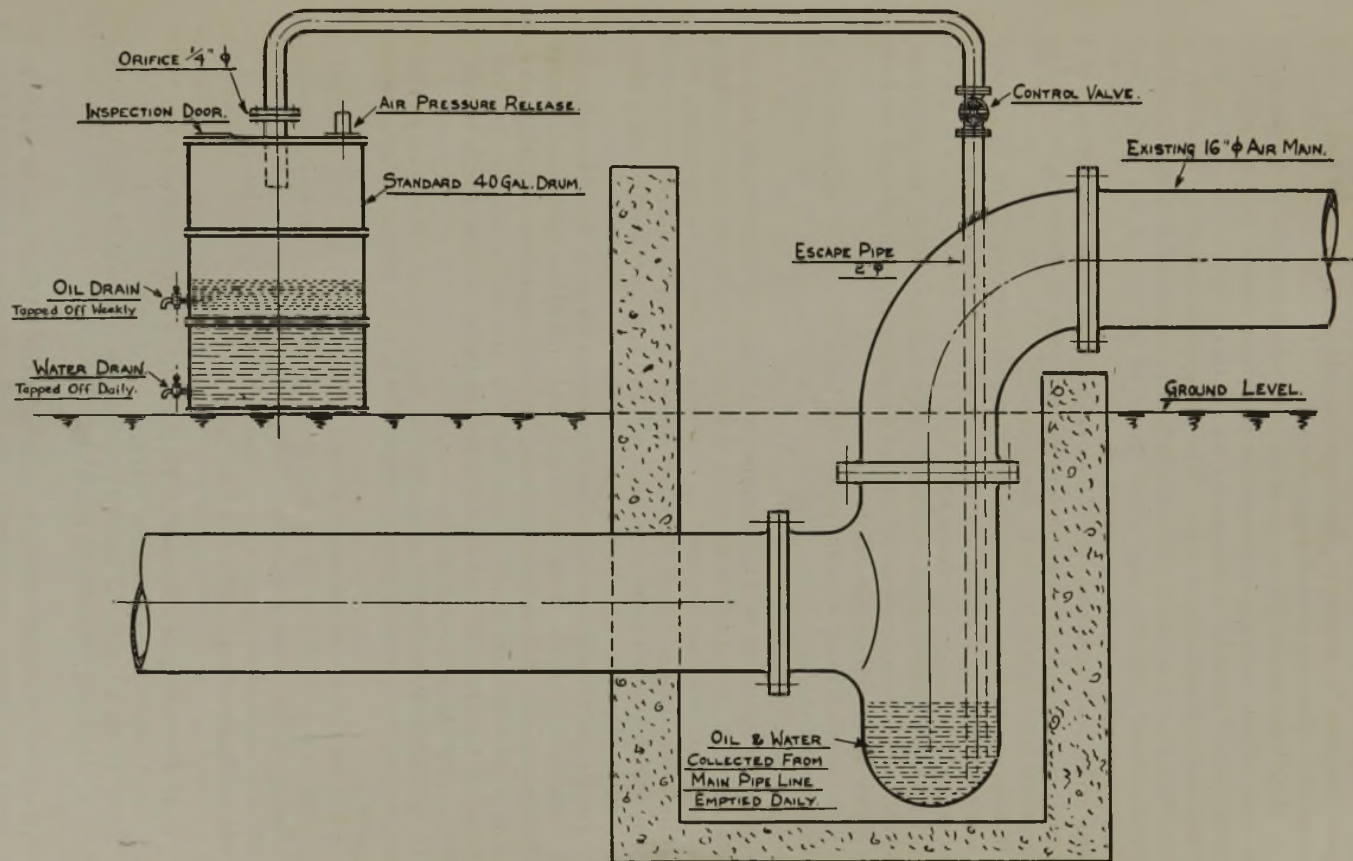


FIG. 1.



is impossible to dictate rates of feed, but it is suggested that where greater supervision can be exercised, more sparing adjustments could bring about economies. (See below and Appendix.)

(i) *Air-Compressor Cylinders*.—Whilst formulæ are available for assessing the approximate average consumption of air-compressor cylinder oils, any general use of formulæ is dangerous, owing to the varying operating conditions and types of oils in service. The oil suppliers have from time to time submitted reports to mine officials in which recommended rates of feed for air-compressor cylinders and other items of equipment are given, and reference to these reports is suggested.

Oil which accumulates in air receivers should be collected, filtered, and re-used, as this lubricant is not subjected to severe conditions in its passage from the compressor cylinder to the receiver.

In rotary vane-type compressors the oil that is fed to the barrel, necessarily in large quantities, is blown out with the air, and a successful method of recovering it is shown on drawing No. 1.

(ii) *Steam-Engine Cylinders*.—To specify minima feeds is dangerous, and it is therefore suggested that the oil suppliers' reports referred to above be perused where these are available.

In the case of some winding plant, the total volume of oil delivered to cylinders and valves is too generous. There appears to be room for economy in such cases.

Generally speaking, it is not possible to reclaim oil carried over with the exhaust steam, owing to the majority of steam-cylinder oils in service being compounded, and therefore readily emulsifiable with the condensate.

(iii) *Locomotives*.—One of the chief sources of waste in connection with steam-cylinder oils is neglect to shut off the main steam-valve to hydrostatic lubricators when the locomotive is idle.

As a guide, average consumption figures are given in the Appendix (1). In connection with the wick oilers commonly fitted on locomotive journal bearings and side rods, reference should be made to section (iv) below.

The chief source of waste in axle-boxes is over-filling and the incorrect placing of the crescent pad at the back of the axle-box; both result in leakage past the wooden seal.

In the cases of locomotive and winding engine valve-gear, such as links, pins, bushes, etc., economies have been effected by fitting grease-cups or nipples.

(iv) *Wick Oilers*.—Wick oilers should be carefully regulated to develop their full value. It is a common mistake to feed more oil than is necessary. A correctly oiled bearing will show little or no oil running out at the ends, and it is necessary to supply only a small amount to replace loss.

The methods of regulating the feed are :

1. Increasing or decreasing the number of strands of wick.
2. Using larger or smaller yarns.
3. Using a tightly or loosely twisted or woven material for the wicks.
4. Applying pressure to the wicks.

Few operators realize how very sparingly the oil-feed can be made and yet meet the bearing requirements when the supply is uniform and con-

tinuous. Frequently, for medium and small-size bearings, a single strand of wick will supply more oil than is required.

Close regulation of a wick oiler is impossible without the use of a wire wick-holder or other means to assure that the discharge end of the wick will always be in its correct position. Wick oilers will continue to feed when plant is shut down, unless the wick be removed, and removal is facilitated by using the proper wire wick-holder. In cases where plant is to be shut down for lengthy periods, all wicks should be removed.

(v) *Bottle Oilers*.—One of the most economical devices for feeding oil to plain bearings is the bottle oiler; the application of bottle oilers to the general shafting of machine shops, etc., is suggested. Since the bottle oiler is inverted and air-tight, except for the spindle clearance, oil cannot leak out unless air enters. When the shaft is stationary, no air enters the bottle and no oil is lost. When in operation, the spindle of the bottle oiler is given a motion so slight that it can scarcely be detected. This motion is sufficient, however, to result in a pumping action which causes air to enter and the oil to leave the bottle at a very slow but uniform rate.

(vi) *Rock Drills*.—It is recommended that air-line lubricators for rock drills be set by the rock-drill fitter or other qualified person at the optimum position, and that the feed be soldered at that position with the object of avoiding change of feed by the underground user. The lubricator should at regular intervals be returned to the drill-fitters' shop to be examined. It has been found that the ambient temperature at different levels affects the viscosity of the oil sometimes to a degree which may necessitate change in the rate of feed at different levels if most economical consumption is to be attained.

Waste of rock-drill oils can be due to one or more of the following causes :

1. The careless filling of rock-drill lubricators underground.
2. The pouring away of oil from four-gallon containers in order to secure the tin.
3. The pouring of oil directly into the machine to boost the line-feed lubricator.
4. Failure to return the lubricators with the oil remaining in them.
5. The practice of the drill boys of bending and releasing air hoses in order to make the lubricators surge and feed momentarily a larger quantity of oil.

See Appendix (2).

(vii) *Air Motors, Air-operated Pumps and Drill Sharpeners*.—The introduction of air-line lubricators, or where these exist, correct adjustment of them might assist in conserving oil.

(viii) *Grease—Plain Bearings*.—As mentioned under item (iii) above, there are many bearings which could conveniently be converted to grease lubrication. It will be appreciated that no precise information can be given as to which bearings should be so converted.

The tendency of Natives to waste grease and oil is appreciated; it will be found frequently that a large amount of grease is accumulated under bearings due to over-feeding. The continual application of grease by high-pressure guns or through cups to conveyor idler bearings and the like is unnecessary, and investigation here is well worth while.

(ix) *Ball and Roller Bearings*.—Frequent greasing of these bearings by means of grease guns or cups is not always necessary, and in a number of cases these fittings can be removed, as better results will be obtained by packing the bearings at prolonged intervals. However, with certain designs of bearings a periodic turnover of the grease in the housing is necessary, and therefore, before grease-cups or other fittings are removed, it is advisable that the manufacturer or supplier of the bearing should be consulted.

(x) *Cocopan Axles*.—A large amount of oil is often wasted, both underground and on the surface, due to excessive oil being scraped off wheel or other types of lubricators. Whilst much of this oil is not recoverable, a certain percentage could be recovered by installing drip-trays for a certain distance on the inside of the track.

Application of grease by means of a brush has been found to be more economical than some of the present methods in use. It is suggested that in future, where convenient, mechanical lubricators on haulages could be placed at points where cars travel at the lowest speed, in order to avoid excessive splashing and waste.

(xi) *Open Gears*.—The most economical means of applying gear dressings to tube-mill spur-rings, classifier open-gears, etc., is by means of mechanical devices to control the quantity delivered to the teeth. Owing to non-availability of materials, a large number of gears are still dressed by hand, and in this connection the application of the lubricant, after heating, is achieved more economically by means of a brush than by pouring the lubricant on to the teeth.

#### (b) *Circulatory Systems—General Remarks and Care in Use.*

High-grade oils usually employed in circulatory systems cannot be worn out in the sense that their lubricating properties are destroyed; but metallic oxides, dust or grit, held in suspension, may render them unfit for further service in that condition. They should not be thrown away, as their continuous re-use is possible if the impurities are removed by some process of purification.

Even the best oils, when subjected to rapid circulation at high temperatures in the presence of collected impurities in a circulatory system, will oxidize gradually, and unless the impurities are removed, the rate of oxidation will increase. Therefore, the degree to which an oil will resist oxidation is an important question, and the correct treatment of oil in service will extend its useful life. There is a limit, however, to the period during which an oil can remain in service without filtering or renewing the charge, and the problem then resolves itself into one of assessing its further useful life. This can be done properly only by chemical and physical analysis, but as those steps would be usually impracticable on the mines, the oil supplier should be consulted in doubtful cases.

It must be borne in mind that the mere filtering of an oil from a circulatory system may not necessarily restore the oil to a condition which will prevent emulsification with water or the further deposition of sludge, and periodic tests are the only satisfactory means of determining its condition.

(i) *Compressor Crankcases*.—In the treatment of oil in service in crankcases of air compressors, it is good practice to withdraw several gallons from the lowest point in the system at weekly intervals and to pass this oil



through a filter. If a suitable type of filter is not available, the description and drawing No. 2 in Appendix (3) may be useful.

Filtered oil plus the necessary new oil can then be used as make-up every week. In this way, solids in suspension and a certain amount of settled sludge are kept at the minimum, and the rest period in the filter assists in maintaining the oil in good condition. Provided there is no leak in the oil-cooling system fitted to a machine, no water, other than that due to condensation from the atmosphere, is likely to gain access to the crankcase oil in a compressor or vacuum pump, and there is little danger of emulsification.

(ii) *Steam-Engine Crankcases.*—The chief sources of contamination of oil in vertical steam-engine crankcases are water and other impurities which gain access either by working down the piston-rod or by entry through the breathers. In an endeavour to reduce the effect of these impurities, it is customary during every shift to drain any accumulated water and deposits from the lowest point in the sump. At weekly periods, several gallons of oil should be withdrawn and passed through a filter as described above.

(iii) *Steam Turbines and Electrically-driven Turbo Compressors, etc.*—The oil from turbines should not be drained and replaced by new oil without previous reference to the supplier of the oil in service. In view of the importance of maintaining turbine oil in good condition, it is considered that advice should be sought on individual cases. A few of the more important points concerning the care of turbine oil are given in Appendix (4).

(iv) *Hoist Hydraulic Systems.*—In these systems the oil is seldom contaminated with water, but service conditions are severe in regard to oxidation. Because of the small passages in the control valves, etc., sludge is dangerous. Periodic examination of the oil-sump for deposited sludge is recommended.

(v) *Gear-boxes.*—Owing to the wide variety of types and sizes (splash and spray lubricated) of gear-boxes and the frequent use of compounded oils in worm gear-boxes, it is difficult to offer any general statement about limiting conditions for the oil. Experience has shown that charges of gear-box oils have had to be discarded, due to contamination with grease which resulted from the over-feeding of grease to bearings on these gear-boxes. Over-filling and the mechanical condition of oil-seals are factors that require attention, and which are often responsible for waste of oil, particularly in underground winches, etc.

(vi) *Gyratory Crushers.*—The chief source of contamination in most instances is rock dust, but in some cases of units fitted with water-seals there is a danger of emulsification if the seals are not maintained in proper condition. Ordinary gravity-type filters are often incorporated in the crusher oiling system, but as these filters will not usually remove water or any oil-oxidation products, periodic treatment of the entire charge is the safest procedure.

(vii) *Diesel Locomotives.*—The modern trend is to use oils containing additives in the crankcases of underground and surface Diesel locomotives, and care should therefore be taken to ensure that whatever filter is used, the method of treatment will not affect the additive. Owing to dilution by fuel and the presence of finely divided carbon, resulting from incomplete combustion, it is often difficult to reclaim oils from Diesel engine crankcases.

Generally speaking, where the quantity of crankcase drainings involved is not large, attempts should not be made to filter the oil. Drainings should be accumulated and the Group Buying Department kept advised.

(viii) *Ring-Oiled Bearings.*—Ring-oiled bearings (or collar or chain) are, in effect, miniature circulatory systems, and the oil from these bearings can be reclaimed. To avoid waste, the bearings should not be over-filled, otherwise the quantity of oil fed by the ring cannot be handled by the oil return grooves, and leakage occurs.

(ix) *Motor Transport.*—The crankcase oils from trucks and passenger-cars can be reclaimed, and should not be discarded, as suitable reclamation plants are in service. Ways and means to reduce consumptions have been advertised widely.

(x) *Transformer and Switch Oils.*—Owing to the importance of maintaining the quality of these oils, apart from the preservation of dry condition by centrifuge, filter presses, etc., they cannot generally be reconditioned completely by simple local processes. These oils can be sent to undertakings that specialize in complete treatment.

(xi) *Cutting Oils and Compounds.*—These media usually become contaminated only with metal shavings and dust, which can be removed by passing the cutting fluid through cotton-waste or gauze filters. A method of adjusting the strength of the emulsion is given in Appendix (5).

(xii) *Wire Ropes.*—Rope dressings collected inside engine-rooms from hoist-drums, etc., can be recovered, but in view of the tacky nature of these products, local reconditioning is usually out of the question. These products can be salvaged, and should be sent to undertakings specializing in this work. To avoid contamination and loss of rope dressings in service, steps should be taken, where possible, to prevent water impinging upon ropes or haulage ropes dragging through water or dirt.

### III. RECONDITIONING OF OIL.

It is desired to emphasize the view that no lubricants of any kind should be discarded, for it is considered that some further use can be found for all used products. In collection, care should be exercised to segregate the various types and grades wherever this is feasible.

It is known that on many mines reconditioning methods are already in use successfully, and it is not intended to submit suggestions that would disturb such practice.

In fact, it is wellnigh impossible to offer recommendations covering the best methods to be employed for oil reconditioning, as such wide variations exist in the type and condition of used lubricants to be handled. In general, where doubt may exist as to what should be done with used lubricants, it is recommended that consultation with the supplier of the product in question is the first step to take.

Bearing in mind the foregoing view, it can nevertheless be stated that contamination by extraneous impurities is usually removed by the use of ordinary gravity-type filters. On the other hand, where decomposition products of the oil itself have to be removed, the selection of the most appropriate type of oil regenerator necessitates technical consideration.



Users should be warned against the indiscriminate use of oil-reclaiming devices when special types of lubricants containing inhibitors, additives, etc., are in service, otherwise there is likelihood that the quality of the lubricant may be impaired.

The reconditioning of greases is not generally practicable on the mines, nevertheless, no used grease should be discarded. When collecting such products, greases recovered from machinery housed in clean surroundings should not be mixed with those recovered from plant operating under unavoidably dusty conditions, where they will have been subjected to greater contamination. In the first instance, the cleaner greases could be employed again for axles of cocopans. In the second case—that of badly contaminated greases—the possibility of recovery should be made a matter of reference to the Group's head office.

By way of reminder, the following methods of oil treatment are mentioned.

1. Settling.
2. Washing.
3. Centrifugal separation.
4. Filtration—gravity or pressure filtration.
5. Chemical treatment.

#### IV. ALTERNATIVE GRADES AND INTER-CHANGEABILITY.

It is impracticable to draw up a schedule showing types and brands of oils that could be used as alternatives in place of the oil customarily used. Manifestly, this matter is related closely to the stock position, and any difficulty in obtaining supply of a particular lubricant should be referred to the oil supplier for advice as to alternatives.

#### V. GENERAL.

In any case where lubricants are in stock and where the mine holding such stock is not sure of the origin and the use to which they can be put, the matter should be referred to the Group Buying Department.

### APPENDIX

#### (1) STEAM LOCOMOTIVES AND ROLLING STOCK.

The following figures might prove of interest :

Cylinder-oil consumption per 100 miles running on English railways is 1.0–1.2 pints; French State 0.6–1.8; and the South African Railways and Harbours 1–2½ pints (2½ pints for the largest class 23 locomotives). An average figure for comparative purposes for mine locomotives would seem to be in the neighbourhood of 1 pint per 100 miles for cylinder oil only.

Motion and journal oil should average about 2 pints per 100 miles, and waste-packed axle-boxes consume approximately 1 pint of oil per 3000 miles.

## (2) CONSUMPTION OF ROCK-DRILL LUBRICANTS.

In drawing comparisons of rock-drill lubricating-oil consumptions between different mines, this is often stated as so much per 100 feet drilled, but this does not take into account the penetration in inches per minute or the type of machine. As the quantity of oil fed to a jack-hammer by an air-line lubricator is a function of time of operation rather than of footage drilled, it would be preferable to arrive at a consumption figure based on time. For example, the 100 feet drilled could be divided by the penetration in feet per minute, and a factor arrived at which could give the fluid ounces con-

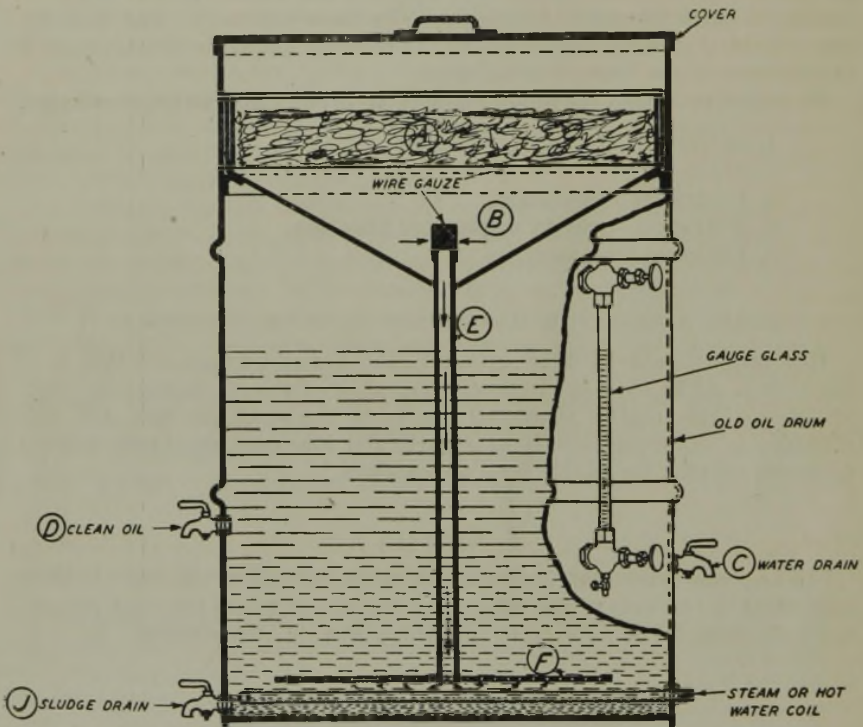


FIG. 2.

sumed per hour of machine operation. This, it is felt, will give a more accurate basis for comparison of consumptions.

As the consumption of drifters is usually higher than that of jack-hammers, the ratio of jack-hammers to drifters used in any particular shaft or mine should also be considered, as this materially affects the overall consumption.

## (3) SIMPLE GRAVITY-TYPE FILTER.

*Instructions for Installation and Operation.*

It should be noted that this filter is not intended to supplant more comprehensive apparatus. Its function is to assist in maintaining oil in good condition during service.

The accompanying drawing No. 2 shows the construction of a simple, inexpensive oil-filter which can be made out of an old oil-drum.

The top compartment *A*, which is a circular iron tray with a gauze bottom, is filled with good, clean cotton or wool-waste tightly packed to within 1 inch of the top, thus providing sufficient space for the oil to spread over the surface. Before the filter is used the waste-packed compartment *A* and the funnel-shaped receptacle *B* are removed, and the body of the filter filled with water to a level indicated by the water-cock *C*. New oil is then poured in until the level rises to the filtered oil-cock *D* which should be approximately 2 inches above cock *C*. *B* and *A* are then replaced.

The oil to be filtered is poured into chamber *A*. It percolates through the filtering medium, passes the gauze screen, flows into the receptacle *B* and in turn passes through the gauze cap and down-pipe *E*; finally it gravitates through the perforated disc *F* (the holes in this disc should not be greater than  $\frac{1}{4}$  inch diameter), and then rises through the water. The oil can then be drawn off through cock *D* ready for re-use. Any impurities settling at the bottom of the filter are withdrawn through cock *J*.

Filtering rate is increased if the water in this filter is heated up to about 180° F. by means of a steam- or hot-water-coil as shown. This thins the oil and speeds settling of entrained impurities. Heating the oil to more than 180° F. will set up convection currents in the oil which hinders precipitation.

The oil when filtered will be darker than its original colour, but this has no effect whatsoever on its lubricating properties.

The waste in chamber *A* will need renewing after being in use for some time, but this is best judged by its condition.

#### (4) STEAM TURBINES.

The length of service of which the oil in the circulatory system of a steam turbine is capable is proportionate to the care given to the oil. The following points deserve attention:—

(a) *Oil and Water Leakages*.—Keep to the minimum leakage of oil at pedestal seats, pipe-joints, etc., and of water into the oil from steam- and water-glands, etc.

Prevent leakage of oil and water in the oil-cooler.

Draw off all water from the system at regular and frequent intervals.

(b) *Oil Inspections*.—Once a week take representative samples of the oil in circulation, preferably in test-tubes, from:—

- (i) pressure oil line just before cooler; or
- (ii) return oil line from bearings; or
- (iii) oil reservoir above level of pump suction.

The samples should be drawn from the same point each time and each sample should be labelled.

Keep each sample for four weeks, and compare the condition of the oil during progressive service.

(c) *Oil Treatment*.—Where automatic by-pass filtration is not installed, withdraw (preferably from the lowest point in the system), daily or weekly,



according to the operating conditions, a portion of the oil circulation for treatment by centrifuge, or by settling or filtration or both.

Maintain the oil level by the addition of new or treated oil.

(*d*) *Temperatures.*—Take daily the temperatures of the oil and of the water entering and leaving the oil-cooler. Changes in these temperatures in relation to changes in atmospheric temperatures will indicate whether or not the oil-cooler is performing its function properly.

Take also daily the engine-room and bearing temperatures. An increase or decrease in engine-room temperature should be reflected in a relative variation in oil-circulation temperature.

(*e*) *Cleaning the System.*—The periods for cleaning the turbine system should be determined and regulated by:—

Marked increase in the amount of deposits shown by comparing oil samples—see (*b*).

Marked increase in the rate of impurities deposited in filters—see (*c*).

Marked change in temperature records—see (*d*) and (*f*).

Clean the settling-tanks and filters at regular and frequent intervals.

It is dangerous to use waste for cleaning oil systems, Mutton cloths, or similar materials, should be used for this purpose.

(*f*) *Log Book.*—Keep careful records by date: of the quantities of water drawn off from the system (item (*a*)); of the samples drawn for inspection (item (*b*)); of the oil withdrawn for treatment and returned to the system respectively, and of new oil added (item (*c*)); of temperatures (item (*d*)); and of the cleaning and re-filling of the entire system (item (*e*)).

The above points, with the exception of references to steam, apply also to oil in circulation in Electrically-driven Turbo Compressors, etc.

#### (5) CUTTING OILS AND COMPOUNDS.

During machining operations heat is generated at the cutting edge of the tool. Where soluble oil emulsions are used, high temperatures may bring about partial evaporation of the water, upsetting the proportion of oil to water. In other instances oil may be lost resulting in a weakening of the emulsion. A point may be reached where the emulsion separates and the entire charge of cutting fluid is discarded. To test the strength of the emulsion a sample should be placed in a graduated flask and a few drops of dilute sulphuric acid added. This will usually break the emulsion, thus enabling the strength of the emulsion, *i.e.*, proportion of water to oil, to be estimated. The necessary amount of oil or water to be added to bring the emulsion back to the correct proportions can then be calculated.

## A NOTE ON OIL FIRES.\*

By A. F. DABELL.

FIRE from liquid fuel is more easily controlled than that from solid combustibles, and calls for less man-power where drainage facilities are provided. Fire from a solid combustible must be fought to a conclusion upon the site of its fuel.

When liquid, the fuel may be transferred at will to chosen sites and extinguished by subtle measures. For example, if a so-called inflammable liquid in a container open at the top and fitted with a drain-cock at the bottom becomes ignited, the duration of the fire may be regulated by draining away the liquid. If drainage be made through a pipe leading to a second container, the fraction of liquid lost by fire will be proportional to the time taken by the transfer. If a barrel of petrol at ground level be connected to another below ground level, similar extinction and salvage are obtainable in case of fire.

Where inflammable fluids are stored in congested areas, their containers can be connected to receptacles of equal capacity (upon waste ground) at lower level, and then, in the event of fire, extinction and salvage are assured.

The same applies to installations of the largest dimensions. Moreover, given fire within any enclosure, it can be starved to death by draining its fuel through a wall or bank. Even a sea of fire from fugitive oil may be brought under control by guttering to a sump with pipe entry, and more readily so if guttering of herring-bone pattern be made in good time.

Common to all installations :—

1. Where topography, expense, etc., are a deterrent, liquid responsible for the fire may be run into the earth by way of a pit or bore sunk to the first water-bearing or absorbent stratum in its vicinity.
2. The greater the distance between containers, the less the risk of re-ignition of vapour released.
3. The period of flickering expiry of burning vapour in the original container will be shortened by the insertion of a gas-trap in the pipeline.

\* Received 29th October, 1942.

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## Geology and Development.

**1017.\* Stratigraphy and Insoluble Residues of Madison Group (Mississippian) of Montana.** L. L. Sloss and R. H. Hamblin. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 305-335.—The western part of Montana, where the Carboniferous Limestone is concealed by overthrusting, belongs to what was once part of the Cordilleran geosyncline. The rest of the State is underlain by a continuous sheet of Madison Limestone (Lower Mississippian), 500-1200 ft. thick, the greatest development being found in a broad west-south-west-east-north-east basin which runs into North Dakota. Faunal evidence indicates a Kinderhook and Osage age, and that the early Mississippian sea of Montana connected with that of the Mississippi Valley.

The lower division of the Madison is the Lodgepole formation. At the bottom of the Lodgepole is the Paine member (180-320 ft.), consisting of shales and thin bryozoan limestones with chert lenticles. The shales, which seem to thin eastwards, have conodonts much like those in correlative Chattanooga and Woodford shales. The black fissile Chattanooga facies covers an area 2000 ml. long, but is treated as having been deposited in shallow, often more or less isolated, basins. Above the Paine is the Woodhurst member (270-340 ft.), with massive limestone beds that may show abundant crinoidal debris above channelled surfaces.

The upper division of the Madison is the Mission Canyon (330-700 ft.), of pure, very massive limestone. In the Little Rocky Mountains current-bedding is common in beds mainly of calcite grains—*i.e.*, limestone sand produced by erosion, and less frequently oolites. About the middle of the Mission Canyon there is a chert horizon. Intense solutioning has taken place partly in the Palaeozoic, partly in pre-Jurassic time, when a karst topography developed and "solution breccias" were formed by collapse of cavern roofs. The Mission Canyon represents the greatest extension of the Madison sea, and, except for clastics near the emerging range of the Uinta-Front in Southern Wyoming, is almost purely calcareous.

In middle Valmeyer time the sea shrank into the centre of the Montana basin, where evaporites were deposited, while erosion went on round the sides. Marine spreading before and during early Chester time provided the Big Snowy sediments, but until late Chester or early Pennsylvanian time a narrow tongue of land persisted along the southern border of Montana.

Petroleum reservoirs have so far been found only in the Mission Canyon formation. In the Kevin-Sumburst field most of the oil is from the top 10 ft. (1) in a loose rubble of eroded limestone pebbles and silts, locally known as the "Ellis Sand"; (2) in layers with cherts and silicified fossils from which the calcite has been dissolved out; and (3) where there has been differential solution of calcite from partly dolomitized limestone. The Turner Valley field, Alberta, yields from three porous zones in the upper 400 ft. of the Mission Canyon (= Rundle) where W. D. C. MacKenzie has claimed that porosity is everywhere associated with dolomitization. The dolomitization often follows stratigraphical horizons, and it is suggested that it may have been controlled (1) by the easier entry of ground-water in areas of much jointing and fracturing, and (2) by more ready circulation of water through cross-laminated layers of calcite sand which are more porous than normal limestone.

The Paine group gives a residue of clay galls bearing dolocasts; also tan and grey chert with silicified bryozoa. Woodhurst residues contain abundant silicified crinoid columnals and brachiopods, brachiopod shells and spines, echinoid spines, hexactinellid spicules; some zones have numerous sub-rounded quartz grains; oolitic grains and oolitic clusters are common. Mission Canyon residues do not exceed 2% of the sample, and yield quartz and white chert grains with accessory magnetite, tourmaline, ilmenite, zircon, garnet, biotite, and muscovite; silicified fossils occur in a few zones; one zone has clusters of quartz crystals.

Points of distinction between these remainders and those of other limestones in Montana are indicated. Residues of the Bighorn dolomite (Ordovician) resemble those of the Mission Canyon, but occur in much greater amount. A. L.

**1018.\* Stratigraphy of North Dakota.** Virginia H. Kline. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 336-379, with bibliography and map.—Only the south-west part of North Dakota is free of glacial drift, which in other areas includes three stages—one of pre-Wisconsin age, and two belonging to the Wisconsin. This sum-

mary is, therefore, based on river sections and well-cores. Several well-logs of type sections are quoted at the end of the paper.

Pre-Cambrian gneiss, granites, and quartzite are found beneath the drift of the Red River valley; and the surface of this pre-Cambrian complex slopes down westward at least 25 ft./ml. Some superjacent sandstone may be Cambrian, but there is no evidence of this system farther north in Manitoba. The Ordovician starts with sandstone and grey to brown shales which pass up into red shale, limestone, and dolomite. The Silurian is mainly limestone and dolomite. The Devonian, present over nearly the whole State, is of red to grey shale and cream limestone.

The Mississippian, recognized only in Kamp No. 1 well, Williams County, is over 2800 ft. thick, with limestone and dolomite followed upwards by red shale and halite, and topped by black and grey shales with coal. The Mississippian is restricted to the western half of North Dakota, as also are red shales and purple sands of the Pennsylvanian and Permian, salt-bearing strata of the Trias, and the Jurassic, which includes Sundance-Ellis shale, sandstone, and limestone, and the Morrison variegated shale.

The Cretaceous, covering nearly the whole State except the Red River valley, dips westward at 10 ft./ml., its basal unconformity decreasing in the same direction. It begins with Lakota white sandstone with some shale and abundant pyrites, succeeded by the Fuson shale break with lenticular limestones, and the Dakota sandstone, which is here a thin bed (0-90 ft.) of micaceous, loosely cemented, white sandstone containing associated pyrites, gypsum, and lignite. A few foraminifera are found in the Dakota that also appear in the overlying Benton dark clays which are distinguished by large selenite crystals and much free sulphur. The Benton fauna includes *Lenticulina* sp., *Gümbelina globosa* (Ehrenberg), *Globigerina cretacea* d'Orbigny, etc.; and at Devil's Lake and Langdon the number of these abruptly increases at horizons respectively 255 ft. and 280 ft. above the top of the Dakota sandstone.

The Niobara "cement rock"—argillaceous limestone—has the same fauna as the Benton plus *Planulina kansasensis* Morrow, *P. complanata* (Reuss), *Gyroidina nitida* (Reuss). It is also characterized by decrease in number of *Globigerina cretacea*.

The Pierre (no. 2) is thicker than the rest of the Cretaceous. It begins with black shales, associated locally with fuller's earth, which weather in plastic fashion like the Benton, but contain fish-scales instead of foraminifera. Higher up are grey shales with zones of concretionary ironstone. Thin limestones are common, and the calcareous shale at Valley City may be equivalent to Chalk of the Upper Gregory in South Dakota.

The Fox Hills group at the top of the Cretaceous is of cross-bedded sand with ironstone.

Tertiary deposits occur in the western half of North Dakota. The Lance formation begins with the Hell Creek grey or brown—"somber"—continental beds of sand, shale, and limestone. In these, gravel and lignite are rare, but there are huge disc-like and log-like concretions of sandstone, and in addition ironstone nodules. The Ludlow formation is similar. But the Cannonball at the top of the Lance is marine and has massive sandstone and interbedded sand and shale.

The Fort Union is of white clay, sandy clay, and sandstone, all of fresh-water origin. It contains thick beds of lignite, and sometimes near the junction of Upper and Lower Fort Union these have caught fire so as to give rise to "clinker." The sands are less coarse and less cross-bedded than those in the Lance. The White River beds are lacustrine and fluvial clays and sands.

There are no important unconformities in the Cretaceous and Tertiary. A. L.

1019.\* **Pre-Cretaceous Topography of Western Edwards Plateau, Texas.** E. H. Jager. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 380-386.—R. T. Hill first recognized the importance in Texan geology of the surface of pre-Cretaceous erosion, which he named the Wichita palæoplain. After deposition of the Trias, erosion was active during Jurassic and earliest Cretaceous time, until the advance of the Comanche sea laid down the basal Trinity sands. L. D. Cartwright in 1932 published a detailed structural contour map of the old peneplain in the eastern part of the Edwards Plateau, and indicated probable islands in the Trinity sea.

In the western Edwards Plateau, Jager demonstrates a topographical elevation in Upton County, and east of it a gentle slope to south-east at 8-10 ft./ml., reduced to



6 ft./ml. in a southerly direction in Crockett County. An apparently pre-Comanche valley crosses the old peneplain, following the course of the Pecos river. This depression was ascribed by Morgan Roberts to solution of subterranean salt-beds. But Jäger thinks the only area with possible sink-hole or "flash" topography, due to solution of Castile evaporites, is that in Blocks 16 and 18 of the University Lands, in Pecos County.

South of the Pecos river the ancient surface rises south-westwards at 25 ft./ml., but soon this is changed to a southward slope of 60 ft./ml. as the Cretaceous thickens into the Rio Grande embayment.

Because of planation before the deposition of Triassic terrestrial beds, Permian structures like the Sheffield channel do not show up well in the pre-Cretaceous features.

Even distribution of the 150-ft. Trinity (= Paluxy) sands and shales indicates few Comanche islands.

Regional uplift has affected the whole of the western Edwards Plateau, and the Fort Stockton plateau has been tilted eastwards. A. L.

**1020.\* Los Angeles Basin Earthquake of October 21, 1941, and its Effect on Certain Producing Wells in the Dominguez Field, Los Angeles County, California.** K. M. Bravinder. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 388-399.—The series of anticlinal oilfields, arranged *en echelon* along the Newport-Inglewood fault line, are regarded as the result of horizontal shearing movements between blocks of the underlying basement. In the October earthquake the epicentre was 3 ml. south-east of the middle of the Dominguez field. The structure here is still growing, and unrelieved stresses, present near the crest of the western block, were released by movement of an east-west fault. The hade of the fault increases towards the surface; and, where the hade is greatest, the horizontal component of movement was at a maximum and damage was most severe to tubing in wells. A. L.

**1021.\* Patterson Pool, Kearny County, Kansas.** M. D. Hubley. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 400-401.—The Cherokee group (Pennsylvanian) has been added to the producing zones of western Kansas, and production has been carried to a point within 33 miles of the Colorado border. The Patterson sand lies at a depth of 4740-4752 ft. Bottom-hole pressure 1128 lb. Pumping capacity about 3964 bbl./day. Gravity of oil 34° Bé corrected. A. L.

**1022.\* Artinskian Series [U.S.S.R.].** C. O. Dunbar. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, 26 (3), 402-409.—Reasons are given why the Artinskian grits and rudaceous strata (?Permian) should be treated as lateral interdigitating variants of the limestones of the Ufa Plateau on the west side of the Ural Mountains. The view that the detritals are wholly younger than the limestone which might be Carboniferous depends on Tolstikhina's report of *Schwagerina lutugini* in the "Lower Artinskian conglomerates," east of Buloga. This point requires corroboration, but the fusuline in question is not restricted to the topmost limestones of the plateau. The *Guide-book, Permian Excursion, Northern Part, Seventeenth International Geological Congress* (1937), confines *S. lutugini* to a zone well below the middle of these limestones. A. L.

**1023.\* Permian of West Texas and South-Eastern New Mexico.** P. B. King. *Bull. Amer. Ass. Petrol. Geol.*, April 1942, 26 (4), 535-763.—This monograph, illustrated by geological panoramas and palaeogeographical maps, gives an account of sedimentation and correlation of the Permian of West Texas and of South-eastern New Mexico. The Permian is buried in the middle of the basin, but exposed in broad plains on the east and in mountains on the west. Two of the western ranges—the Guadalupe Mountains and the Glass Mountains—are fully described as type sequences. The four series of rocks dealt with are the Wolfcamp (probably Permian), followed by the Leonard, Guadalupe, and Ochoa. The rocks of the Guadalupe Mountains region were laid down near the edge of the Permian Delaware basin, at the margin of which differential rates of subsidence, contrasting salinities, etc., result in complex changes of facies as between a shelf area and a basin of maximum subsidence. At times, along



the line of hinge dividing the two, very interesting reef or "reef-knoll" deposits were accumulated.

On the shelf the Wolfcamp series takes the form of the Hueco limestone, unconformable on Pennsylvanian, but with a transitional Upper Carboniferous-Permian fauna. In the basin it becomes black and shaly.

The Leonard, in places unconformable on Wolfcamp, consists in the marginal area of Victorio Peak limestone, on the hinge of grey "reef-knoll" limestone, and in the basin of black, thin-bedded Bone Spring limestone with shale.

On the margin the Guadalupe begins with an unconformity. In the basin it is mainly sandstone, and the lower member thins out against the Leonard. The middle and upper members change on the shelf into the reef-masses of the Goat Seep and Capitan limestones. Peripherally to these there are finely bedded limestones, and finally the evaporites of the Chalk Bluff formation.

The Ochoa is dominantly of evaporites, mainly anhydrite and salt, with some dolomitic limestones and red beds. Potash salts are mined in three places. There is overlap on the Guadalupe.

Monocline flexures on the margins of the basin seem to have moved before, during, and after Permian time, and affected facies distribution, especially in the Leonard. The "reef-knolls" of the Guadalupe are closely related to the margins of the basin. Probably initiated by shoaling, a condition partly of tectonic origin, their growth was maintained by continued greater subsidence of the basin than of the adjacent shelf areas.

Basins and shelves appear to correspond with uplifts and subsidences initiated before Wolfcamp time when the West Texan region formed a foreland—which was gently folded, upraised, and deeply eroded—with reference to a southern geosynclinal which was being compressed to give the Marathon folded belt. Wolfcamp seas spread over the whole area, but from the Leonard onward the trend was towards withdrawal, so that red beds, evaporites, and lagoonal deposits encroached farther into the Delaware basin. The connection of limestone "reef-knolls" with minor marine advances following upon big retreats of the sea may be significant, if the material of these is partly derived by erosion and solution of older limestones. On p. 638 King shows diagrammatically the theoretical relations between reef-growth and subsidence of a basin. When there is no subsidence towards the basin, the reef grows in a horizontal direction. With upward growth of the reef greater than subsidence, the reef takes up successively higher positions towards the centre of the basin. If upward growth is equal to subsidence, the reef ascends vertically. Where subsidence (= marine advance) exceeds reef-growth, the accumulation of poorly bedded limestone takes place at higher and higher levels in positions at a gradually increasing distance from the centre of the basin. For reef-growth King (p. 730) postulates warmer, more agitated water in which calcium carbonate would be less soluble than in the cooler, quieter water of the deep basin. The oxygenated disturbed water would favour food-getting by organisms. Lime-secreting animals and plants would thrive in it, and, on account of its saturation with lime, their shells after death would be safe from dissolution. Limestone barriers formed in such alongshore positions would also prevent sediment from reaching the deeper water. Thus there is evidence of depths of 1000 ft. or more in late Guadalupe time when reef-building was at its acme.

It is suggested that in two instances—at the end of Leonard and at the end of Guadalupe times respectively—the withdrawals of the sea may have been eustatic due to a widespread alteration of sea-level. Either that, or there was broad uplift of the continent over an immense territory.

A. L.

1024.\* **Pseud-Abysal Sediments.** W. G. Woolnough. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, 26 (5), 765-792.—The late Neogene has seen great orogenic activity. Continents at present stand much higher out of the sea than during most of geological time. Existing conditions tempt geologists, trained in North Atlantic countries, to misapply Sir Charles Lyell's theory of uniformity of erosional and depositional processes. Woolnough re-propounds that, during certain ages when land was "ultra-base-levelled," accumulation of terrigenous materials contributed by rivers to the sea was subordinate to purely marine deposition upon much-extended continental shelves. Woolnough refers illustratively to the advanced ep-Archæan and ep-Alonkian penepains of the Grand Canyon, as described by R. P. Sharp, and regards

mechanical erosion (other than by wind) as ceasing when peneplanation is "perfect."

The radiolarian hornstones (Trias or Jurassic) of the Moluccas and Borneo are often intercalated in coarsely clastic beds, so that they can scarcely be of abyssal origin. Nevertheless, they were formed under conditions of (1) reduced transportation of detritus, (2) virtual absence of calcium compounds, (3) presence of soluble silica and probably also of iron-hydroxide and alumina in colloidal form, (4) possible carbonation and low oxygenation of adjacent water, (5) presence of organic acids or bacteria. In the area of deposition required for the radiolarian cherts, benthonic organisms could not exist, calcareous shells were excluded or subject to solution, the dentine on sharks' teeth might be dissolved, and manganese nodules—as in Timor radiolarites—could be formed.

Woolnough suggests all this is possible in fairly shallow waters if on land the ultimate stages of peneplanation and chemical weathering are reached. The red clays of the East Indies are usually associated with basic and ultrabasic igneous masses, which possibly, where exposed to erosion, had lost all their lime. Woolnough tries to explain the absence of current-bedding in his shallow seas by introducing barriers. These would cut off free marine circulation; and toxic bottom conditions can also be ascribed to this circumstance.

Reference is made to K. André (1905), who doubted the deep-sea origin of these East Indian radiolarian rocks and those of the Alpine Trias. The cherts of the Culm may also be a case in point, since along the right bank of the Rhine Posidonia beds and Culm facies are intercalated. The determining factor seems to be one of sedimentation, not of depth.

A. L.

**1025.\* Geology of Honda District, Colombia.** J. W. Butler. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, 26 (5), 793-837.—The town of Honda is situated on the Rio Magdalena, north-west of Bogota. Here different sedimentary facies characteristic of the Upper and Middle Magdalena Valley regions may be traced into each other, and so be correlated. Three distinct geomorphological sub-provinces occupy north-south belts. Going from east to west, we find:—

(1) The West Slope of the Cordillera Oriental is made up of the Guadas group (Eocene) resting on Cretaceous and overthrust westward upon the Honda series (Miocene), which lies conformably on the Colorado series (Upper Oligocene). The Colorado is of sands with subangular pebbles of quartz and black chert, followed by mottled shales and sandstones, above which a 15-cm. seam of lignite is succeeded 1.5 m. higher up by a 30-cm. fossiliferous bed containing *Corbula*, *Hemisinus* (?), and fish teeth. This marine to brackish assemblage is taken to represent the La Cira zone. Later there are shale, white sand, and coal. Large selinite crystals and yellow halite precipitate occur throughout.

Although amphiboles are practically absent in the Colorado, they are characteristic in heavy residues from the Honda series, in which the Lower Honda (1600 m.) is distinguished by finer texture and by absence of andesitic and dacitic pebbles from the Upper Honda (2400 m.). On a heavy mineral basis correlation is with the Real series. Plants in an outlying patch of Upper (?) Honda, at Falan, include *Bambusium*, *Heliconia*, *Ficus*, *Persea*, *Nectandra*, suggesting a wet tropical environment.

(2) The Llanos of the Magdalena Valley are underlain mainly by alluvial fans of the Mesa formation (late Pliocene or early Pleistocene), up to 350 m. thick, deposited from western mountains upon what may be a syncline of Honda strata produced by intense post-Honda folding. One fan dammed the Magdalena river at the town of Honda, so that, as well as current-swept deposits, some of the beds were laid down under still-water conditions in "Lake Hettner." Trains of boulders are taken as marking stream channels. There is much pyroclastic material from volcanoes of the Cordillera Central.

The succeeding Guali formation (Pleistocene), 21-33 m. in thickness, is mostly reworked Mesa, and occurs in modern valleys. Although porous like the Mesa, it is more densely colonized by vegetation, since it frequently carries a veneer of alluvium.

(3) The east slope of the Cordillera Central consists of metamorphic and plutonic rocks—Tolima bathylith. From it streams flow into the Llanos.

Earlier authors like H. Stille and J. V. Harrison regarded the Magdalena Valley as a graben. Others have suggested that it is a ramp valley with overthrust faulting



on the west side as well as on the east. While leaving the question open, Butler inclines rather to the view that a pre-Tertiary peneplain embracing part of the Cordillera Central has been tilted eastward. In any case the valley is of tectonic origin, structurally outlined in the post-Miocene rather than late Cretaceous; and erosion was the most important agent in its development between Honda and Mesa time.

A. L.

**1026.\* Base Exchange and Sulphate Reduction in Salty Ground-Waters Along Atlantic and Gulf Coasts.** Margaret D. Foster. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 838-851.—In the Gulf Coast plain, if samples are taken down dip towards the sea, the shallow waters in sands are of normal calcium bicarbonate type, but the deeper waters contain instead sodium bicarbonate formed by reaction with base-exchange minerals—glauconite and certain hydrous alumino-silicates—which at the time of deposition, if not subsequently, were subjected to the action of sea-water. The deep waters are typically poor in calcium and magnesium, and also low in sulphate and chloride.

Sea-water is 30-75 times more concentrated than uncontaminated waters of the Coastal Plain, so that a small admixture of sea-water rich in calcium, magnesium, sulphate, and chloride, should produce a notable increase of these constituents. In no case, however, does there appear to be a simple mixture of sea-water and fresh water. Accordingly it is concluded that base-exchange minerals in the sands cannot be in equilibrium with present-day sea-water or with mixtures of sea-water and fresh ground-water. This suggests that the sandy strata have been flushed more or less free of salt-water farther down dip than at present by water having lower Ca/Na and Mg/Na ratios, and that base-exchange minerals have removed Ca and Mg from encroaching sea-water and have substituted sodium.

The poverty of sulphate recalls oilfield waters, and those associated with sulphide in carbonaceous rocks. It is not known to what depths of burial in sediments sulphate-reducing organisms—anaerobic bacteria—remain active; or whether inanimate organic matter may play a very slow part in reducing sulphates at low temperatures, although such reduction can take place at 700-1000° C.

Murray and Irvine—*Trans. R. Soc. Edinb.*, xxxvii, 1895—found that water from blue muds of the ocean bottom was lower in sulphate and higher in bicarbonate than normal sea-water. As the calcium content of the water was not above normal, the increase of bicarbonate was apparently due to deoxidation of sulphates by organic matter, and to the carbonic acid thus produced decomposing certain minerals.

Connate waters with low sulphate and high bicarbonate content may have existed in the rocks since the time of formation. This water might migrate seaward as the head of sea-water fell, and later return as the head rose.

A. L.

**1027.\* 1941 Supplement to Sutter (Marysville) Buttes Development, Sutter County, California.** W. Stalder. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 852-856.—The possibilities of the Marysville andesite core with later rhyolite and andesite stocks were recognized in 1932 by Stalder, and since then six wells have been drilled. These have obtained commercial quantities of gas (1) in baked and cracked shales adjacent to the core and (2) in lateral tilted sands. Cretaceous sediments, close to the core, dip at as much as 75°, and this is attributed to the initial andesite intrusion (see also C. B. Hunt, *Bull. A.A.P.G.*, February 1942).

In Ione sandstone, and Butte gravels (Eocene),  $\frac{3}{4}$  mile south of the core, dips of 90° are found, where beds already steeply inclined were pushed to a vertical position by a chonolith, 2000 ft. thick, which juts out sideways from the core.

Well No. 2 met diorite at 7014 ft. It is not known if this forms part of an isolated intrusion or is part of a basement complex. In the former case, Stalder suggests that oil may yet be drilled at 13,000-14,000 ft. in a continuation of the Horsetown oil-sands (Cretaceous), known from their outcrop on the west side of the Sacramento Valley.

All the gas at Marysville Buttes has a gasoline odour, but cannot be classified as a wet gas.

A. L.

**1028.\* A Silurian Graptolite Zone in Crane County, Texas.** C. E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 857-861.—From black shaly limestone at



9340 ft. down, in University Lands, Block 31, Crane County, Texas, *Monograptus vomerinus* (Nicholson), indicating a Silurian age, and a conodont like *Gyrognaathus primus* Stauffer, have been discovered. One specimen of the graptolite suggests approach to *M. vomerinus basilicus* Elles and Wood, which is also found in the Chicago area. *M. vomerinus* appears in the Upper Lockport shale (Niagaran), at Blue Island, Illinois, and has a long range in the Wenlock of Britain. It also occurs in Bohemia and Australia. A. L.

**1029.\* Test on Cedar Creek Anticline, South-Eastern Montana.** O. A. Seager. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 861-864.—A 9680-ft. boring, completed in October 1941, of which an outline log is given covering all formations from pre-Cambrian to Cretaceous, with the exception of the Silurian and Devonian, which are absent, provides a valuable check-up on the underground stratigraphy of Montana, about which—as in the Baker-Glendive anticline—there has been confusion. A. L.

**1030.\* Selected Annotated Bibliography on Oil-Field Waters.** L. C. Case and others. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 865-881.—This bibliography covers Canada, Rumania, Russia, Trinidad, and Venezuela, as well as the U.S.A., but does not include references to the Water Supply Papers of the U.S. Geological Survey. Papers by about a hundred different authors are briefly outlined. A. L.

**1031.\* Wildcat Drilling in 1941 with Comments on Discovery Rate.** F. H. Lahee. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 969-982.—A wildcat is a hole drilled completely outside the boundaries of pools already developed, and far enough from producing areas to be a test of new possibilities. "Semi-wildcats" are described by Lahee as wells drilled in known fields for exploration below established oil horizons. These are excluded from the present account.

Wildcats completed in 1941 in twenty-four States of the U.S.A. numbered 3264 against 3038 in 1940. Average depth increased from 3339 ft. to 3559 ft. in the whole area; and from 4209 ft. to 4372 ft. in the southern States.

Of wildcats located on technical advice of a geological and/or geophysical nature 471 were successful for oil or gas, and 1928 were dry. Thirty wells sunk for non-technical reasons were successful, against 771 that failed, two producing and sixty-two dry sites were selected for no ascertainable reason.

Wildcatting is on the increase in California, Texas, Kansas, Louisiana, and Illinois; but decreasing in Michigan and Mississippi.

Five times as many wildcats result in discovery where professional advice has been sought as where the drilling is for non-technical reasons. In 1939 the figure was between 1.5 and 2.2 times. Deep drilling has increased the demand for geological help. A. L.

**1032.\* Developments in 1941, Gulf Coast of Upper Texas and Louisiana.** O. L. Brace. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 983-990.—The unfavourable trend in Upper Texan coastal discoveries, which set in about 1937, continued in 1941. Fifteen new areas were brought into production, but the new reserves are certainly smaller than those of ten areas discovered in 1939.

Coastal Louisiana had a reasonable year with seventeen new productive areas, although none of these is outstanding.

Activity on the Wilcox (Eocene) trend has been successful in Texas, but not in Louisiana. The new Magnolia field in Montgomery County, Texas, may have big reserves. A. L.

**1033.\* Developments in South-Eastern United States in 1941.** U. B. Hughes. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 991-999.—The trends in the south-eastern U.S.A. are: decrease of wildcat and geophysical activity, inception of core-drilling programmes by eight major companies, continuation of the leasing programme in South Mississippi and its extension into Alabama and Florida, and gradual eastward shifting of exploration.

A 12,399-ft. hole in south-western Alabama has penetrated the Buckner limestone,

Smackover limestone, and Eagle Mills formation of Jurassic age. The Smackover produces oil in Arkansas and evidently extends across the Mississippi embayment.

The Tinsley oil-pool, Mississippi, has been outlined, and a new sand, the McGraw, has been found in the base of the Eutaw (Upper Cretaceous).

Four new salt domes are reported. A test of the Wilcox (Eocene) on top of the King's dome, Warren County, which proves to be uneconomic, shows low-gravity asphaltic oil and water, suggesting possibilities in the Wilcox of the region.

Production for 1941, entirely from Mississippi, was made up as follows: Tinsley field (327 wells), 15,279,323 bbl.; Pickens field (3 wells), 209,997 bbl.; Cary field (1 well), 3758 bbl.; Sharksburg (1 well), 7753 bbl. A. L.

**1034.\* Developments in South Texas During 1941.** L. B. Herring. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, 26 (6), 1000-1006.—Prorating of casing caused comment, but necessary materials were available until the last few days of 1941. Production remained steady at 81 million bbl., but the proportion of yield to that of the U.S.A. as a whole, fell from 6.29% to 5.8%. Reserves added by newly discovered areas were small, except for completion of good wells in Wilcox sands, in La Salle and Bee Counties.

Electrical logging having led to a neglect of the saving of samples, geologists are now having to re-educate drillers in the value of palaeontological data.

The Vicksburg flexure, trending north-east parallel with the coast, and evidenced by down-dip thickening of Lower Frio and Vicksburg beds, can be measured through thousands of feet. Closely associated with it are anticlines, faults, unconformities, and sand wedges, all contributing as traps for gas and oil. Traceable from Starr County, on the Rio Grande, to Jackson County, on the Gulf of Mexico, it is the outstanding structural feature of South Texas.

Only one new gas-recycling unit was started, but there is rebuilding of old plants to stabilize and retain the butanes and propanes. These are now in huge demand for synthetic rubber and 100-octane gasoline. A. L.

**1035.\* West Texas and South-Eastern New Mexico Development in 1941.** West Texas Geological Society Committee. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, 26 (6), 1007-1039.—In 1941 West Texas saw greatest development since 1937. 2325 wells were drilled, of which 2190, or 94%, were producers. The Slaughter field in the San Andreas zone of the Leonard (Permian) was the most active, with 678 new wells over a proved area of 57,000 acres.

Drilling in the pre-Permian was of prime importance in the Abell field, Pecos County, where 40 wells were completed as producers in the McKee sand of the Simpson (Middle Ordovician). In addition, 7 yield from the Waddell sand of the same series, and 1 from the Ellenburger (Cambro-Ordovician), which is more productive elsewhere, e.g., in the Apeo Pool, Pecos County, and in Reagan and Crane Counties.

In Todd field, Crockett County, discovered in March 1940, 6 new producing wells have been sunk in Strawn crinoidal limestone (Lower Pennsylvanian).

In south-eastern New Mexico there was a decline of 31.5% in the number of wells drilled in 1941, and the proportion of dry holes rose to 70 out of a total of 371. The most active field was the Maljamar, with 61 new wells, only 3 of which were dry. There were four new discoveries in the Yates, Seven Rivers, and Grayburg zones, all of which belong to the Guadalupe series (Permian). A. L.

**1036.\* New Developments in North and West-Central Texas, 1941.** North Texas Geological Society. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, 26 (6), 1040-1049.—In 1941, 1972 oil-producing wells were drilled as against 1130 dry holes. There were 53 new gas wells.

Wichita County leads with 438 new oil-wells against 119 dry. Since the value of the Ellenburger (Cambro-Ordovician) in the K.M.A. area was discovered in April 1940, 116 wells have been sunk into it, and of these 104 are flowing, 9 are pumping, and 3 are dry. The total production of Wichita County for the year was 15,702,000 bbl. Archer County was next, with 7,585,000 bbl.

As well as in the Ellenburger, discoveries have been made in Mississippian limestone; in the Bend, Caddo, Strawn, Canyon, and Cisco groups of the Pennsylvanian; and in



the Wolfcamp (probably Permian). The only virgin producing horizon discovered is the Dothan limestone (Permian) of Merkel pool, Taylor County. A. L.

**1037.\* Developments in East Texas During 1941.** F. R. Denton and R. M. Trowbridge. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, 26 (6), 1050-1057.—Increase of exploratory tests resulted in the finding of three new oilfields. Two produce from the Woodbine, base of the Gulf series (Upper Cretaceous), and one from the Rodessa zone of the Lower Glen Rose, middle of the Trinity (Lower Cretaceous).

In the Hawkins field, the major 1940 discovery, 243 oil-wells, 3 gas wells, and 8 dry holes were completed. There is extensive faulting and probably over 900 ft. of closure on top of the Woodbine sand. One marginal hole reaching the Paluxy (Lower Cretaceous) has proved dry. Pipe-lines with a daily capacity of over 40,000 bbl. have been laid to the field.

Altogether 1145 wells—202 dry—were drilled, as compared with 659—114 dry—in 1940. A. L.

**1038.\* Colombian Area's Outlook Improved by Well Showing.** Anon. *Oil Wkly*, 31.8.42, 106 (13), 48.—Tres Bocas 3 on the Barco concession has given oil at the rate of about 170 bbl./day. This well lies 3 ml. east of No. 2-A, a 400-bbl. producer recently completed.

Casabe 5 on the Yondo concession in the Magdalena Valley is reported to have yielded oil at the rate of 800 bbl./day on test, and constitutes the fifth consecutive producer in this area. G. D. H.

**1039. An Engineering Study of the Magnolia Field in Arkansas.** H. F. Winham. *Petrol. Tech.*, Sept. 1942, 5 (5), A.I.M.M.E. Tech. Pub. No. 1491, 1-20.—The surface structure at Magnolia was defined as early as 1921, and the first wildcat was drilled in 1923. Several shallow wells followed which were not taken below the Upper Cretaceous and did not find commercial oil or gas showings. In 1935, the lowermost Glen Rose was penetrated, again without showings. Seismic work preceded the drilling of the discovery well, which went to 6325 ft. without finding commercial production. This well was deepened to the Smackover and eventually completed as a producer at 7647-7652 ft. and 7664-7669 ft. in 1938. It lies near the northern margin of the pool. Development spread east and west until 87 wells were producing at the end of 1939, after which development slackened. A 40-acre spacing was adopted. Three strings of casing are set in all wells.

The gas-oil contact was at 7140 ft. below sea-level, and the oil-water contact at 7318 ft. The gas was cemented off, and each well was tested on completion to determine that the gas-oil ratio was below 2000 cu. ft./bbl. An active water drive was expected and was found. The wells were cored and tested thoroughly for permeability and porosity. Impervious streaks which would prevent vertical migration were found in the 300 ft. of reservoir rock. The casing was perforated at the permeable streaks, working from the lowest upwards and plugging when water encroached.

From the Upper Cretaceous all the beds of Eagle Ford or Woodbine age are missing, and from the Comanchean nearly 2500 ft. of Washita-Fredericksburg and Upper Glen Rose strata have been eroded. Below the Cretaceous are beds which may be Jurassic (Buckner, Smackover, and Eagle Mills). Production at Magnolia has been found only in the Smackover, although shows have been reported and tested in the Glen Rose and Cotton Valley. The Smackover lime consists of dolomitic shale, oolitic limestone, and crystalline limestone, with the oil in the oolitic limestone, the greatest recorded thickness of which is 340 ft.

The Smackover lime structure is an east-west anticline. The average northerly dip is 6°, the southerly dip 4°. Production begins about 30 ft. down in the Smackover lime, and covers an area estimated at 4494 acres, with the maximum measured structural relief 372 ft. On the south flank is an upper porous and permeable streak which is separated in its upper part from the main producing zone, and this contains a secondary gas-cap. This porous zone extends to the northern flank.

The producing horizon has an average porosity of 18.5%, 20% of connate water, and permeability ranging 0-16,000 millidarcys, with an average of 1500 millidarcys. There is a possibility of some shallow production from the Rodessa, Cotton Valley,



and Travis Peak. The oil averages 39° A.P.I., and may have 30–400 lb. of salt/1000 brl. It has a shrinkage of 34%.

The total output was allowed to reach about 21,000 brl./day, and in December 1941 the allowable was about 165 brl./day/well. Efforts have been made to equalise the bottom-hole pressures throughout the field. The original bottom-hole pressure was 3465 lb./in.<sup>2</sup>; it had fallen to 3129 lb./in.<sup>2</sup> in December 1941, when 18,377,000 brl. of oil had been obtained from 116 wells. The original gas–oil ratio was 700 cu. ft./brl., and the present ratio about 889 cu. ft./brl. All the gas is processed (about 17,000,000 cu. ft./day), and yields about 3.1 gal. of gasoline/1000 cu. ft. The original reserves are conservatively estimated at 180,000,000 brl., giving 455 brl./acre-ft. The water has advanced, some wells producing considerable amounts of water. The majority of the wells may have a life of 10–15 years. G. D. H.

**1040.\* Trenton Pay Revives Interest in Western Part of Basin.** H. E. David. *Oil Gas J.*, 10.9.42, 41 (18), 77.—The Illinois Trenton consists of the Kimmswick, Plattin, and Joachim formations in the south, and the Galena-Platteville in the north. The Kimmswick, due to its tightness, gives only a little oil. At Dupou the Trenton is much more permeable, but the eastward extent of this type of Trenton is unknown because of the lack of exploration.

Early in May 1942 a "Trenton" limestone strike which opens up several hundred square miles for exploration was made at St. Jacob. Ten wells have been completed in a pay having a maximum thickness of 45 ft. The wells gave 80–120 brl. of oil/day before acidization, but are reported to have potentials of 500–1000 brl./day after acidization. None of the wells has gone right through the Trenton, which lies about 2317 ft. deep, with the pay zone 33 ft. below the top of the Trenton. The field, which is on a south-trending anticline with a dome, may cover at least 1000 acres. Streaked saturation has been found in the Trenton of St. Clair County, and this strengthens the belief that several additional Trenton oilfields will be found on the west rim of the Eastern Interior Basin.

The term "Trenton" as applied to Ordovician limestones in Illinois is incorrectly used. The Trenton limestone of Middle Ordovician age is a limestone series found in New York and eastern Canada. When oil was found in Ohio in a limestone of almost the same age on the crest of the Cincinnati Arch, the older term was applied to it. During the first Illinois play following the discovery of oil on the La Salle anticline, the structural similarity of this feature to the Cincinnati Arch led to the hope that "Trenton" oil would be found, and the term came into use in Illinois. G. D. H.

**1041.\* The Problem of Petroleum Reserves in the United States.** Part I. J. H. McCammon. *Oil Wkly.*, 14.9.42, 107 (2), 17.—The A.P.I. estimate of proved reserves on 1st January, 1942, was 19,589,296,000 brl. of oil, the combined reserves of seventeen fields accounting for 43% of this total. At present petroleum supplies almost a third of the U.S. mechanical energy, and it serves as a raw material for many products. The full extent of its usefulness has not yet been reached. The demand for petroleum has increased phenomenally, while the relative importance of individual fields has shown a sharp decline, and although proved reserves are increasing, it is questionable as to whether it is possible to maintain a production in excess of a demand not limited by high prices.

In most years since 1859 the additions to reserves have exceeded the production. Lahee's analyses of the effectiveness of American exploration show that while more and deeper wildcats have been drilled, less oil has been found in recent years excepting 1941. Pratt uses a rather different method of analysis, and also indicates a downward trend since 1936. The number of dry holes per major field has risen markedly. Lahee attributes the falling discovery rate mainly to the growing difficulty of finding new geological traps for oil. The remaining undiscovered reserves he considers as largely either in unexplored regions, in deeper unreached reservoirs, or in stratigraphical traps seldom locatable by surface observation.

Geological conditions for oil formation have been very favourable in Texas, and so it now provides 40% of the U.S. output, and possesses half of the reserves. Nine fields in the Upper Gulf Coast have 60% of the reserves of that district. No deep-seated dome with major closure has been found since 1937, and the increases in reserves

have been mainly from extensions to known fields. In the Yegua there is a zone of potentially most petroliferous sands, and structural traps within this zone have proved most prolific. Gradational up- and down-dip sedimentary changes limit the favourable zone. Subsurface data indicate that no major reserve will be established by deeper drilling on the large non-piercement type structures of the deeper coastal zone. The main productive reserve of each of the few non-piercement domes is so far limited to only one formation. Although the number of new discoveries has increased in recent years, their aggregate magnitude has declined. Down-dip the Wilcox sands are said by Brace to be relatively poor, whereas up-dip the unfavourable factor is lack of structure.

West Texas has 13% of the national reserve, 70% of it being provided by seven fields. On the basis of the wells drilled this has been the second most active area of exploration. The Ordovician production has not been comparable to that of the Permian. Virgin territory in West Texas is diminishing rapidly. The Central Basin Platform has now been fairly well outlined, and much effort has been expended in searching for production between established fields on this uplift. The Delaware Basin has so far yielded only small fields, and major structures are believed to be absent, while production from the pre-Permian seems unlikely because of the suggested great thickness of Permian in this basin. The major West Texas reserves are trapped by structures along the positive areas.

During recent years no outstanding fields have been found in the other producing areas of Texas. G. D. H.

**1042.\* Typical Oil-Field Structures : Fault-Line : Luling and Powell Fields, Texas.** Anon. *Oil Gas J.*, 17.9.42, 41 (19), 32-B.—The northern and western part of Texas has remained above sea-level except locally and for brief intervals since the end of the Palaeozoic, while the coastal plain sector tilted south and east throughout the Cretaceous and Tertiary. Between these two areas is a curved hinge-line, the Balcones-Mexia system of parallel faults, along which the downward movement was intensified. Most of the faults are normal, those of the Balcones system dipping south, and those of the Mexia system dipping north. Oil accumulated on the south, up-thrown side of the Mexia system, at high points where the reservoir rocks are cut by the faults. In the down-faulted block between the two fault systems a little oil has been found on local structures, the accumulations bearing no relation to faults.

At the northern end of the Mexia system oil is in the Lower Cretaceous Paluxy sand; in the Mexia district the basal Upper Cretaceous Woodbine sand is the chief pay; and in the San Antonio district the Lower Cretaceous Edwards lime is the main pay, with some oil in the Georgetown, Buda, Austin Chalk, and Taylor Marl. All the production is related to local or regional unconformities. Any horizon which produces on anticlines or domes in any part of this region is a potential pay where it is truncated up-dip by a fault.

There is evidence of up-dip migration of oil in the reservoir horizons until it is stopped by a fault. Oil is generally believed to have been formed near to the horizon in which it now occurs. At many points the oil is in part of a local slight dome or anticline broken by a fault.

The discovery of the minor structures traversed by faults depends mainly on the discovery of the fault-line and its projection downwards to the producing horizon. The seismograph and gravity surveys facilitate the location of the faults.

Four maps and two cross-sections are included.

G. D. H.

**1043.\* Many Deep Pays are Found in Montague County Campaign.** R. Ingram. *Oil Gas J.*, 17.9.42, 41 (19), 68.—This year a 7000-ft. wildcatting campaign began in Montague County in the northern part of the Fort Worth basin. A normal Ordovician section has been revealed in the deeper parts of the basin, thus giving possibilities of several pay horizons in addition to those already productive nearby. Fourteen deep pools have been opened in Montague County since January 1939.

The Fort Worth basin is bounded on the west by the Bend Arch, on the east by the Muenster Arch, and on the north by the Red River uplift. Early production in North Texas was associated with the regional highs around the basin, and there were a number of large shallow fields. When the shallow areas were largely depleted, deep drilling began, and deep pays were opened in or near the shallow fields. Gradually



exploration extended from the highs into the Fort Worth basin. A normal section of Pennsylvanian and a full Mississippian section were proved, together with the Simpson and Ellenburger. Several oil discoveries followed. Parts of the Mississippian and Simpson are eroded on the surrounding highs. An east-west Ellenburger high was shown to cut across the basin. Most of the deep wells have found production in the Strawn, Smithwick, or Marble Falls, but the Ellenburger is a drilling objective.

Extensive geophysical work has been carried out, and many local structures have been tested.

The pre-Cisco producing horizons of Montague County are listed with the fields, depths, and number of wells. An Ellenburger lime stratum contour map shows the sites of the pools.

G. D. H.

**1044.\* Study Shows Crude Oil Output Moving Up to Correct Under-Estimates.** W. V. Howard. *Oil Gas J.*, 1.10.42, 41 (21), 14.—The minimum daily average production in April was 568,000 bbl. below that of February, while the demand for crude was only 244,000 bbl. below February's demand. The average daily production for the first eight months of 1942 has been 28,000 and 34,000 bbl. higher than during the same period of 1940 and 1941. During the first eight months of 1941 refinery runs were low, and an average of 104,000 bbl. was added to storage. A reversal of conditions in 1941 caused 55,000 bbl./day to be taken from storage. So far in 1942 supplies of crude have almost balanced demand. The refinery runs are down by 147,000 bbl. compared with 1941, and imports are down by 83,000 bbl. Since February 1942 imports have fallen from 110,000 bbl. to zero, and at the same time apparent exports have risen from 79,000 bbl. to 169,000 bbl. The August refinery runs are 105,000 bbl. above the March figure, and 224,000 bbl. above the May low.

Data are tabulated for each month since the beginning of 1940 on production, storage, imports, refinery runs, etc.

G. D. H.

**1045.\* Typical Oil-Field Structures : Unconformities : Zenith, Wherry, and Hollow-Nikkel Fields, Kansas.** Anon. *Oil Gas J.*, 1.10.42, 41 (21), 64-B.—The Central Kansas Uplift bounds the Anadarko Basin on the north. It was uplifted at various times during the Palæozoic, sometimes possibly together with a much larger area, for some of the unconformities found on the uplift extend over much of the Mid-Continent area. The major unconformity is at the top of the Mississippi limestone. The Uplift was submerged in the Pennsylvanian, Permian, and Cretaceous.

In many of the fields on the Uplift the reservoirs are associated with unconformities. The oldest is the granite wash, then the Arbuckle limestone, Viola limestone, Misener sand, Hutton and Mississippi limestones, basal Pennsylvanian conglomerate, Kansas City-Lansing, etc. At Nikkel and Voshell accumulation is along an uplift dissected by a fault; at Zenith on a nose. Wherry shows evidence of terracing. In many of the fields, especially the larger ones, there are few signs of local structure, and oil accumulation is governed by porosity.

Many of the fields are shallow with numerous pays, and so much drilling has taken place, mainly during the last ten years. The most effective method of discovering new fields has been the exploration of minor structural irregularities on subsurface key beds, for most of the records are modern. Random drilling has proved of considerable value.

Stratum contour maps and cross-sections of some of the fields are included.

G. D. H.

## Geophysics.

**1046.\* Geophysical History of Darrow Dome, Ascension Parish, Louisiana.** J. B. Eby and T. I. Harkins. *Petrol. Tech.*, July 1942, 5 (4), A.I.M.M.E. Tech. Pub. No. 1495, 1-8.—The Darrow salt-dome is circular and rises to within 4625 ft. of the surface. Its diameter is about 4800 ft., and the cap-rock is less than 75 ft. thick. Some oil has been obtained from Miocene sands above the cap-rock, but most of the oil comes from a narrow band of wells on the east and south flanks in Miocene beds at 5670-5840 ft., and in Oligocene beds at 6890-6985 ft., 7028-7060 ft., and 8260-8270 ft.

As a result of repeated refraction shooting and gravity work in 1927 and early 1928, the impression persisted that Darrow was a dome, but it was not defined. Early in



1927 a refraction shooting report suggested the existence of a dome-like uplift in the deeper beds, but the investigation showed only very slight disturbance. In March 1928 torsion balance and refraction shooting pictures appeared, the former showing several closing gravity isogals, and the latter one closing refraction line, but neither gave clear-cut positive evidence of a salt dome. Two wells drilled because of lease considerations did not show the occurrence of a dome.

In 1929 reflection shooting began. This was difficult because of the soft surface alluvium, and because the beds several thousand feet deep were soft, lenticular, and without good reflecting horizons. Moreover, it was not then known that there were very steeply dipping beds. Detectors were set up first on one side of the shot-point and then on the opposite side, the first lines being almost north-south and on the south flank of the dome. The reflections on the northern line actually showed less time for the far detector than for the near one, and on the south line there was a much greater difference in reflection time between the near and far detectors than is normal for the overall time, a feature which can only be due to a steep southerly dip of the reflecting horizon. An effort was made to correlate all the reflections obtained with the aid of differential times, and this proved successful. No deep reflections were found round the top of the dome. The first well drilled after completing the reflection picture found Miocene oil at 4025-4035 ft. and salt at 4627 ft.

Reflection dip shooting on the Gulf Coast was initiated at Darrow, and proved successful. Both the torsion balance and the refraction seismograph gave some, if not satisfactory, dome indications, in spite of the unfavourable conditions.

G. D. H.

### Drilling.

**1047.\* Cements for Oil- and Gas-Wells.** Part I. L. C. Uren. *Petrol. Engr.*, August 1942, **13** (12), 23-26.—The subject is first treated historically. The chemical and physico-chemical properties of Portland cement are then discussed. From the physical point of view three periods are recognized in the hydration of Portland cement: the so-called "initial set," the "final set," and the hardening period. The changes that characterize these different periods are the result of chemical readjustments that, as explained in the article, require time to achieve. The initial set is said to have occurred when the cement slurry has lost its plasticity and become friable to such a degree that two pieces of a broken specimen when placed in close contact will not unite to form a homogeneous mass. After the initial set has occurred, the cement undergoes a further chemical change, as a result of which it acquires greater hardness until the final set has been achieved. It is arbitrarily defined as that condition when a certain degree of rigidity is attained, as determined by a penetration needle of standard proportions. With most Portland cements the final set occurs in from 2 to 5 hrs. after the initial set. It is of no particular significance in oil-well cementing. Following the final set, further chemical readjustments throughout a period of 28 days result in a gradual increase of strength and hardness. The rôles of accelerators and retarders are described, together with the influence of fineness and grinding. A.S.T.M. tests and A.P.I. tentative code are reviewed.

The influence of deep-well conditions is stressed. Pressures of many hundreds of pounds/in.<sup>2</sup> are imposed by the well fluid (50 lb. or more/100 ft. of depth). The methods of placement employed require that the neat cement slurry be of such consistency that it can readily be passed through pumps. This ordinarily means that the amount of water used shall be 40% or more of the weight of the cement, and methods of placement often permit of further dilution by the well fluid. In the well the cement slurry is usually contaminated to some extent with mud, and perhaps also with oil. The cement slurry is often maintained in turbulent flow through pumps and pipes for a  $\frac{1}{2}$  hr. or more after it is gauged with water. Gas blowing through the slurry after it has reached its intended position in the well may keep it agitated until the initial set occurs. Saline ground-waters from strata penetrated by the well may alter the setting properties of the cement. Certain sulphate waters may make the cement "unsound" after it has set. Permeable formations penetrated by the well may absorb some of the water from the cement slurry. Any of these conditions may seriously alter the setting properties of cement so that it does not perform its intended function satisfactorily. This part of the paper is appended with 35 references.

A. H. N.

**1048.\* Durability of Cements in Contact with Brines and Chemical Solutions.** H. H. Miller. *Petrol. Engr.*, August 1942, **13** (12), 50.—Results on durability experiments carried out on 27 cements from different manufacturers under certain controlled conditions are reported. Of all neat cements tested to date, the acid-soluble cement and lumnite cements are the most resistant to salt brines. The resistance of lumnite cement lies mainly in the fact that, because of its low lime content, it hydrates without forming compounds easily altered by contact with brine. The resistance of acid-soluble cement is due mainly to the Pozzolanic reaction of the carbonate with the active lime of the cement to form a new desirable compound.

Cements containing fly-ash are considerably more resistant to brine and salt solutions than those containing other adjuncts as tested. Fly-ash, which is the residue of burnt, powdered coal, was obtained from six different sources and was different mainly in the particle size and carbon content. The proportion of fly-ash used as a replacement for cement varied from 1 to 75% in steps of 1-3-5-10-20-25-30-50-75%. The maximum strength and durability with all cements tested were obtained with 20% fly-ash having a low carbon content of approximately 2% carbon and a surface area of about 2600 sq. cm./gm., although fly-ashes of higher carbon content and with surface areas of 800 sq. cm./gm. and finer showed marked improvement in the resistance to brines. Fly-ashes of moderately low carbon content and a high fineness will form a Pozzolanic reaction, thus improving the quality of the cement. The Pozzolanic reaction in cement is quite complicated, but it is generally accepted that when Portland cement hydrates, certain complex reactions take place, freeing a water-soluble highly reactive lime. It is with this active lime that the silicates of the Pozzolanic materials combine to form a new calcium silicate compound and prevent the formation of a crystalline aluminate type material that is readily acted on by brines.

The behaviour of a cement in oil-well brines depends on the individual characteristics of the cement itself, as different cements will vary in chemical composition, degree of fineness, and water-cement ratio, and on the nature of the brine. The most harmful effects to cement are due to sulphates in the brine, as they act on the aluminate compound. The sulphites are also very hazardous, due to their tendency to oxidize and form sulphates. Magnesium chloride in brine plays an important part in bringing destruction to cements. Hydrogen sulphide, which commonly occurs in oil-wells, is very destructive to cement, as it combines with the calcium to form a hydrosulphide. Durability is also definitely related to water-cement ratio, as cements containing low water ratio showed a marked degree of resistance. A. H. N.

**1049.\* Oil Well Cementing.** J. V. Polk. *Petrol. Engr.*, August 1942, **13** (12), 82. *Paper Presented before Petroleum Industries Association.*—Channelling and mud-cake removal in cementing operations are discussed. Squeeze cementing is studied at greater length. Squeezing in wells where thief sands, channelling, mud cakes, or other conditions cause the well to "take" the cement slurry under little or no pressure, more than one application of cement is nearly always necessary in order to effect a shut-off, or to attain the pressure desired. Experience has shown that the most effective way is to pump a quantity of cement into the formation, allow it to obtain at least a partial set, and then pump in more cement, allowing each succeeding batch to block-off more channels, until all are closed with cement, which at the end of the job will be "put away" under the desired pressure. This type of operation is known as a "multiple-batch" cementing. The multiple-batch method of cementing is made possible by using the cement retainer with its circulation joint, which provides for the placement of any number of batches of the slurry in one extended operation, in which only one cementing hook-up is used, and only one complete shutdown is necessary to allow the cement to reach its final set before drilling out. A. H. N.

**1050.\* Big Modern Storage Yard Stresses Prolongation of Stacked Drilling Equipment Life.** G. M. Wilson. *Oil Wkly.*, 24.8.42, **106** (12), 14-20.—Due to possible difficulties with replacements of parts, special care is being taken in storage of equipment. One large yard is described in detail. Practically every piece of drilling equipment, from the draw-works down to the drilling line and V-belts, is given a thorough overhaul, repaired if necessary, then placed in storage in such a way that it



will be well preserved, yet be immediately available whenever it may be called upon for further use.

Draw-works, boilers, and mud-pumps are neatly stacked in one portion of the yard in such a way that they will not become separated, thus assuring that all previously-mated pieces will be sent out on a new job as a single unit; a systematic and orderly scheme is carried out in racking and treating of all drill-pipe, drill-collars, and kellys on well-designed pipe-racks; tool-joints are removed and given a thorough over-hauling; subs, adapters, fishing tools, and similar small tools are cleaned, painted, and stacked in orderly rows along a specially-designed rack; all sand-lines and drilling lines brought in from the job are efficiently cleaned, lubricated, measured, and generally checked over in a single operation through use of an unusually efficient portable shop-made machine; and all small tanks used for storing drilling mud and water at the well are thoroughly cleaned and painted, inside and out. One of the most recently installed features of the yard, and one the importance of which cannot be over-estimated at this particular time, in view of the current rubber shortage, is a large, cool, air-conditioned "potato cellar," in which are stored rotary hoses, belts of all kinds, cordage, and other such perishable goods.

Wherever possible, except where replacements have been made, every piece of equipment that was part of the original rig is kept together, so that when the unit is once more set up on a location, little time will be lost in assembling and pipe-fitting. When a load of drill-pipe is brought in from a well, it is first cleaned of all mud-cake, both inside and out. The interior surface is cleaned with the aid of an air-nozzle operating under 120 lb. pressure. The nozzle, which effectively blasts out the mud-cake particles, has a long extension handle to permit running it from one end of the pipe to the other.

Following this preliminary cleaning to remove the dried-out mud, the pipe is cleaned inside and out with the steam cleaning unit, particular attention being paid to tool-joints and collar-threads. It is then carefully inspected, and defective portions of threads or collars are marked with a distinctive colour of paint. Red paint indicates that the collar is swelled out, while yellow means that it must be refaced. Many other details of the practices of this yard are given. Each major item of the usual equipment on an oilfield is discussed with the special precautions taken to preserve it for the longest possible time.

A. H. N.

**1051.\* Unitization of Gulf Coast Rigs Saves Time in Moving.** N. Williams. *Oil Gas J.*, 17.9.42, 41 (19), 31-32.—The extent to which unitization of equipment and standardization of rig layouts have been carried in some Gulf Coast rig assemblies is reflected by the comparatively short time required for their moves. Even some of the biggest, heaviest, and most complete deep-drilling rigs, having extensive auxiliary equipment specially provided to combat the hazards encountered in deep drilling, can be dismantled, moved, and set up again on another location and be drilling within less than 24 hrs. Such a time schedule is being followed regularly by one major company for its rigs operating in one of the deeper South Louisiana fields.

In this particular field the wells are drilled to depths of 12,000 ft. or lower. The short time required for moving rigs, although the rigs are among the largest and most complete on the Gulf Coast, has contributed to reducing over-all well-time to less than 30 days, and in some cases to as few as 26 days. Drilling and completing wells to such depths in this short time has enabled the company to effect important savings in the development of the field. This is a dry-land field, so that the short rig-moving time is not attributable to employment of barge-mounted rigs. The time required for moving heavy land rigs cannot be reduced to approach that of the drilling-barge rigs used in maritime operations along the Gulf Coast. The latter rigs represent the highest degree possible of unitization, in which all equipment is mounted permanently on barges to be towed intact from well to well.

Photographs illustrate the discussion on unitization.

A. H. N.

**1052.\* Four-Year Operation Shows Merit of Rig Design.** H. F. Simons. *Oil Gas J.*, 1.10.42, 41 (21), 33-34.—A review of the record of a rig which has been operating for four years continuously and of its several parts as well as the practices used in drilling with it is given. During the 4 years the rig has drilled 23 wells to depths from 3700 ft. to 5400 ft. for a total of 130,000 ft. This drilling has all been in South Central Oklahoma in the neighbourhood of Ada. This is an area where the formations are as hard or harder than those normally encountered in Mid-Continent drilling.



During the drilling of the 130,000 ft. of hole, the original chains on the rig have never been replaced. This is credited entirely to the use of an individually driven rotary table, which relieves the draw-works chains of unnecessary wear, and at the same time permits complete inspection and repair of the chains while drilling is in progress. The chains are inspected each tour and any missing cotter keys replaced. Worn pins are removed so that there is no play between the pins and the side bars. Lubrication with a light oil helps to prevent chain wear and trouble.

Drill-pipe now in use on the rig is the string which was purchased with the rig, and it has been used to drill every foot of hole. Only one twist-off has been experienced with the pipe, and that was 2 years ago. It is still in good shape, and will be continued in service. The pipe is subjected to as much speed and weight as the average string (75-150 r.p.m. and 10-20 tons). However, it is always broken on a different joint each trip, and the joint-threads and faces are watched for any defects. The wear on the pipe is evenly distributed, as the position of the joints in the string are changed on each well—*i.e.*, the bottom joints on one well become the top joints in the string on the next well.

Details are given of other parts and practices.

A. H. N.

**1053. Patents on Drilling.** W. D. Mounce. U.S.P. 2,296,366, 22.9.42. Appl. 29.12.41. Bore-hole tool with a magnetic device.

A. Muhlbach. U.S.P. 2,296,397, 22.9.42. Appl. 8.5.40. Well-tool adapted to lower or raise apparatus from wells.

W. F. Bates and C. A. Yeatman. U.S.P. 2,296,659, 22.9.42. Appl. 28.12.40. Method and equipment for moving drilling rigs by loading the derrick structure on a trailer unit for transport.

W. L. Horner. U.S.P. 2,296,852, 29.9.42. Appl. 3.1.38. Earth exploration by analysing cores from the sand to predict production of gas, water, or oil whilst drilling.

T. E. McMahan. U.S.P. 2,296,939, 29.9.42. Appl. 5.5.41. Well-bit protector for bits with toothed cutters.

P. Jones. U.S.P. 2,296,996, 29.9.42. Appl. 3.8.40. Directional drift recorder by means of light rays being recorded on a disc after reflection by a concave mirror.

J. S. Page. U.S.P. 2,297,020, 29.9.42. Appl. 15.5.40. Circulating fluid washer for deep wells.

V. V. Shepherd and O. R. Peugh. U.S.P. 2,297,029, 29.9.42. Appl. 2.1.40. Whipstock sleeve for drillable liners in deep-well drilling.

L. Spencer. U.S.P. 2,297,031, 29.9.42. Appl. 23.3.40. Circulation valve for cement retainers.

J. McClinton. U.S.P. 2,297,157, 29.9.42. Appl. 16.11.40. Drill-bit for deep wells.

C. E. Reed. U.S.P. 2,297,192, 29.9.42. Appl. 2.7.40. Earth boring-tool having a toothed cutter on roller bearings.

J. Johnson. U.S.P. 2,297,415, 29.9.42. Appl. 16.6.39. Whipstock consisting of a top and a bottom portion connected by tubular pressure chamber.

E. G. Leonardon. U.S.P. 2,297,568, 29.9.42. Appl. 25.2.39. Spontaneous potential by induction measurements on earth formations.

W. M. Mazee. U.S.P. 2,297,660, 29.9.42. Appl. 27.7.40. Non-aqueous drilling mud having an alkali soap of certain types.

A. H. N.

## Production.

**1054. Oil-Reservoir Behaviour Based upon Pressure-Production Data.** H. C. Miller. U.S. Bur. Mines. Report of Investigations No. 3634. April 1942.—It is pointed out in this report that the daily production of crude oil in December 1941 showed

an increase of 16% over the figure for 1940, due to a combination of maximum civilian demand and rising defence requirements. So long as the war lasts it is essential to maintain a steady and adequate supply of petroleum. To do this, maximum efficiency of oil recovery from underground reservoirs must be achieved. Moreover, any producing method which jeopardizes total ultimate recovery must be regarded as conflicting with the best interests of national defence.

It has been found that some of the efficiency of recovery of oil from reservoir sands and rocks is sacrificed if the oil and gas are withdrawn too rapidly. Proration has proved the advantages to be derived from shortening the time during which gas expansion is an important factor in oil production, and controlling production so that oil recovery is the result of water-drive. Further, since the rate of withdrawal of oil and gas from water-drive reservoirs in which the oil is saturated with gas determines whether the oil moves to the well as a result of gas expansion, water-drive, or a combination of both, there is need for a method of determining the relative importance in oil recovery of each type of drive.

This report gives details of a graphic method for representing reservoir-pressure and oil-production data. The cumulative decline of reservoir pressure (in pounds per square inch) is plotted as ordinates on a logarithmic chart against cumulative oil recovery (in barrels) as abscissæ. Thus the relation between cumulative decline of reservoir pressure and cumulative recovery can be plotted on a logarithmic chart by straight lines for large increments of liquid recovered. For some reservoirs one or two and for most reservoirs not more than three or four inter-connecting straight lines will exhibit the pressure decline-oil recovery relations for the entire producing life of the well. The lines have different slopes, and the slope angles, when studied in conjunction with the physical characteristics of the oil and the type of reservoir, are capable of revealing whether the source of energy driving oil through the sands and porous rocks to the wells is the result of gas expansion, natural water-drive, or a combination of both.

The author does not suggest that the method of plotting pressure-production data will permit comparison of the oil-recovery efficiency of one field with that of another, although it may be possible to do so after the mechanics of production have been analysed for many more reservoirs than have hitherto been studied in this respect.

H. B. M.

#### 1055.\* Permeability as a Function of the Size Parameters of Unconsolidated Sand.

W. C. Krumbein and G. D. Monk. *Petrol. Tech.*, July 1942, 5 (4), A.I.M.M.E. Tech. Pub. No. 1492, 1-11.—Several attempts have been made to relate permeability to the particle size in unconsolidated sands, but few studies have included the effect of sorting on the permeability. The permeability depends on the square of the average grain diameter, the standard deviation of the size distribution, the mean shape, the standard deviation of the shape distribution, and a non-dimensional packing parameter. In the experiments described, the shape and packing factors were kept as constant as possible, while the size parameters were varied. A glacial outwash sand was sieved into  $\sqrt[4]{2}$  classes from 0.125 to 8 mm., the twenty-four sets of separates being mixed to give normal phi curves. In the first set the phi standard deviation,  $\sigma_\phi$ , was kept fixed at 0.21, while the phi mean varied from -0.75 to 1.25. In the second set the phi mean was kept at zero and  $\sigma_\phi$  was varied from 0.15 to 0.8. Permeability measurements were made on the different sands, and also on some of the separates, all measurements being made at a standard porosity of 40%.

On plotting permeability  $k$  against geometric mean diameter on log.-log. paper the sieve separates, and the mixtures which also had fixed standard phi deviations gave straight lines with the same slope, showing that the permeability varies as the square of the mean diameter. The mixtures of constant phi mean and constant geometric mean diameter showed a decrease in permeability as  $\sigma_\phi$  increased. Plotting data for the last set of sands as log. permeability against  $\sigma_\phi$  gave a straight line, pointing to an exponential relationship. This was shown to hold, and  $k = C \cdot GM\xi^2 e^{a_1 \sigma_\phi}$ , where  $C$  is the permeability at  $\sigma_\phi = 0$ ,  $a_1$  is a constant, and  $GM\xi^2$  the geometric mean diameter.

When  $\sigma_\phi$  is constant,  $k = C_1 \cdot GM\xi^2$ ,  $C_1$  being an exponential factor dependent on  $\sigma_\phi$ .

The first relationship was tested on Wilsey's permeability data for a series of artificial



sands of variable mean size but of fixed spread, and gave good agreement with the experimental data.

A permeability surface was drawn relating permeability, geometric mean size, and  $\sigma_g$  for logarithmically normal size distributions of fixed porosity, although, as far as the experimental evidence goes at present, it has not been proved to apply to particles less than about 0.25 mm.

G. D. H.

**1056.\* Phase Behaviour in the Methane-Propane-*n*-Pentane System.** R. H. Dourson, B. H. Sage, and W. N. Lacey. *Petrol. Tech.*, July 1942, 5 (4), A.I.M.M.E. Tech. Pub. No. 1490, 1-10.—The compositions of the coexisting phases in the methane-propane-*n*-pentane system were determined at 160° and 220° F. throughout the two-phase region at pressures of 500, 1000, and 1500 lb./in.<sup>2</sup>, and at 2000 lb./in.<sup>2</sup> at 160° F. The method involved the withdrawal of samples of coexisting gas and liquid phases from a vessel containing a heterogeneous mixture of methane, propane, and *n*-pentane. The samples were withdrawn under substantially isobaric, isothermal conditions after equilibrium had been attained, and their composition was determined by the conventional low-temperature fractionation procedure.

The experimental results permitted the calculation of gas-liquid equilibrium constants, as well as the establishment of the critical behaviour of this ternary system. The results are presented in tabular form, and diagrams show the molal composition at various temperatures and pressures, the effect of methane on the dew-point and bubble-point pressures, the pressure-composition diagram at 220° F., the temperature-composition diagram for 1500 lb./in.<sup>2</sup>, the influence of pressure on the equilibrium constant for methane at 160° F., equilibrium constants for propane and *n*-pentane at 160° F., and the equilibrium constants of the methane-propane-*n*-pentane system when *C* equals 0.4 (*C* = the mol. fraction of propane in the liquid phase divided by the sum of the liquid phase mol. fractions of propane and *n*-pentane). G. D. H.

**1057.\* Determination of Oil-Well Capacities from Liquid-Level Data.** C. C. Rodd. *Petrol. Tech.*, July 1942, 5 (4), A.I.M.M.E. Tech. Pub. No. 1475, 1-9.—Proration laws in Kansas took into consideration the quantity of oil which could be obtained from a well in a prescribed period, and various methods were used at times to obtain high potentials, potentials which could not be maintained and which were possibly conducive to early water encroachment. By 1938 the use of the bottom-hole pressure-gauge instead of the physical testing of wells had become common. Since 1937 devices have been developed which detect wave reflections from tube couplings and the well liquid level, and so permit the computation of the depth to the liquid level in the annulus around the tubing. These devices provide a ready means of measuring the liquid draw-down of a producing oil-well.

Potentials determined from bottom-hole pressures or liquid-level measurements are based on a straight-line relationship between the pressure at the bottom of the well and the rate of production. Such potentials give the productivity index—the number of barrels of oil/day/lb. reduction in bottom-hole pressure. In all but a few of the several thousand wells tested in Kansas the relationship between pressure and liquid production approximated a straight line. The factors needed for determining a well's capacity are the stable pressures at two producing rates, or the static pressure and a stable pressure at one rate. The former method is preferred.

By control of the casing pressure many wells can be produced without an appreciable quantity of liquid in the annulus. In such wells the effect of the liquid column becomes negligible, and bottom-hole pressures may be found from the casing pressure and the gas-column pressure. In some wells, the density of the annular liquid column remains constant at different rates of production. If these wells can be produced under zero casing pressure, the bottom-hole pressure can be considered as proportional to the height of the liquid column. The use of bottom-hole pressure gauges is troublesome. Many wells that produce little gas can be tested by the use of fill-up data.

The theory and calculations underlying the various methods of finding the productivity index are described.

G. D. H.

**1058.\* Progress in Reservoir Technology.** Part I. M. Muskat. *Petrol. Engr.*, August 1942, 13 (12), 27-30.—The paper deals with the progress achieved in the last decade. Core analysis, thermodynamics of reservoirs, reserves estimation, and bottom-



hole pressure measurements constitute the four major portions of the first part. The treatment is, in general, descriptive and historical. Certain general rules are indicated in the case of bottom-hole pressure measurements. When the rate of pressure decline is combined with the production data in the manner used in the dynamical method of reserves estimation, it is possible to estimate the degree to which the oil withdrawals are replaced by the evolution of the dissolved gases, the expansion of gas in free gas zones, or by the intrusion of surrounding bottom-water or edge-water. The absolute value of the pressure decline below the virgin pressure also represents a measure of the depletion of energy in the reservoir, and hence of the depletion of recoverable oil. The pressure variations over a field, as indicated most conveniently by isobaric contours, give a graphic picture of the differential behaviour over the productive area of the field. Widely spaced contours and low-pressure gradients indicate a uniform degree of depletion or a high degree of fluid inter-communication between the various parts of the field either through the medium of an overlying gas-cap or the pay itself. Closely spaced pressure contours and high-pressure gradients reflect large variations in the extent of local depletion, or indicate poor fluid inter-communication, and the presence of inter-lease migration tendencies. Erratic and irregular contours will result either from a haphazard fluid withdrawal pattern over the field, or a marked lenticularity in the producing section. On the other hand, systematic trends of increasing pressures towards the boundaries of a field are indicative of the presence of undepleted energy sources at these boundaries, either in the form of additional oil reserves or mobile edge-water drives. Conversely, systematic trends of decreasing pressures towards the field boundaries correspond to the pinching out of the producing section, or to a failure of surrounding edge-waters to exert an effective drive on the reservoir.

A. H. N.

**1059.\* Repairing and Redrilling Oil Wells.** J. R. Thomas. *Petrol. Engr*, August 1942, **13** (12), 46.—The writer contends that repair work at all times offers a very lucrative return for small investment/unit. Over a period of 20 years, during which time the writer has been directly connected with the repairing of hundreds of wells, the average cost of production has been found to be approximately \$120.00/brl. of daily production, which is less than half the cost basis on which the poorest grade producing property can be bought in the open market. The larger part of this work was done before well surveys, electrical logs, and other modern devices were available to assist the engineer. With these modern aids repair work should be even more attractive from the standpoint of sound economics.

Examples are given to illustrate the value of repair work on old wells.

A. H. N.

**1060.\* Use of Explosive Cord for Cleaning Perforations.** W. A. Sawdon. *Petrol. Engr*, August 1942, **13** (12), 42.—The explosive applied to well-cleaning operations is provided in the form of a cord and is run into the well on a conductor cable. The cord extends through the zone to be cleaned and is detonated from the surface by electrical current. Best results are obtained when the explosive is in fluid, as the fluid facilitates the transmission of pressure that cleans the openings. The kind of fluid or the static head does not matter. The cord has been used in wells having temperatures as high as 275° F.

Although the explosive cord has the appearance of a slow-burning fuse, it explodes at a high rate of speed, the speed of detonation being more than 4 miles/sec. The amount of explosive/linear foot of cord, however, is very small, and is not sufficient to damage casing or liner. The cord is relatively safe to handle, as it requires considerable shock to begin detonation. The cleaning action of the explosive method of well-cleaning depends on the pressure induced by the explosion. As the full pressure must be applied to make it effective, the cleaning value is derived from the speed of detonation, because any open perforation to which pressure is applied in the usual manner will permit fluid to flow through it and relieve the pressure on the clogged perforations. Due to the great speed of detonation, fluid cannot pass through an open perforation fast enough to relieve the pressure on the clogged or partly clogged perforations, and the pressure is thus applied to all parts of the liner opposite the cord, to all perforations, whether open, partly closed, or closed.

Details of the method and results of experiments conducted above ground are given in brief.

A. H. N.

**1061.\* Development, Operation, and Valuation of Oil and Gas Properties.** Part 13. P. J. Jones. *Oil Gas J.*, 20.8.42, 41 (15), 43-44.—This is the concluding part of the series, and deals with estimation of oil reserves from production-decline rates. Formulae are given with illustrative problems worked out in full. Graphs are included. Pay-out of investment is briefly discussed. A. H. N.

**1062.\* Safeguarding Oil and Gas Wells against Bombing and Sabotage.** J. O. Farmer. *Oil Gas J.*, 20.8.42, 41 (15), 49.—Neither policing nor sand-bagging offers unflinching protection for well connections. The best protection lies in the use of safety mechanisms of a positive or automatic nature, placed several hundred feet below the surface, where they cannot be damaged by bomb impact or rendered ineffective by sabotage.

Full protection of a well against uncontrolled flow requires safeguarding of both the casing annulus and the tubing bore. If the casing annulus is not used as a flow conductor, it can be sealed off positively by setting a packer near the bottom of the well. When this is done on Gulf Coast marine locations, additional protection is gained by leaving the annulus full of heavy mud above the seal. The weight of the tubing, plus the weight of the mud column, holds the packer against the upward thrust of the formation pressure, and leaves the casing annulus dead at all times, thus assuring complete protection. Special packers for protecting the annulus in certain other circumstances are discussed.

The protection of the tubing section of the flow system is discussed historically from the development of the "storm chokes" in marine wells up to the present-day pressure-differential valves. The new valve is an over-sized bottom-hole choke into which is built a spring-loaded valve designed to remain open so long as the capacity of the bottom-hole choke is greater than that of the surface choke. As long as this relationship exists, virtually all the pressure drop is carried across the surface choke, since it is the point of greatest flow restriction. The instant the capacity of the surface choke approaches or exceeds that of the bottom-hole choke, the point of pressure reduction is transferred from the surface choke down to the bottom-hole choke, where the resultant pressure differential instantly snaps the spring-loaded valve closed.

The valve assembly consists of an orifice section, a spring-loaded main valve, and an equalising or by-pass valve. The main valve is above the orifice section, and is held open by the compression of a coiled expanding spring placed between the orifice section and the adjusting nuts on the lower end of the valve stem. Chevron-type packing prohibits flow between the valve stem and the orifice section; consequently all the flow from the tubing is directed through the opening in the orifice section. Any pressure drop across the orifice section acts against the area of the valve stem, tending to close the main valve against the action of the coiled spring. As long as the capacity of the surface choke is materially less than the capacity of the combined areas through the orifice section, practically all the pressure drop takes place at the surface choke—there being only a negligible drop across the valve stem. However, when the capacity of the surface choke approaches that of the openings, through the safety-valve orifice section, a pressure differential is set up across the valve stem, causing it to close instantly and to shut off all flow through the tubing. Heading, or surging, does not close the valve. The valve is shown in section. A. H. N.

**1063. Applying Bottom-Hole Pressure Data to Production Problems.** Part I. E. N. Kemler. *Oil Wkly*, 31.8.42, 106 (13), 22.—Proration by restrictions on maximum gas-oil ratio is discussed. Flow in a reservoir is the main subject of the first part of the paper. It is likened to flow in pipes. If the flow is viscous—that is, a viscous fluid such as a heavy oil and a small pipe size is used—the quantity which will flow will be proportional to the difference between  $P_1$  and  $P_2$ , or

$$Q = C_1(P_1 - P_2).$$

The proportionality factor  $C_1$  will depend on the viscosity of fluid, length of pipe, and size of pipe. If  $P_2 = P_1$ , then no flow will take place; and if  $P_2$  is atmospheric pressure, the maximum flow rate will occur. In the case of an oil reservoir, three pressures may be known or desired as indicated in a drawing in the paper.  $P_m$  is the static reservoir pressure, or the maximum pressure available for forcing the fluid from the reservoir.  $P_p$  is the pressure in bottom of the well, and is called the producing



bottom-hole pressure, and  $P_s$  is the top-hole producing pressure. As in the case of the pipe, the quantity of fluid produced by a well will be proportional to the pressure difference forcing the fluid through the sand or to  $P_m - P_2$ , or

$$Q = C(P_m - P_2).$$

This proportionality factor  $C$  will obviously depend on the type and thickness of sand or formation through which the fluid must flow. It is called the productivity index factor. It is generally equal to the brl./day which will be produced if the pressure at the sand-face is 1 lb./in.<sup>2</sup> below the static reservoir pressure, or will be equal to the production increase in brl./day for each lb./in.<sup>2</sup> decrease in bottom-hole producing pressure. In that case,  $P_m$  and  $P_2$  are given as lb./in.<sup>2</sup> and  $Q$  is brl./day. In the case of the pipe the relation given in the first formula holds only so long as the flow is viscous. The same condition applied to the second formula for flow through a sand. Fortunately the flow conditions except at very high rates are such that the relation given in the second equation apply. Little data are available to indicate what would occur at very high rates, although pipe-flow data would indicate a much smaller increase in production with increased pressure differentials in these cases. Application of bottom-hole pressures in using these formulæ is indicated.

A. H. N.

**1064.\* Pumping Experiment Designed to Check Various Factors.** G. M. Stearns. *Oil Gas J.*, 3.9.42, 41 (17), 31.—This is an advance report on experimental research being carried out on a pumping equipment at the University of Oklahoma. In planning the equipment set-up, the following requirements were kept in mind: (1) The conditions of an actual producing oil-well must be reproduced as nearly as possible. (2) The equipment must be so arranged that all pertinent phenomena can be observed and mathematical data accurately recorded. For this reason, it was decided to place all the equipment above the surface of the ground. (3) The equipment arrangement should be as flexible as possible, in order to allow changing from one test run to another without excessive delay. (4) The hook-up must be mechanically sound and safe for those who work on the project. A diagram illustrates the set-up.

Tests are being made first to determine the effect of variations in certain factors on the volumetric efficiency of one type of pump assembly when pumping oil of the specifications given in the paper. This is accomplished by holding all controllable variables constant except one for each test. Variation of the one variable and subsequent plotting of the pump efficiency for various values of that one factor will indicate the effect of that one isolated condition. In a like manner, each controllable factor can be isolated one at a time.

The variables investigated in this manner include: (1) Pumping speed. (2) Well depth. (3) Valve spacing. (4) Pump submergence. (5) Oil temperature. (6) Size and length of gas anchor. Similarly, different pump assemblies with the same oil will be tested to determine the effect of each variable. No results are yet given, but it is hoped to publish some within the year.

A. H. N.

**1065.\* Applying Bottom-Hole Pressure Data to Production Problems.** Part 2. E. N. Kemler. *Oil Wkly*, 7.9.42, 107 (1), 26.—The significance of bottom-hole pressure in studying pumping data and in carrying out pumping tests is detailed and illustrated by a typical test on a well. The calculation of well capacity by extrapolation of production *v.* bottom-hole pressures graphs to zero pressure is illustrated. Bottom-hole pressure data at various rates of production either obtained from use of bottom-hole pressure gauge or fluid-level measurements is helpful in determining the size of equipment which should be installed on a well. The rational method of determining the size of equipment for use in a well is to make preliminary tests with drilling-in equipment in case a well is drilled in with cable tools or with a temporary pumping unit. In this case a well does not need to be produced at full capacity, since bottom-hole pressure data combined with production data at any reasonable rate of, say, 10% of the well's capacity or more, will permit extrapolation to maximum conditions. While some extra expenses would be involved in such a procedure, the proper fitting of equipment to the well will justify such expense where variable well size may be expected. The investment of a few hundred dollars in testing may result in several thousand dollars savings in investment and capital charges, and may possibly influence



operating expense either through lower maintenance costs or less operating labour required. The acoustic method of measuring fluid levels for the purposes of ascertaining bottom-hole pressures is described in brief.

The use of bottom-hole pressure or fluid-level data as a means of determining the well's capacity to produce has been applied to the determination of so-called potentials. While large amounts of fluid can be produced from moderate depths with sucker-rod-type pumping equipment, the cost required to obtain this production is not generally desirable. The size of equipment required to obtain this production is out of line with that required for normal operation under prorated conditions for a considerable portion of the life of the field. Fluid-level or bottom-hole-pressure data have been used to obtain the index of a well's capacity to produce, and have resulted in considerable reductions in investment, operating costs, and operating labour. Inasmuch as tests commonly made previous to the introduction of the productivity indexes were actually a measure of the equipment's ability to produce, the introduction of some method such as the productivity method will give on the average just as satisfactory results even though they are not absolutely correct. For areas such as Western Kansas, where little or no gas is produced with the oil, this method will work with the limits of accuracy with which data can be obtained. A. H. N.

**1066.\* Reservoir Pressures at Rincon Stabilized by Gas Return.** N. Williams. *Oil Gas J.*, 10.9.42, 41 (18), 39-40.—There are nine horizons of producers in the field, but only four are at present injected with gas. First recorded bottom-hole pressure in the D, or 3700-ft. sand, was 1590 lb. By the time the pressure-maintenance operations were started the pressure had dropped to 1520 lb. On May 1, after 1 year of operations and with 188,540,000 cu. ft. of gas having been returned to the sand, the pressure for some time had remained around 1536 lb. Bottom-hole pressure in the G, or 4000 ft. sand, had dropped from 1764 lb. (first recorded pressure) to 1665 lb. As of May 1, 401,812,000 cu. ft. of gas had been injected and pressure was 1675 lb., at which level it had been for some time.

When gas injection was started in the I (4165 ft.) sand, bottom-hole pressure was 1375 lb., having declined 75 lb. from the pressure first recorded. Up to May 1, more than 273,450,000 cu. ft. of gas had been injected, and the rate of pressure decline had been substantially slackened, but the period of operation had been so short that definite results had not been determined. A similar condition exists in the K (4250 ft.) sand, in which only 25,500,000 cu. ft. of gas had been injected up to May 1.

It is proposed that as pressures in these sands become stabilized and as additional gas becomes available through new development, the return of gas will be extended or shifted to other sands. By rotation of gas injection to the various sands as pressures in these sands decline, it is hoped that pressure drop in all sands can be kept at a minimum, thus prolonging the flowing life of the wells and increasing the ultimate recovery. A. H. N.

**1067.\* Applying Bottom-Hole Pressure Data to Production Problems.** Part 3. E. N. Kemler. *Oil Wkly*, 14.9.42, 107 (2), 40.—Flowing wells are studied in this part of the paper. The principles involved and the mechanism of flow in wells are first discussed. Graphs are used to illustrate the use of bottom-hole pressures in predicting the life of a naturally-flowing well by working out a typical example. Bottom-hole-pressure tests on flowing wells can be used for determining well potentials. Potentials in the case of flowing wells are more indefinite than for pumping wells. In the latter case the potential as determined by bottom-hole-pressure tests may be a value which is in excess of equipment capacity. Physical difficulties such as excessive gas may prevent actually realizing the indicated maximum well capacity. In the case of flowing wells the potential may refer to the indicated ability of the well to produce—that is, the indicated brl./day which the well will make if produced with zero pressure on the formation. It is pointed out that the ability of a flowing well to produce depends on the pressure drop in the tubing, as well as on the static bottom-hole pressure and the effective permeability or productivity-index factor. Any predicted actual ability to produce will depend on this pressure drop in the tubing. Any reference to potential on flowing wells must therefore be accompanied by the definition of potential if the result is to have meaning.

Potentials on flowing wells may be taken either with bottom-hole-pressure gauges

or by one of the fluid-level-measuring devices. In cases where considerable gas is produced through the casing, difficulty may be encountered in obtaining an accurate fluid level. Back-pressure methods have, however, been developed for such purposes, and satisfactory tests may usually be obtained by either method. A. H. N.

**1068.\* Corroded Casing Threatens Arkansas Sour Gas Fields.** E. Sterrett. *Oil Wkly*, 14.9.42, 107 (2), 32.—Unless present encouraging corrective attempts prove successful, processing and utilization of Arkansas' vast and strategically located stores of sour gas face a possible serious set-back through the discovery that many of the casing strings in the 115 producing wells of the Magnolia field, Columbia County, have been perforated from within by corrosive action and are permitting leaks to the water-string or into barren formations above the string setting. A Commission is studying corrective procedures. Lacking laboratory reproduction of down-the-hole conditions under surroundings which permit observation and evaluation of the factors resulting in the casing failure, two possible reasons have been advanced. The electrolytic theory finds support in the fact that currents of an order as high as  $2\frac{1}{2}$  amp. have been detected at some wells, even though these strings may have been insulated from the surface flow-string by dielectric gaskets. So far no method has been worked out whereby protective or cathodic currents could be introduced and controlled within the affected wells for the arresting of the destructive action.

The hydrogen-sulphide theory advanced by some observers requires the presence of water before the  $H_2S$  present in the gas, in the proportion of 1500 grains/100 cu. ft. of gas, can become an agent of metal destruction. Since the gas does contain a certain amount of water vapour, and conditions at some points within the annulus between tubing and casing string fall to a temperature far enough below bottom-hole values to cause condensation, it is entirely possible that this vapour, condensing on the cool casing rather than on the relatively warmer tubing, would tend to flow down the string, the concentration being aided by inclination of the string or by the line of contact between tubing and casing. The fact that the casing alone is attacked by the dilute sulphuric acid formed by dissolving the hydrogen-sulphide of the gas in the droplets of water would tend to support the inclined trough hypothesis, rather than the tubing-contact theory.

Detection methods by pressure measurements are discussed. Remedial measures are still diverse and experimental. These are briefly discussed. A. H. N.

**1069. Joule-Thomson Coefficients for Two Natural Gases.** B. H. Sage, D. F. Botkin, and W. N. Lacey. *Petrol. Tech.*, September 1942, 5 (5), A.I.M.M.E. Tech. Pub. No. 1504, 1-5.—The Joule-Thomson coefficients of two natural gases were determined at pressures up to 600 lb./in.<sup>2</sup> through the temperature range 70-310° F., by measuring the temperature change on the passage of gas through a porous thimble under a known pressure difference. Deviations from steady state flow may have given rise to uncertainties as large as 2% in the measured coefficients. From these data and information relating to the isobaric heat capacities of the components at infinite volume, the heat capacities of the gases were computed throughout the same ranges of pressure and temperature.

The methods of correlating the isothermal changes in the enthalpy of pure substances, which have been based on the law of corresponding states, have been expanded to apply to multi-component mixtures. Also the enthalpy of multi-component gaseous hydrocarbon systems has been estimated from the partial enthalpies of the components determined by the behaviour of binary hydrocarbon mixtures. Enthalpies predicted by different methods were compared with those calculated from the experiments, and are shown in tabular form. In general the agreement between the several values was within about 3 B.Th.U./lb., but the partial enthalpy approach seems to give better values of the enthalpy with respect to temperature at low pressures than were obtained by the more general approach. The comparisons show that at pressures below 600 lb./in.<sup>2</sup> the currently available methods of prediction may be employed with some confidence. G. D. H.

**1070. Patents on Production.** C. J. Gibson. U.S.P. 2,296,514, 22.9.42. Appl. 15.7.40. Brush for cleaning perforated casing or lining by means of wire bristles.



C. W. Sproull. U.S.P. 2,296,582, 22.9.42. Appl. 10.7.39. Pump-operating mechanism by means of hydraulic power for deep-well pumping.

M. De Groote and B. Keiser. U.S.P. 2,296,600, 22.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type by subjecting the emulsion to a demulsifier comprising a water-soluble esterification product of certain classes of compounds.

J. H. Puls. U.S.P. 2,296,821, 22.9.42. Appl. 8.4.41. Multi-stage well-pump for deep-well pumping.

A. Boynton. U.S.P. 2,296,833, 29.9.42. Appl. 31.1.39. Input air or gas-control valve for cased wells.

A. Boynton. U.S.P. 2,296,835, 29.9.42. Appl. 31.1.39. Differential-type pneumatic piston pump.

A. J. Zschokke. U.S.P. 2,296,971, 29.9.42. Appl. 14.2.41. Bullet retainer for gun perforators.

M. E. Chun. U.S.P. 2,296,981, 29.9.42. Appl. 24.9.40. Method and apparatus for determining the point of water entry into oil-wells.

R. W. Lohman. U.S.P. 2,297,006, 29.9.42. Appl. 7.3.41. Gun-perforator firing system using electrical means.

G. F. Turechek. U.S.P. 2,297,037, 29.9.42. Appl. 14.2.41. Gun-perforator cartridge with easily removable case.

G. F. Turechek. U.S.P. 2,297,038, 29.9.42. Appl. 25.2.41. Gun perforator with a plurality of gun units.

W. G. Wellington. U.S.P. 2,297,041, 29.9.42. Appl. 19.2.41. Gun perforator.

E. L. Barker and C. P. Gillespie. U.S.P. 2,297,044, 29.9.42. Appl. 14.3.39. Bottom-hole choke for wells.

R. H. McKee. U.S.P. 2,297,062, 29.9.42. Appl. 23.5.38. Separation of oil from gas on production from a field.

J. P. Walker. U.S.P. 2,297,297, 29.9.42. Appl. 27.5.40. Treatment of oil, gas, and water mixtures in a continuous-closed system of treating oil emulsions.

L. A. Layne. U.S.P. 2,297,308, 29.9.42. Appl. 7.9.40. Well-bottom assembly for gravelling.  
A. H. N.

### Transport and Storage.

1071.\* **Corrosion of Pipe-Lines.** A. H. Stuart. *Petroleum*, February 1942, 5 (2), 33.—One of the major corrosion problems in industry refers to buried pipe-lines, and in these the development of pits is more important than general corrosion. The most important factor in this respect is the nature of the soil, and it has been shown that pit depth varies roughly as the acidity of a soil and inversely as its resistance to an electric current.

Coating of the pipe is the most obvious form of protection, but while suitable coatings are readily available, the development of a satisfactory technique for applying them is difficult. The surface of the pipe must be thoroughly cleaned and dried before the coating is applied. The coating of moist pipes leads to the development of rust under the protective layer, with subsequent deterioration of the coating. To overcome this trouble pickling has been tried with some success.

Other methods consist of spraying the surfaces with aqueous solutions which precipitate an anti-corrosive chemical film on the iron. Combinations suggested are zinc sulphate or lead nitrate sprayed simultaneously with potassium dichromate or disodium phosphate. The films deposited afford a bond for the paint or other protective material afterwards applied.  
D, L. S.



**1072.\* Protecting Buried Metals Against Corrosion.** Starr Thayer. *Oil Gas J.*, 2.4.42, **40** (47), 37.—A short, general account of the methods used for combating pipe-line corrosion losses, which may amount to upwards of 100,000,000 dollars annually.

In laying new pipe-lines extra expense which may be incurred in avoiding known corrosive areas—*e.g.*, swamps—is not considered justifiable, but protective coatings are usually applied.

Older lines can be given cathodic protection, based on correcting the potential differences which may exist between small sections of the pipe-wall or may be due to changes in soil conditions.

The various methods in use for making the pipe-line cathodic to the surrounding soil are described, and examples are given of the practical effects of the process.

J. C.

### Cracking.

**1073.\* Compositions of Catalytically Cracked Gasolines.** J. R. Bates, F. W. Rose, S. S. Kurtz, and I. W. Mills. *Industr. Engng Chem.*, 1942, **34**, 147.—The composition of catalytically cracked gasolines has been investigated by analysis for olefins and aromatics by well-established methods, followed by a fractional distillation examination of the residual paraffins resulting from controlled acid washing. This examination shows that the ratio of *iso* to normal paraffins present in catalytically cracked gasolines is considerably higher than that existent in thermally cracked gasolines. This high concentration of *isoparaffins* in the lower boiling range, together with the high aromatic content in the higher boiling range, is responsible for the octane number of catalytically cracked gasoline.

Comparative data for the ratio of *iso* to normal paraffins for C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, and C<sub>7</sub> hydrocarbons are given for cracked gasolines from various sources.

J. W. H.

**1074. Patent on Cracking.** J. V. Marancik and H. Z. Martin. U.S.P. 2,296,722, 22.9.42. Appl. 26.8.39. Method of catalytically cracking hydrocarbon oils to form lower-boiling motor-fuel products. A cracking catalyst substantially free from carbonaceous deposit is suspended in a stream of the oil to be cracked and the resultant suspension is passed through a cracking zone. Afterwards the catalyst is separated from the cracked products and suspended in a stream of oil, which is more amenable to cracking than the first stream. This suspension is passed through a separate cracking zone, and the products are fractionated to produce a motor-fuel fraction.

H. B. M.

### Hydrogenation.

**1075. Catalytic Poisoning in Liquid-Phase Hydrogenation.** A. G. Deem and J. E. Kaveckis. *Industr. Engng Chem.*, 1941, **33**, 1373.—Sulphur compounds in five different states of oxidation were investigated to determine their effect on the rate of hydrogenation of phenol, naphthalene, and quinolene employing a Raney nickel catalyst. Only those compounds in the lower state of oxidation poisoned the reaction to a high degree.

J. W. H.

### Polymerization and Alkylation.

**1076.\* Low Temperature Catalytic Alkylation of *iso*Paraffins.** P. D. Caesar and A. W. Francis. *Industr. Engng Chem.*, 1941, **33**, 1426.—A reaction mechanism is proposed which accounts for substantially all the observed paraffin isomers resulting from the low-temperature alkylation of *isoparaffins*.

J. W. H.

### Synthetic Products.

**1077.\* Present Status of Synthetic Rubber.** E. R. Bridgwater. *Industr. Engng Chem.*, 1941, **33**, 1342.—The various types of synthetic rubber are reviewed, their uses discussed, and the quantities produced during the years 1939–41 are given. The article summarizes the production of synthetic rubber in a general manner.

J. W. H.

**1078.\* Butadiene is Real Bottleneck in Synthetic Rubber Programme.** J. P. O'Donnell. *Oil Gas J.*, 26.3.42, 40 (46), 128.—The requirements of the U.S.A. synthetic rubber programme will be minor compared to the demands for high-octane gasoline, since 500,000 tons annually will require 3,750,000 bbl. of butadiene, whilst 100 octane fuel has a projected goal of 91,250,000 bbl. annually. In spite of the fact that neither has the raw material resources of the U.S.A., Germany is estimated to be producing 100,000 tons of synthetic rubber annually and Russia 50,000 tons. Germany uses butadiene, made not from petroleum, but from coke and lime via acetylene, acetaldehyde, aldol, and butylene glycol. Russia's process is less involved, starting with ethyl alcohol, by the fermentation of grain and potatoes, followed by catalytic conversion (passing the vapours over Al-Zn oxide at 400° C.) into butadiene.

W. Nelson has estimated that 129,000 bbl. of butane are available daily in the U.S.A. From butane, butadiene may be obtained by dehydrogenation via butylene. Catalysts of the Cr, Mo, Va oxide-on-alumina type are employed at low pressures and at 600–650° F. in a typical process. By the use of recycling, yields as high as 79% from butene and 65% from butane have been reported.

A list of the principal synthetic rubbers, manufacturers, raw materials, and compositions is given, but only the following five are in relatively large-scale production: (1) polymerized butadiene, (2) Buna S, (3) Buna N or Perbunan, (4) polysulphides (Thiokol), (5) neoprene. Russia alone makes (1) in quantity, Germany having abandoned it for the more versatile copolymers (2) and (3).

Buna S is produced by the copolymerization of butadiene and styrene, emulsified in water with soap or other emulsifier. Catalysts and modifying agents may be added (types are quoted), and the mixture is maintained at 50° C. for about 12 hrs. An inhibitor or stabilizer—*e.g.*, phenyl- $\beta$ -naphthylamine—is added to prevent further polymerization, and the resultant latex, coagulated with acetic acid, washed and dried, is similar to natural latex. Buna S is the type which Government plants will produce, and compounded with carbon-black is reported to be superior to natural rubber in heat and abrasion resistance. It is the least expensive of the major synthetics available for tyres, and because of its importance, a detailed table of its properties compared with those of natural rubber is given.

Buna N (Perbunan) is the result of copolymerizing butadiene and acrylonitrile, and is superior to natural rubber in oil and solvent resistance. Buna S and N may be varied in properties by varying the ratio of the copolymers, the polymerization environment, and the conditions of vulcanization.

Neoprenes, made by the polymerization of chloroprene (chlorbutadiene) by emulsification in water, are superior to natural rubber in resistance to sunlight, heat, and oils, and are less inflammable.

A table is given of the reactions involved in the above processes.

Polysulphide rubbers produced by condensation of organic dihalides with sodium tetrasulphide are outstanding in oil, solvent, and oxidation resistance, and are made in Japan as well as in the U.S.A. Various other synthetic rubbers are briefly described.

In 1941 neoprenes constituted about 52% and butadiene types 35% of the U.S.A. total production of 12,000 tons. The present plans to raise the production to 400,000 tons annually are discussed, and companies participating, new plants, and others under construction are referred to. The 1942 production should reach the impressive but inadequate total of 95,000 tons, and the rate of 400,000 tons annually will not be reached until late 1943 or 1944.

The dominant rôle is to be played by butadiene types, and the liquid butadiene will be shipped under pressure to the processing plants. The styrene for Buna S may be made by dehydrogenation of ethyl benzene, or may be separated from cracked gases or recovered during the manufacture of carburetted water gas. Acrylonitrile may be obtained by dehydrogenation of ethylene cyanohydrin or by catalytic addition of HCN to acetylene.

A short account of the history of synthetic rubber processes is given, including Germany's processes during the World War and later. It is interesting to note that Thiokol was first obtained during a search for an anti-freeze.

A discussion of the comparative costs of natural and synthetic rubber, at present expensive, indicates that there are differing opinions as to whether the synthetic materials will eventually be cheaper than the natural, but their peculiar properties will in any case ensure them a market.

J. C.



**1079.\* Thermodynamics in Isomerization.** P. Buthod and W. L. Nelson. *Oil Gas J.*, 26.3.42, **40** (46), 120.—The isomerization process is important, since it converts low-octane-number normal paraffins into high-octane-number isoparaffins—e.g., normal heptane of octane number 0 into 2 : 2 : 3-trimethylbutane of octane number 101.

Almost any chemical reaction is theoretically possible, but practical factors are the extent to which it will proceed and the rate at which it occurs. Thermodynamics is of little help as regards the second factor, but the first can be studied by computation, involving the free energy concept. The method for calculating the compositions of the equilibrium mixtures, resulting from the isomerization of the lower-range gasoline hydrocarbons, is outlined, and is dependent on an equation, relating the standard-free energy change of the reaction with the absolute temperature, the gas constant, and the mass-law equilibrium constant. Results, shown graphically, have been worked out for the isomerization of butane, pentane, hexane, heptane, and octane hydrocarbons, and show that the desirable branch-chain products of high octane number predominate if the process can be carried out at low temperature. Thus, when a mixture of 8 carbon-atom (octane) molecules is isomerized at 1000° F., the product has an octane number of about 14, but if the reaction is carried out at 100° F., the octane number of the product will be 96, irrespective of the feed-stock octane number.

The results of thermodynamic computation must be interpreted with caution, and the figures quoted are applicable only to isomerization reactions, and not to decompositions, alkylations, etc. Side reactions, of which carbon formation is a troublesome example, complicate the situation. Moreover, many of the isomerization reactions will be very slow at the desirable low temperatures, and commercial application will be dependent on the discovery of suitable catalysts. In spite of its disadvantages, the thermodynamic method is the only general method available by which probable reactions can be selected from the vast number of possible reactions, and a thorough mathematical study to determine free energies from existing physical data, and from these the most probable reactions for each boiling range of petroleum, might form the basis of a petroleum chemical industry. J. C.

### Refining and Refinery Plant.

**1080.\* Agitation.** A. W. Hixson and S. J. Baum. *Industr. Engng Chem.*, 1942, **34**, 120.—The performance of propellers in liquid-solid systems is correlated in the form of a dimensionless equation. Data for four geometrically similar systems are correlated by this method, from which it is concluded that model experiments can be made in the prediction of agitator performance. J. W. H.

**1081.\* Electrical Stability of Mineral-Oil-Treated Dielectrics.** F. M. Clark and E. L. Raab. *Industr. Engng Chem.*, 1942, **34**, 110.—An investigation is made on the acid refining of distillate oils to the greatest-impregnating dielectric stability. For the type of distillate studied it is shown that the object of the refining is to remove the olefin type of hydrocarbons without appreciable removal of the aromatics. The greatest electrical stability was obtained with a 22% aromatic unsaturation content, which was obtained by the use of approximately 4.5 lb. of 96% acid per gallon of oil at a treatment temperature of 20° C. J. W. H.

**1082.\* Catalytic Desulphurization by Use of the Gray Process.** A. M. Martin and L. Carlson. *Oil Gas J.*, 26.3.42, **40** (46), 138.—Sulphur in gasoline was formerly objected to because of its possible corrosiveness and its odour, but now its most important effect is depression of lead susceptibility.

Sulphuric acid refining improves lead susceptibility to a limited extent, but large volumes of acid are required, high losses are entailed by solution and polymerization of the gasoline, whilst there are the problems of acid recovery and sludge disposal. Doctor sweetening converts mercaptans into less odoriferous compounds, which, however, still depress the lead response, whilst other methods in large-scale use remove mercaptans but not other sulphur compounds.

In the Gray catalytic process both mercaptan and non-mercaptan sulphur com-



pounds are largely eliminated by passing the gasoline vapours through a bed of solid adsorbent catalyst, such as fuller's earth, at elevated temperature. A flow diagram pertaining to an actual commercial installation is shown. A large part of the sulphur present is converted into  $H_2S$ , and the removal of the  $H_2S$  is the only other treatment necessary for the gasoline.

Tables are given of the different effects of a wide selection of clays on straight-run gasolines, and in a discussion of the applications of the process it is claimed that the octane number is improved, as well as the lead response. The total sulphur reduction may range from 60 to 85%, but the process for any stock is best assessed by the lead tetraethyl saving; it may be applied to certain aviation base stocks as well as to motor fuel.

Operating costs are low, the unit being of simple design with a measure of automatic control.

J. C.

**1083.\* Three-Way Refinery Developed for War Production.** O. W. Wilcox. *World Petroleum*, April 1942, **13** (4), 26.—The American refining industry faces an enormous task in meeting the ever mounting requirements for 100 O.N. aviation gasoline. To enable the small refiners to play their part, the O.P.C. (Office of the Petroleum Coordinator) has evolved a standard plan for proposed combination units to produce aviation gasoline, toluene for explosives, and butadiene for synthetic rubber. Where a single refiner's operations are not large enough to justify the erection of the optimum capacity 3-way plant, it is suggested that several smaller refiners combine to construct and operate such a plant.

The standard design allows various alternatives to fit special conditions, and aims at flexibility, but in general conforms to a scheme shown in a simplified flow sheet, and begins with crude, specially selected for its content of high-octane material, entering a topping still. Topping plants will not necessarily be installed at the combination 3-way units, and existent topping stills will if possible be used. In such cases the refiners will pool their reduced crudes, naphthas, and alkylation materials and deliver them to the combination plants.

The heavy naphtha will go to a reforming unit, which may be of conventional thermal type or of modern catalytic design—*e.g.*, the Houdry or the U.O.P. The reduced crude goes to a catalytic cracking unit, which may be of the Houdry type or may employ a fluid catalyst (details not allowed to be made public), but in any case the products are gas, gasoline, and gas oil or domestic fuel oil. This gas, together with gas from the reforming unit, will go to the gas-recovery unit, to be stripped of all products of military value, which include propylene (for chemicals or for *isopropyl* alcohol to be used as a blending agent, or to be mixed with *isobutane* for the alkylation unit) and ethylene (for styrene production for artificial rubber). The flow diagram shows a styrene unit, which involves the complication of a benzene supply for combination with the ethylene. The benzene may be obtained from outside, or may be produced by close fractionation of the aromatics in the toluene cut.

Accurate control of temperatures and pressures will be necessary in the gas-recovery unit for maximum yields of butanes and butenes. Details of debutanizing equipment are not given, but the  $C_4$  cut is shown as being split into two fractions, one containing *n*-butane and butene-2, and the other *isobutane*, *isobutene*, butene-1, and possibly butene-2. The first fraction will be dehydrogenated to produce 99.5% pure butadiene. The second fraction goes to an alkylation plant to produce alkylate for 100 O.N. fuel and residue, "heavy alkylate," for motor fuel. Various alkylation processes may be used, but most employ sulphuric acid as catalyst. Butadiene production may be increased by obtaining outside supplies of butane from natural gasoline plants or by preparing alcohol from ethylene and converting catalytically to butadiene. On the other hand, the production of alkylate may be increased by taking all the available butene-2 to the alkylation unit or by bringing in outside *isobutane* to alkylate propylene.

The gasoline from the catalytic cracking plant is fractionated to produce a "heart cut" rich in toluene, which goes to the toluene extraction unit, which also receives reformed gasoline (dependent upon its toluene content). Toluene extraction may be effected by azeotropic distillation, by distillation with methanol, or by extraction with sulphur dioxide or phenol. The raffinate, plus the remainder of the catalytically cracked gasoline, is catalytically treated to reduce gum and improve stability, and then

fractionated, one cut becoming aviation blending stock and the other high-O.N. motor fuel.

The gas oil from the catalytic cracking unit, if not otherwise required, may be thermally cracked for motor fuel and for additional gas supplies. J. C.

**1084. Increasing Production with Clean Condensers.** C. L. Weldell and W. B. Borst *Refiner*, August 1942, 21 (8), 243-245.—The problems involved and their solutions in increasing the capacity of a 6500-brl. plant to 8500, by attention to the condensers and heat exchanges, are discussed. The plant is confined to gasoline, kerosene, and fuel oil, and utilizes two crude units and one Dubbs unit. A. H. N.

**1085. Laboratory Control Reduces Refinery Corrosion.** A. W. Trusty. *Refiner*, August 1942, 21 (8), 250-252.—Some brines contain mostly sodium chloride and give less corrosion than other brines containing magnesium salts. The chemist should analyse the briny water from each crude oil processed at his plant to determine the relative proportions of sodium, calcium, and magnesium ions. Where calcium and magnesium are present, the total salt content of the crude oil should be reduced to a lower figure than in the case of a brine containing only sodium chloride.

Salt is most commonly encountered in crude oil in the form of brine-drops. It is only the very small brine-droplets which are difficult to remove from the oil. Larger drops, exceeding 0.01 mm. in diameter, settle readily, and are removed from the crude oil in the field. The presence of wax contributes to the difficulty of salt removal. Both brine-drops and solid salt crystals are stabilized by a thin coating of wax in the crude. A temperature of 120° F. will dissolve the wax in East Texas crude, while a temperature of 160° F. is required to dissolve the wax in Rodessa crude oil. The salt content of an oil is usually determined by diluting the oil with an organic solvent to decrease the viscosity and to minimize emulsion formation, followed by thoroughly agitating the oil with warm water, settling, and analysing the water extract. The water extraction is quite satisfactory in cases where the salt occurs in the form of brine solutions. If the salt is present in the form of crystals, however, it has been found that prolonged shaking does not completely dissolve the solid salt.

Centrifuging, likewise, will remove crystalline salt with difficulty. Ten minutes of centrifuging removed all the water, but 2 hrs. of centrifuging failed to remove all the salt from a sample of Rodessa crude containing crystalline salt. Details of tests for determining the salt content and the chemical compositions of the salt are given. Determination of  $p_H$  and the effects of sulphur in cracking plant corrosion are discussed.

A. H. N.

**1086. Metallizing to Prolong Life of Equipment.** J. E. Young, Sr. *Refiner*, August 1942, 21 (8), 246-248.—If one or two points are always remembered when making use of this process, there will be little difficulty in obtaining good results. First, the deposited metal is not welded to the base metal. The bond is purely mechanical, and for this reason the preparation must be thoroughly and carefully done. Second, regardless of the kind of wire used, the metal is "cast," and should therefore be machined and handled like a casting. This cast metal provides an excellent wearing surface, usually wearing several times longer than rolled metal of the same specification.

The most frequent refinery applications are: resurfacing pump-rods and shafts, building up bearing and packing areas on steam turbines, pistons and piston rods on gas engines and air compressors, seal rings in centrifugal pumps, filling in cavitated areas of centrifugal water-pumps, and many others that will occur in normal shop operation. The worn part is usually set on a lathe, a thread is cut with very rough sides, and the metal is melted and sprayed on the worn part to deposit in the thread and interlock in the rough interstices. Care has to be taken that no grease, moisture, etc., is deposited on the threaded worn part before application of the sprayed metal. Details are given regarding precautions, and methods to be adopted. A. H. N.

**1087. Multi-Component Distillation.** C. D. Shiah. *Refiner*, August 1942, 21 (8), 240-242.—This paper presents a new graphical method for the stepwise calculation of multi-component distillation problems, which, with the aid of Shiah's K-chart, uses a single curve to represent the equilibrium curve for all the components. Use



is also made of both Hibshman and Robinson and Gilliland's technique to obtain the concentration of each component, as well as the temperature on any plate with practically no trial-and-error work. The paper is supplemented with a large chart, the derivation and use of which are explained and further illustrated by an example worked out in full.  
A. H. N.

**1088. Proper Electrodes for Refinery Welding.** W. L. Archer. *Refiner*, August 1942, 21 (8), 253-256.—In order to establish standards for welding electrodes, the American Welding Society and the American Society for Testing Materials collaborated in issuing a specification for welding electrodes. Thus the user of welding is enabled to talk about welding rods in terms of their current characteristics and physical properties by merely stating the grade. A table gives a summary of the American Welding Society classification number as a guide to welding positions, description of electrode and current requirements, heat treatment, and primary physical properties of all-weld metal tension specimens. The table deals with four electrodes, but the paper discusses only three grades.  
A. H. N.

**1089. Petroleum-Refining Methods Available for War-Time Demands.** J. F. Thornton and W. C. Dickerman. *Petrol. Tech.*, September 1942, 5 (5), A.I.M.M.E. Tech. Pub. No. 1503, 1-7.—The spreading of war is making exceptional demands on the oil industry. Large quantities of 100-octane gasoline, extreme service lubricants, toluene, and miscellaneous products are needed. The 100-octane gasoline is blended from isopentane, base stock, and alkylate. isoPentane is fractionated from natural or refinery gasoline. It has not yet been necessary to resort to the isomerization of normal pentane. Catalytic cracking is rapidly becoming the major source of the base stock, which should have a good octane rating and high lead response. Alkylate, the most important component, is synthesized from isobutane and olefin.

Fortunately the United States finds itself with well-developed processes already available for the production of the highest-quality lubricants. Toluene is now being produced by new methods from special cuts fractionated from selected crudes, or from catalytically processed naphthas.

Designers of refinery equipment are modifying past practices in order to conserve materials as far as possible.  
G. D. H.

**1090. Patents on Refining and Refinery Plant.** Standard Oil Development Co. E.P. 547,942, 18.9.42. Appl. 19.6.40. Separation of olefins from gaseous mixtures containing them by contacting the mixtures with a saturated absorbent solution of cuprous salt in a solvent taken from the class consisting of ethers and alkyl and aryl nitriles, and alkyl and aryl phosphates.

W. W. Gary. U.S.P. 2,296,992, 29.9.42. Appl. 21.7.39. Method of separation of light hydrocarbons including methane and ethane from a crude petroleum oil and of recovering desired hydrocarbons from the separated light hydrocarbons and from a hydrocarbon gas mixture.  
H. B. M.

### Chemistry and Physics of Hydrocarbons.

**1091.\* Latent Heats of Vaporization.** H. P. Meissner. *Industr. Engng Chem.*, 1941, 33, 1440.—An equation and a graphical solution to an equation are given which enables the molal latent heat of vaporization to be computed from the vapour pressure, if the critical temperature and pressure of a pure liquid are known. The calculated latent heats are compared with the experimentally determined values for some thirty compounds which shows that the equation is valid to an accuracy of  $\pm 9\%$  for both polar and non-polar liquids with an average error of  $\pm 5\%$ .  
J. W. H.

**1092.\* Dielectric Properties of Hydrocarbons and Hydrocarbon Oils.** J. C. Balsbaugh, A. G. Assay, and J. L. Ongley. *Industr. Engng Chem.*, 1942, 34, 92.—A study is made of the influence of oxidation on the dielectric properties of several pure hydrocarbons and a series of hydrocarbon oils. It is shown that in the presence of copper, the salt of a 5-carbon dibasic acid is formed. If the oxidation is carried out under



restricted oxidation conditions a highly dissociated electrolyte is formed giving high conductivities or power factors. Measurements of the electrical properties of the oil itself are made, and similar measurements for the oil in combination with paper.

J. W. H.

**1093.\* Theory of Open-Tube Distillation.** J. W. Westhaver. *Industr. Engng Chem.*, 1942, **34**, 126.—An equation expressing the H.E.T.P. in terms of  $V_a$ , the vapour velocity,  $r_0$ , the radius of the tube, and  $D$ , the molecular diffusion coefficient of the vapour stream is given as

$$\text{H.E.T.P.} = (11/48) V_a r_0^2 / D + D / V_a.$$

This fixes the minimum value of the H.E.T.P. as  $0.96r_0$ , and it occurs at a vapour velocity of  $2.1(D/r_0)$ , which is considerably below the range of any experimental data. At ordinary vapour velocities it is shown that the theoretical H.E.T.P. and experimental data are in good agreement.

J. W. H.

**1094.\* P-V-T Relations and Derived Quantities for Hexanes.** E. A. Kelso and W. A. Felsing. *Industr. Engng Chem.*, 1942, **34**, 161.—The molal volumes and pressure-volume-temperature relations for 2:3-dimethylbutane, 2-methylpentane, and *n*-hexane have been determined over the temperature range 100–275° C. From this data the values of  $Z$  in the gas equation  $pv/RT = Z$  and the fugacity coefficients  $f/p$  have been calculated.

J. W. H.

**1095.\* Pressure-Temperature Chart for Vapours.** M. Hirsch. *Industr. Engng Chem.*, 1942, **34**, 174.—A new method of plotting logarithmic pressures using convergent isotherms is given which enables an estimation of the vapour pressure to be made from a limited amount of data. The use of this method is illustrated in detail by examples and comparative data calculated by the method, and determined results show that the method offers considerable accuracy.

J. W. H.

**1096. Specific Volumes and Phase-Boundary Properties of Separator-Gas and Liquid-Hydrocarbon Mixtures.** K. Eilerts and R. V. Smith. U.S. Bur. Mines. Report of Investigations No. 3642, April 1942.—It is pointed out in the introduction to this report that a knowledge of the phase relations of fluids produced from "combination wells" at the pressures and temperatures characteristic of production from natural reservoirs is essential to efficient recovery and refining practice. In this connection "combination wells" are taken to mean those wells where gas and light volatile hydrocarbon liquid in quantities of economic significance are recovered at a relatively high ratio of gas to liquid. For purposes of laboratory investigations described, accurate samples of the fluid from such a well were prepared by mixing (in the proportions of the measured gas:liquid ratio) gas and liquid taken from the separator under conditions of steady flow.

Specific volumes as a function of pressures up to 5000 lb./in.<sup>2</sup> abs. and temperatures ranging from 70° to 280° F. were measured on ten mixtures of separator gas and liquid samples. Distillation analyses were made to determine the composition of the natural hydrocarbon mixtures, and further experimental data were collated to provide information for evaluating phase-boundary properties of the mixtures in terms of pressure, temperature, and composition.

Results obtained in regard to specific volumes of two-phase fluids at sub-atmospheric pressures were used in calculations of compressibility factors of mixtures containing 50% or more separator gas.

Bubble-point and dew-point phase boundaries of mixtures for the temperature range of 70–280° F. were determined from specific volume data. The locus of the maximum pressures (composition constant, temperature variable) at which given mixtures could be maintained in coexisting gas and liquid phases and the locus of maximum pressures (temperature constant, composition variable) for maintenance of the two-constituent system in coexisting gas and liquid phases were evaluated as a function of pressure, temperature, specific volume, and composition. The maximum pressure at which a mixture of the separator gas and liquid in any proportion could exist in two phases was 3940 lb./in.<sup>2</sup> abs. At this pressure, common to both

loci of maximum pressure, the temperature was 149° F. and the composition 62.6 mass-per cent. separator gas.

H. B. M.

**1097.\* Hydrocarbon Hydrates.** I. C. Bechtold. *Petrol. Engrn.*, April 1942, 13 (7), 57.—Increased pressure in transmission systems during the last 10 years has increased the frequency of formation of solid hydrocarbon hydrates, which has led to their study from a commercial point of view and to the accumulation of considerable fundamental data.

The chemical composition is not easily ascertained by analysis, since the hydrates are stable only under conditions of relatively high pressure and low temperature; in all ordinary circumstances they will exist in the presence of unknown amounts of excess vapours. For example, ethane hydrate has been reported as  $C_2H_6 \cdot 7H_2O$  and  $C_2H_6 \cdot 6H_2O$  by different investigators. Hydrates of methane, ethane, propane, and the butanes have been reported in the literature, but there appears to be doubt as to whether *n*-butane forms a hydrate. Villard has described hydrates as dissociable compounds, capable of existing only in the solid state, formed by water with various gases, isomorphous between themselves, crystallizing in the cubic system, and of composition represented by the general formula  $M \cdot 6H_2O$ .

The equilibrium conditions for the coexistence of solid hydrate, vapour phase, and water are represented graphically for the pure gases methane, ethane, and propane, but for actual natural gas they will be dependent on composition. It is considered that it is possible to determine the conditions conducive to hydrate formation in apparatus such as pipe-lines, pressure vessels, and plant equipment; a typical example is discussed.

The elimination of hydrates already formed may be effected by lowering the pressure, which is not always practicable, or by raising the temperature, which is often dangerous and not generally satisfactory, since it is rarely possible to heat the entire system and to prevent re-formation at some other point. Substances may be introduced which have a lowering effect on the decomposition temperature—*e.g.*, methyl, ethyl, or propyl alcohol in small amounts, or gaseous ammonia. In the latter case, if carbon dioxide is present there is danger of solid ammonium carbonate formation, which may cause more trouble than the hydrate plug.

Prevention of hydrate formation is more important, and may be effected by dehydrating the gas so that it will never be saturated with water vapour under any temperature and pressure conditions it may encounter in the system. Well-known methods include refrigeration, glycol absorption, action of solids such as activated alumina or silica gel, contacting the gas with calcium chloride or sodium chloride brine, and so on. Local conditions of temperature and the pressure in the installation will determine how much water must be removed.

J. C.

**1098. Hydrocarbon Chemistry for the Refinery Worker.** P. H. Faust. *Refiner*, August 1942, 21 (8), 227–231.—An elementary review of the chemistry of the hydrocarbons is given. Thermodynamical principles are briefly sketched. The paper ends with a short description of chemistry in the refining and conversion of petroleum products.

A. H. N.

**1099. Gas Analysis with the Mass Spectrometer.** J. A. Hipple. *J. Appl. Phys.*, September 1942, 13 (9), 551–560.—The fundamentals of gas analysis by mass spectrometry are discussed. The sample of gas to be analysed is admitted to a vacuum tube in the region of a small slit, by means of a capillary leak; the gas flows through the tube and out of the pumping lead by means of mercury or oil-diffusion pumps, the pressure being of the order of  $10^{-4}$  mm. Hg or lower. An electron beam cuts across the gas stream and ionizes some of the molecules of the gas. The electron current is of the order of a few microamperes, and the electron accelerating voltage is usually variable between 0 and 100 volts. The beam of ions travels through a second slit, towards which it has been accelerated by a difference of potential of about 500 and 1000 volts existing between the two slits. The beam travels in a straight line until it meets a magnetic field at right angles to the main path of the beam, when it bends into a circular path, and by an appropriate adjustment of the ion accelerating voltage and the magnetic field strength, ions of a particular mass to charge ratio are



caused to follow the curve of the vacuum chamber, emerging from the magnetic field region after a deflection of  $90^\circ$  and entering a third slit. Upon leaving the third slit the ion beam is captured in a Faraday cage, and the current corresponding to this particular mass is measured. For example, if it is desired to analyse a sample containing a mixture of nitrogen (mass 28) and oxygen (mass 32), with the fields adjusted for mass 28 to pass through the tube, mass 32, being bent less by the magnetic field, will hit the ground inside the tube and be lost. Having measured the current corresponding to mass 28, the voltage between the first slit and the second slit is decreased until mass 32 passes through all the slits, and this current is then measured. These two readings are then a measure of the relative number of molecules of  $N_2$  and  $O_2$  in the original sample. In an instrument of general utility, the first, second, and third slits are of the order of half a millimeter, and the radius of curvature in the magnetic field 10–15 cm. The ion current passing through the tube may be  $10^{-10}$  to  $10^{-15}$  ampere.

References are given to papers dealing with particular molecules, such as He, Ne, etc., including hydrocarbons, which have been so analysed and studied.

In working with hydrocarbons especially, it is important to avoid thermally dissociating the molecule by the heat from the filament; to get a reproducible mass spectrum, all the dissociation must be due to electron impact. For this reason an oxide-coated filament is used in this work, although a tungsten filament could probably be used if sufficient precautions were taken. The design is such that the gas is admitted to the ionization region and then pumped out past the filament.

Rather complicated mixtures of hydrocarbons have been successfully analysed. The results of the analysis with the mass spectrometer checked exceedingly well with the known composition of the mixture. In this work, mixtures of as many as five components were analysed. In one case the mixture was methane, ethane, propane, *isobutane*, and *n-butane*; in another, the components were *isobutene*, (1-butene, 2-butene lumped together), *isobutane*, and *n-butane*. A. H. N.

**1100.\* The Cyclization of Hydrocarbon Mixtures.** S. J. Green. *Journ. Inst. Pet.*, September 1942, 28 (225), 179–207.—An exhaustive study of previous work on the subject, together with thermodynamical analysis of the possibilities of cyclization form the introductory part of the paper. Experimental apparatus and procedure are described in detail. The results of the work are given in full, together with incidental work on the desulphurization of the material by the catalysts. The chief conclusions are summarized as follows:—

$Cr_2O_3$  from chromic acid, on fluoridin as carrier, showed negligible activity, whereas when the sesquioxide was prepared from chromium nitrate, using the same carrier, the aromatics and unsaturateds in a hydrocarbon mixture were increased by 16%. Copper chromite and molybdenum sulphide on various carriers were active, but the introduction of activated alumina increased the activity of these and other catalysts considerably. Activated alumina alone was also active.

Various mixtures were passed over a molybdenum–alumina catalyst, and it was found that *n*-heptane is more easily aromatized than technical heptene. The reactions of other mixtures are discussed, and *o*-xylene was identified from the aromatization of 2 : 2 : 4-trimethylpentane. At  $550^\circ C$ . 2 : 2 : 4-trimethylpentane was converted into 25% aromatics, but this conversion was accompanied by extensive cracking. Desulphurization and aromatization of benzole fractions were found to be technically inseparable processes. The activities of various catalysts for desulphurization were studied. Molybdenum sulphide showed greater activity than chromium sulphide, except when the former was prepared outside the catalyst tube.

In general, the cyclization of hydrocarbon mixtures results in a spreading of the distillation curve, formation of gas and carbon, and an increase in aromatic and unsaturated hydrocarbons. At the same time hydrogenation reactions take place. The product from such a reaction will therefore depend on the conditions of the reaction and on the nature of the substrate. By the choice of suitable conditions, and by varying the composition of the substrate, it is possible to achieve several different reactions at the same time, using a single catalyst.

The paper is appended with 46 references to the literature.

A. H. N.

**1101.\* The Separation of Gases.** M. Ruhemann. *J. Inst. Pet.*, October 1942, 28 (226), 215–239.—Separation of gases necessitates the introduction of another phase



into the single-phase, multi-component gaseous mixture. This is performed either by introducing liquid or solid absorbent phases or by the liquefaction of the gas itself into a two-phase system. The methods of achieving these purposes are given.

Problems of separating the constituents of air and of coke-oven gases are studied specifically. The paper is appended with 13 references and a discussion covering pp. 231-239. A. H. N.

**1102. Patent on Chemistry and Physics.** M. De Groot. U.S.P. 2,295,163, 8.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type characterized by subjecting the emulsion to the action of a demulsifying agent consisting of a water-soluble esterification product derived by reaction between one mole of a polybasic compound and two moles of a water-insoluble hydroxylated compound. The polybasic compound is the esterification product of (a) a polyalkylene glycol having between 7 and 17 ether linkages and the alkylene radical thereof containing from 2 to 6 carbon atoms; and (b) a polybasic carboxy acid having not more than 6 carbon atoms. The water-insoluble polyhydric material is a hydroxylated fractional ester derived by reaction between a detergent-forming monocarboxy acid having from 8 to 32 carbon atoms, and a polyhydric alcohol having from 2 to 12 carbon atoms. H. B. M.

### Analysis and Testing.

**1103.\* Laboratory-Size Continuous Distillation Unit.** R. W. Hufford and H. A. Krantz. *Industr. Engng Chem.*, 1941, **33**, 1455.—Constructional details are given for a laboratory scale continuous distillation unit having a fractionating column equivalent to 55 theoretical plates. The equipment is fabricated of metal, and the normal operating feed rate is 1 litre/hr. when employing a 3 : 1 reflux ratio. J. W. H.

**1104.\* Front-End Volatility of Gasoline Blends.** N. B. Haskell and D. K. Beavon. *Industr. Engng Chem.*, 1942, **34**, 167.—A graphical method is presented enabling the volatility as measured by the A.S.T.M. 10% point and Reid vapour pressure of refinery gasolines to be predicted from a knowledge of the C<sub>4</sub> and C<sub>5</sub> content of the blend. A correlation is given relating A.S.T.M. distillation loss to the C<sub>4</sub> and C<sub>5</sub> content of the stock. J. W. H.

### Motor Fuels.

**1105.\* Gasoline Additives.** J. A. Moller. *Oil Gas J.*, 26.3.42, **40** (46), 82.—Curves, showing (a) how increased compression ratio gives increased power output, (b) how compression ratios and octane numbers of fuels have risen during the last decade, and (c) fuel octane-number requirements against compression ratios, are used to indicate why present-day engines necessitate fuels of higher octane number than formerly. Improving performance by advancing the spark also leads to increased octane-number requirements, as is shown by graphs of spark advance against fuel octane number necessary at different engine revolutions. A series of curves of standard and optimum spark advance for some 1941 passenger cars show that the optimum spark advance is not available to engine manufacturers because of the lack of commercial fuel which would perform satisfactorily. Increasing the air/fuel ratio in the interests of economy must also be paid for in higher anti-knock fuel quality.

The above relates to new engines, but the factors of wear and deposition in used engines again necessitate higher octane ratings of the fuel. The conclusion is reached that due to deposition the designer must arrange for an engine-fuel requirement of 7 octane numbers less than the commercially available fuel he intends the engine owners to use.

In a study of deposition (meaning total deposition including lead compounds, foreign materials such as road dust sand, etc., and carbonaceous matter) combustion-chamber volumes were periodically measured and piston crowns photographed and weighed, etc. Octane requirements of engines were found to increase gradually with use until an equilibrium was reached, and this is accounted for by a "deposition-cycle" theory. Types of deposit are illustrated and classified; as the compression

ratio is increased the quantity decreases, but the deposit becomes of a type more difficult to handle. For each speed and set of loading conditions there is considered to exist a different set of "deposition equilibria," and any additive which will maintain the deposition equilibrium below that which would otherwise be attained leads to a saving of power. Additives should also help to maintain clean valves, etc. Curves are presented showing how the addition of very small amounts of suitable additives can bring the octane requirements of an engine back to almost those of the new engine.

Spraying suitable materials into the combustion chambers through the carburettor while the engine is idling, and later through the spark-plug holes, allows soaking into the deposit, thus aiding in its removal. This temporary purging treatment may cause an immediate reduction in octane requirements of the fuel, which may be maintained by the use of the proper additive to the fuel. The additive must be of such a nature as to leave no residue itself, but the author does not reveal the nature of the additives the effects of which he describes. J. C.

**1106.\* Propane—A Substitute for Butane in Motor Fuels.** R. C. Alden, H. M. Trimble, L. A. McReynolds. *Oil Gas J.*, 26.3.42, 40 (46), 80.—The 100,000 brl. of butane now present in gasoline, if all diverted for aviation gasoline, synthetic rubber, etc., could be replaced by 28,000 brl. of propane to get gasoline of equal Reid vapour pressure. In actual fact a 50–75% realization of such a diversion would be the practical maximum. Propane cannot be exactly equivalent to butane, but propanized gasoline is better than gasoline containing nothing lighter than  $C_5$  hydrocarbons.

Investigations were carried out with various butane-free fuels, and blends of these with propane and with *n*-butane in varying proportions. Probable vapour-locking temperatures, deduced from v.p. and front-end A.S.T.M. distillation characteristics, are considerably higher for propanized fuels than for butanized fuels of equal v.p. "Possible" and "easy" starting temperatures were also deduced, and it was shown that whilst these temperatures are higher for the propanized than for the butanized fuel, they are lower than for gasoline containing no volatilizing agent, typical figures being  $-33^\circ F.$ ,  $-25^\circ F.$ , and  $-4^\circ F.$ , respectively, for possible starting with winter fuels.

Since the light hydrocarbons have high octane numbers, removal of butane would increase T.E.L. consumption, on the average, by about 25%, but when propane is substituted the necessary increase is only about 9%.

A few accelerated laboratory tests to measure relative evaporation losses led to the conclusion that under the majority of storage conditions the butanized gasoline would lose volume faster than the propanized gasoline of equal v.p.

In the case of 4% propane inclusion for winter gasoline, difficulty might be encountered with the archaic specification of 95% minimum A.S.T.M. distillation recovery, which, although meaningless, is still in force in several States. J. C.

**1107.\* Performance Value of High Octane Aviation Gasoline.** G. A. C. Leaver. *Oil Gas J.*, 26.3.42, 40 (46), 88.—The advantage of high-octane rating in aircraft fuel is demonstrated by a curve of octane number against brake mean effective pressure, whilst it is emphasized that detonation in aircraft engines may be much more disastrous than in car engines. High-octane fuels are usually blends of special products, and the relevant physical properties of the most important of these are tabulated. Volatility must be controlled for best performance, whilst Reid v.p. must be kept below 7 lb. to guard against possible vapour lock. A combination of low specific gravity and high calorific value increases the range or load capacity of a machine, which eliminates ethanol as an aviation fuel.

The polymerization processes for the preparation of high octane gasolines are discussed simply, from a theoretical view-point, and formulæ of some paraffin hydrocarbons and octane numbers are given to show the effect of molecular structure on octane number.

The article concludes with brief references to some blending agents—viz., isopentane, isopropyl ether, and neohexane. J. C.

**1108. Trend in Aviation Gasoline Processes Towards Fuels of Fewer Compounds.** G. Egloff. *Nat. Petrol. News*, 15.4.42, 34 (15), R.120.—The current trend in the de-



velopment of aviation fuels is to reduce the number of hydrocarbons present in the fuel. Processes such as polymerization, alkylation, dehydrogenation make it possible to control the proportion of a particular hydrocarbon produced. The author states that the ideal fuel would be a pure hydrocarbon, which would give a far greater power output than any gasoline known to-day. Flow-sheets and brief descriptions are given of the *iso*-octane process, alkylation process, isomerization process, together with that of a polymerization unit.

H. G.

**1109.\* Practical Application of Gas Producers to Road Transport, Including Passenger Service Vehicles.** S. G. Ward and W. J. Morison. *J. Institute Fuel*, June 1942, **15** (84), 131.—A long, comprehensive paper discussing the general application of portable gas-producers to road transport and the results in their development jointly achieved by the Tilling group of omnibus companies and the University of Birmingham. The conclusion is reached that much greater numbers of vehicles can now be converted with confidence, and so help to ease the present liquid fuel position.

As home-produced alternatives to imported fuel acetylene, hydrogen, and methane suffer from various disadvantages, whilst town's gas, either at low or high pressure, is unsuitable for large-scale expansion, one reason being dependency on the interrupted functioning of gas-works.

Portable gas-producers and the fuel they yield have disadvantages, among which are the high weight of the ancillary equipment, the low calorific value of the gas, and the necessity for its purification, the loss of engine power involved, the difficulties of handling solid fuels, and the necessity for regular servicing. Advantages are that sufficient fuel can be carried to give the vehicle a wide range, reliance is not placed on a few large gas-producing centres, the fuel cost per mile is lower than for petrol, and that diesel vehicles, modified to operate by spark ignition, can be converted. These far outweigh the disadvantages when compared with other possible replacement fuels.

The main gas-producer designs are classified, and a list of types manufactured in this country is given, with references. With all systems the primary reaction is the formation of CO by incomplete combustion of the carbon of the fuel. Some secondary reactions, such as the formation of  $\text{CH}_4$  from water vapour and carbon, are desirable, whilst the main undesirable secondary reaction is that yielding  $\text{CO}_2$ . The reactions involved and the properties and compositions of the gases obtained in the dry-blast and the wet-blast (water or steam injection) systems are discussed in detail. The ratio CO to  $\text{CO}_2$  is dependent on time, temperature, etc., and a table is given of typical ranges of gas compositions for anthracite and for low-temperature coke.

The gas leaving the producer contains the major fuel constituents CO,  $\text{CH}_4$ , and  $\text{H}_2$ , the diluents  $\text{CO}_2$ ,  $\text{O}_2$ , and  $\text{N}_2$ , variable proportions of  $\text{H}_2\text{S}$ , organic sulphur compounds, cyanogen compounds, free and combined ammonia, tarry matter, suspended solids, and water vapour.

The excessive cylinder wear obtained with producer-gas is shown by experiments with wet scrubbers and by service practice to be due, not primarily to abrasion by fine dust passing the fairly efficient commercial filters, but mainly to the corrosive gaseous impurities which such dry filters do not arrest. These gaseous impurities may corrode cylinders either by deposition of solutions of soluble ammonia and sulphur compounds on the walls, or by sulphuric, nitrous, and nitric acids formed in the cylinders by combustion in the presence of water. The desirable attributes of gas cleaners are discussed and summarized, and from theoretical reasoning it is considered that one of the best systems is to pass the gas through a cyclone or similar device to remove coarse dust, and then through a water-washer to remove ammonia, sulphur compounds, and finer dust.

Filters, washers, and other parts of producer units have been examined by bench tests, road tests, and extensive service tests.

With the bench-test plant the dust content of filtered gas was determined by means of an electrostatic precipitator, and the efficiencies of several different designs of wet washers, oiled filters, etc., were compared. Laboratory investigations included examination of fuels, clinkers, cooler deposits, washer or filter deposits, wash-waters, gas system and engine deposits, etc., whilst laboratory tests were also made with small producers to study the effects of such variables as fire-bed conditions, temperature of gas at the washer inlet, and fuel treatment on the removal of sulphur



compounds from the gas. Road tests were carried out with an omnibus, equipped with a suitably modified Leyland Tiger engine and a trailer carrying a producer, cooler, and gas-cleaning plant. Optimum conditions for removal of S and  $\text{NH}_3$  were determined by testing with different types of wet-washer, cooler and cyclone, with wet- and dry-blast, with different fuels; the effect of wetting agents on the wash-water was also determined. The conclusion is reached, *inter alia*, that under the best conditions the gas entering the engine has a sulphur content of about 10 gm. per 1000 cu. ft., and at the worst about 20 gm. The wet-washer not only reduces the S content, but removes most of the  $\text{NH}_3$ .

Developments on service vehicles, mostly of 7-8 litres capacity, have also provided much data, and not until wet-washers were used were good cylinder-wear figures obtained. A full description, with diagrams, is given of the plant now used and also of the service routine. Figures for cylinder wear average about 4000 miles per thousandth of an inch, and are comparable to those obtained when similar vehicles operate on petrol. Upper cylinder lubrication and soda doping of the anthracite fuel reduced cylinder wear and total fuel costs were 1.67*d.* per mile, as against 2.75*d.* per mile for petrol and 1.52*d.* per mile for diesel oil.

Of the fuels available in this country, anthracite is considered generally superior to low-temperature and to activated gas coke. A highly reactive dust-free fuel of suitable size is required to give easy lighting, good performance, and desirable flexibility; it must not form tar; it should be low in ash, S,  $\text{N}_2$ , and  $\text{Cl}_2$ ; it should be resistant to shatter and abrasion; the ash should not give rise to clinker troubles; it should have high bulk density and uniformity of properties.

The present position is discussed in relation to costs of conversion and availability of fuel supplies and, on the results of experience, detailed recommendations are made of the type of plant required for conversion of passenger vehicles, goods vehicles, and municipal service vehicles. Possible applications of portable gas-producers, other than for essential transport, are listed.

The article concludes with a discussion of future developments and points which require further investigation, whilst a short description is given of vehicles which are being made specifically to operate on producer-gas.

Numerous diagrams, graphs, and tables of numerical results are included.

J. C.

**1110.\* The Examination of Ethyl Alcohol and Alcohol Blends for Use as Motor Fuel.** S. J. W. Pleeth. *J. Inst. Pet.*, October 1942, 28 (226), 240-256.—Details are given about the testing and properties of ethyl alcohol and alcohol blends for use as motor fuels. Precautions to be taken in certain tests—*e.g.*, vapour-pressure tests—when dealing with alcohol blends, are particularly stressed.

A. H. N.

**1111. Patents on Motor Fuels.** Texaco Development Co. E.P. 547,457, 28.8.42. Appl. 8.6.40.—Isomerization of straight-chain paraffin hydrocarbons of gasoline boiling range to produce corresponding *isoparaffin* hydrocarbons. The paraffin hydrocarbons substantially free from olefin and aromatic hydrocarbons are contacted with a metallic halide isomerization catalyst and maintained under isomerization conditions. The isomerization reaction is effected in the presence of added *isobutane* or *isopentane* in an amount by weight which is substantially in excess of the paraffin hydrocarbons undergoing conversion. In this way catalyst deterioration is substantially reduced.

R. E. Schaad. U.S.P. 2,295,808, 15.9.42. Appl. 13.9.40. Production of anti-knock motor fuel from substantially saturated hydrocarbon oil. The oil is subjected to catalytic destructive hydrogenation to produce a substantial quantity of *isobutane*. From the resultant products are separated an *isobutane* fraction and a fraction higher boiling than hexane. The last-named fraction is subjected to catalytic dehydrogenation to form normally liquid olefins. These are mixed with the *isobutane* fraction, and the product subjected to catalytic alkylation to react olefins with *isobutane*. The resultant alkylate is recovered.

G. W. Talbert and E. W. Blizzard. U.S.P. 2,296,069, 15.9.42. Appl. 21.3.40. Preparation of a hydrocarbon fuel for use in an internal-combustion engine and con-

taining a small amount of a higher alkyl aryl sulphonate in which the aromatic nucleus contains not more than 2 nuclei and the higher alkyl substituent has from 20 to 30 carbon atoms joined carbon to carbon.

F. E. Frey, P. V. McKinney, and W. H. Wood. U.S.P. 2,296,511, 22.9.42. Appl. 27.6.36. Continuous process for reacting paraffins of low molecular weight with normally gaseous olefins to produce predominantly paraffinic oils in the motor-fuel boiling range and of higher molecular weight.

V. R. Kokatnur. U.S.P. 2,296,558, 22.9.42. Appl. 20.9.38. Preparation of a motor fuel consisting of an organic combustible material of high flash and high boiling point and a true peroxidic compound of fatty acids which is soluble in the oil.

R. B. Thompson. U.S.P. 2,297,114, 29.9.42. Appl. 24.6.40. Production of gasoline containing a small proportion of lead tetraethyl which normally tends to decompose on storage, and as a stabilizer, a small quantity of an alkyl amine salt of an alkyl pyrophosphoric acid ester.  
H. B. M.

### Gas, Diesel, and Fuel Oils.

1112.\* **Determining Fuel Oil Heat Losses.** W. F. Schaphorst. *Petrol. Engr*, June 1942, 13 (9), 127.—Several years ago a chart was prepared by this author on fuel heat losses relating to coal only. This has now been converted to fuel oil, the chart being based on the formula

$$L = \frac{0.08(5\text{CO}_2 + 700)C(T - t)}{\text{CO}_2 H}$$

where  $L$  = % fuel loss.

$\text{CO}_2$  = %  $\text{CO}_2$ .

$C$  = % carbon in fuel.

$T$  = temp. of outgoing flue gas.

$t$  = temp. of air entering the furnace.

$H$  = B.Th.U. per lb. fuel.

An example of the working of the chart is given.

D. L. S.

### Lubricants and Lubrication.

1113.\* **Extreme Pressure Lubricants.** G. L. Simard, H. W. Russell, and H. R. Nelson. *Industr. Engng Chem.*, 1941, 33, 1352.—The film-forming action and use of lead naphthenate and free sulphur in extreme-pressure lubricants for use with hypoid gears is discussed. From measurements of the film-forming action by means of an electron diffraction camera it is shown that the addition of these agents resulted in greater film-forming tendencies in unrefined oils than in refined oils. The formation of iron oxide and lead sulphate shows that oxygen must be included in considering the chemistry of E.P. lubricants.

The data from which the foregoing conclusions have been drawn are based on laboratory static and friction tests and on actual service tests on hypoid gears. J. W. H.

1114.\* **Properties of Synthetic Lubricating Oils.** E. Neyman-Pilat and S. Pilat. *Industr. Engng Chem.*, 1941, 33, 1382.—Seven new liquid hydrocarbons of the aromatic and naphthenic series containing 22 carbon atoms per molecule have been synthesized and their physical properties determined for comparative purposes with similar data obtained on petroleum fractions in order to correlate physical properties with chemical structure.  
J. W. H.

1115.\* **Oxidation Characteristics of Pure Hydrocarbons.** R. G. Larsen, R. E. Thorpe, and F. A. Armfield. *Industr. Engng Chem.*, 1942, 34, 183.—The oxidation characteristics of some 40 pure hydrocarbons over the temperature range 110–150° C. have been determined by analysis of the oxidized oils for oxidation products and by analysis of the volatile products formed. Analyses include acidity, saponifiable matter, carbonyl values, alcohol and peroxide determinations, and examination of the volatile products for  $\text{CO}_2$ , water, and acids.



It is concluded that paraffins and cycloparaffins are quite reactive, simple aromatics are still more reactive, but that polynuclear aromatics and naphthenes are very stable, due to the formation of oxidation inhibitors during the oxidation.

It is also concluded that the oxidation stability of lubricating oils is not due to the stability of their component hydrocarbons *per se*, but to their oxidation inhibitor content.

J. W. H.

**1116.\* Superfinish and its Effects on Lubrication.** J. Devon. *Petroleum*, February 1942, 5 (2), 31.—Surfaces which were once thought to be perfectly smooth are now known to consist of a regular series of jagged edges. Our knowledge of the nature of these surfaces has been considerably assisted by the use of the profilometer, which is capable of measuring projections to a millionth of an inch. This has shown that the scratch depth for various machining operations in micro inches are: Turning 50/500, grinding 35/250, burnishing 10/550, honing 5/50, lapping 3/10, microfinish 0.5/10.

Superfinish is produced by an additional operation following the final dimensional precision operation. It is a species of controlled machine lapping or honing in which the laps or hones travel the whole surface in a slightly spiral path, which spiral is reversed before the end of each stroke. Each stroke commences at a different point, so that no cutting points of the laps follow the same paths they have already travelled.

The use of superfinish applied to pistons and cylinders of cars is to produce a new article with a surface equal to that after 1000 miles running-in. It is also claimed that its adoption will make lubrication a much simpler and more effective operation.

D. L. S.

**1117.\* Uses and Limitations of Filtration as a Means of Recovery of Waste Oil.** A. H. Stuart. *Petroleum*, March 1942, 5 (3), 49-50.—A few years ago the only filter found in the lubricating system of an I.C. engine was a fine-wire gauze strainer capable of removing only very coarse particles. Filtration of oil in the system has now been much improved, and it is possible to obtain a filtrate free from dirt and from a proportion of the oxidation products formed during use.

In the reclamation of used oil it is necessary to remove particles of very small dimensions, and adsorptive principles are frequently employed. This type of filtration is without effect on mineral oil, but is apt to remove the polar constituents often added to increase oiliness. Thus an oil reclaimed by adsorptive filtration may be in excellent condition, and yet weak in the components essential for efficient lubrication.

In reclamation by filtration the oil is usually heated before processing to reduce its viscosity, and this may have the effect of increasing the solubility of the sludge in the oil, and thus allowing it to pass the filter.

It is concluded that the filtering of used oil by small users by means of modern filters is well worth while if it is remembered that the filtrate may not be quite up to the standard of the new oil.

D. L. S.

**1118.\* Are so many Varieties of Lubricants Really Necessary?** A. T. Wilford. *Petroleum*, June 1942, 5 (6), 94-98.—This article discusses the possibility of simplification of grades of lubricants in the interests of both users and suppliers.

Three main considerations arise in selecting a lubricant for a particular application—quality, viscosity (or consistency for a grease), and price.

Quality is not easy to define, and depends to a great extent on the conditions under which the lubricant is to be used.

Viscosity can be precisely defined, but the value at one temperature only is of limited use. Viscosity index should therefore always be determined.

Price is related to both quality and physical characteristics, but, in general, the selected lubricant will be the cheapest one capable of doing the job.

In choosing an oil for a particular application, users are greatly influenced by the recommendations of the manufacturers of the plant or vehicle concerned, and in practice are often led to stock an unnecessary number of grades, each for some particular piece of plant.

The author considers the S.A.E. and B.S. classification of lubricants, which is solely on a viscosity basis. He does not consider viscosity to be very critical in the operation of road vehicles, oils ranging from 120 to 300 sec. Red. I at 140° F. giving apparent satisfaction.

In special cases viscosity of oils or consistency of greases may have to be limited to within a fairly narrow range, but in the majority of cases a fairly wide variation can be allowed, both for transport vehicles and for industrial use. Some simplification is therefore possible, and it is shown that oils marketed for some particular purpose can be successfully utilized for a number of other applications.

Greases have been considered from the same angle, and the author is of the opinion that here also a reduction in the number of grades can be justified. D. L. S.

**1119. Plain Bearing Lubrication of Machine Tools.** E. Worthington. *Petroleum*, September 1942, 5 (9), 152.—Systems of lubrication fall broadly into two types, (a) some form of gravity feed, (b) pressure-feed arranged either for intermittent or continuous operation. Typical lubrication systems are illustrated and their method of operation described. The gravity-fed spindle bearing is designed for light load and speeds up to 10,000 r.p.m., and requires a spindle oil of 27.7 A.P.I. grav., viscosity S.U. at 100° F. 105 secs., at 210° F. 45 secs.

The high-pressure intermittent feed systems have been found efficient in practice, particularly for lower speed shafts, slides, and handle-operated mechanisms, but elaboration of piping is on occasion too great for war-time application. The continuous pressure-feed system is normally limited to peripheral speeds of 2000 r.p.m. The sealing of the ends of the bearing needs special investigation for higher speeds.

The class of lubricant employed is a light oil consisting of 1 part spindle oil and 3 parts kerosine. R. A. E.

**1120. A Standardization Scheme for Mineral Lubricating Oils.** G. J. C. Vineall. *Petroleum*, September 1942, 5 (9), 148.—Suggestions are presented in respect of a scheme for standardization of industrial lubricants, the oils being separated into grades depending on viscosity Redwood I, into classes based on viscosity index, and into qualities depending on special requirements for specific purposes. A system of nomenclature which would include the three divisions is also presented. It is considered that the standard test methods of the Institute of Petroleum and the A.S.T.M. should be adopted in any system of standard classification. As regards grades, capital letters are suggested, *A* to *I* covering a total viscosity range in terms of Redwood I at 140° F. from under 45 up to 500 secs., and *W* to *Z* a range at 200° F. from 100 to above 210 secs. The basic quality specification suggested is: S.G. at 60° F., 0.850/0.960; flash point P.M. closed, Grades *A/I* 300° F. min., Grades *W/Z* 500° F. min.; pour test, Grades *A/I* 30° F. max., Grades *W/Z* 80° F. max.; mineral acidity nil, organic acidity 0.2 mgm. per gm., saponification value 1, asphaltenes Grades *A/I* 0.05% max., Grades *W/Z* 1.0% max. Roman numerals I to III are proposed for indicating viscosity indices, Class I covering oils of over 80, Class II oils of 50–80, and Class III oils under 50. Special qualities could be indicated by small letters—*e.g.*, *p* could denote refrigeration oils having a max. pour point of – 25° F., *o* oils which, after Air Ministry oxidation, show an increase in coke value of under 1 and a viscosity increase ratio of under 2, and *a* an asphaltene content of max. 0.1%. The special qualities proposed for classification are based on limitations in respect of colour, pour test, carbon residue, oxidation, demulsification, and asphaltenes. It is recommended that no limitation as regards composition should be imposed in any general specification. It is suggested that motor oils and compounded oils could be incorporated within the scope of the scheme proposed, but that the use of addition agents should be regarded as a matter between supplier and consumer. Conventional laboratory test methods may not enable definite evaluation of service performance of an oil for a particular use, but are currently used as a basis for manufacture and specification, and it is felt that a codification of oils on the lines proposed would be of value as a guide to users and suppliers. Additional specific requirements could be superimposed. R. A. E.

**1121. Patents on Lubricants and Lubrication.** Standard Oil Development Co. E.P. 547,972, 21.9.42. Appl. 17.11.39. Preparation of a lubricant consisting of a hydrocarbon lubricating oil compounded with a metal salt of a dihydroxy dialkyl diaryl sulphide or polysulphide or polymers of such compounds, or selenide or telluride analogues.



Standard Oil Development Co. E.P. 547,973, 21.9.42. Appl. 17.11.39. Process for the preparation of a lubricant consisting of a hydrocarbon lubricating oil and a small proportion of a metal salt of an alkyl phenol containing a nitro-, amino-, or alkyl-substituted amino-substituent group in the aromatic nucleus.

Standard Oil Development Co. E.P. 548,038, 23.9.42. Appl. 17.4.40. Preparation of a lubricant consisting of a hydrocarbon lubricating oil and a small proportion of a ketonic compound.

R. Rosen and R. M. Thomas. U.S.P. 2,295,053, 8.9.42. Appl. 19.7.38. A lubricant consisting of a well-refined hydrocarbon oil to which has been added less than 2% of an organic trisulphide to increase resistance of the oil to oxidation.

C. M. Loane. U.S.P. 2,295,179, 8.9.42. Appl. 26.10.40. Preparation of a lubricant consisting of a lubricating oil and the reaction product of a phosphatidic material and an aromatic amine at temperatures below 300° F.

M. H. Arveson. U.S.P. 2,295,192, 8.9.42. Appl. 26.10.40. Preparation of a lubricant consisting of a lubricating oil and from 0.01% to 5% of the reaction product of a hydrogenated phosphatidic material and an organic amine at temperatures below 300° F.

W. J. Sparks and D. C. Field. U.S.P. 2,296,315, 22.9.42. Appl. 18.10.38. Preparation of a lubricant consisting of a lubricating oil containing a co-polymer of an eleosterin and an olefine.  
H. B. M.

## Asphalt and Bitumen.

1122. **Asphalt Paving Emulsions Properties, Uses, and Tests.** E. J. Barth. *Refiner*, August 1942, 21 (8), 232-239.—A brief history of the use of asphalt emulsions is given, followed by their general uses for waterproofing, rotproofing, and paving. Emphasis is laid in the paper on the use of asphalt emulsion as paving material. Fast, medium, and slow breaking emulsions are described, and their uses in different types of roads are summarized. Emulsifying agents are listed under organic and inorganic headings. (A) Organic: This group includes water- or oil-soluble soaps, such as soaps of sulphonated petroleum, fatty oils of vegetable or animal origin, and naphthenic acids; proteins, rubber, amines, casein, procein, fatty acids, and their metallic soaps; oxidized paraffin wax-acids, rosin, tannates, waste products from the paper industry, such as waste sulphite liquor, and tall-oil, and other miscellaneous materials usually in the form of soaps containing one or the other above materials. (B) Inorganic: This group comprises alkalis, ammonia, various salts such as the silicates, phosphates, hydroxides, and colloidal material such as hydrous oxides, hydroxides, bentonite, clays, and materials of that type; Portland cement, etc.

The characteristics of different types of asphalts used for emulsification are discussed in some detail. Bitumen consists of four empirically designated hydrocarbon groups: asphaltenes, asphaltic resins, oil resins, and the oils. The asphaltic resins and the oil resins are now commonly included under the name of "resins." Asphalt itself when it is practically a pure bitumen is a dispersion of high-molecular-weight hydrocarbons or asphaltenes; this component is of low hydrogen content, and recent determinations show the molecular weight of this fraction to be approximately from 10,000 to 140,000 molecular weight. The characteristics of asphaltene are studied. This is followed by the study of the rôle of the emulsifying agent in the emulsions under two groups: (1) The commonly employed emulsifiers are oil- or water-soluble substances, typified by the soaps of monovalent metals. These emulsifiers act as such due to their property of lowering the surface tension of either the asphalt or the water. The general rule has been that when the soap is more soluble in water than in asphalt, such as sodium oleate, an asphalt-in-water emulsion is formed; if the emulsifier is more soluble in the asphalt, such as calcium or magnesium oleate, a water-in-asphalt emulsion most generally forms; it has also been found that the component most completely wetting the compound, or emulsifier, will be the external phase in the emulsion. The solubility rule is a good rule to follow, although it has probably many exceptions.



(2) The second type of emulsifying material is that which is either wetted by one component more than the other, is practically insoluble, or only slightly soluble, in both phases, affects the surface tension only slightly, and forms plastic adsorbed films on the dispersed asphalt particle, or around the water particle, due to peptization and swelling. Under this group are the materials most commonly used to be colloidal clays, such as bentonite, various oxides, silicates, Portland cement, ground slag, certain salts of the heavy metals, etc. Emulsions formed with these types of materials show greater stability than those containing emulsifiers of the first group, are known to "break" at a much slower rate, and then only mostly when the water in the emulsion has begun to evaporate. Emulsions containing the second group of emulsifiers are not sensitive to the presence of foreign substances, dissolved salts, and changes in the electrical charges of the dispersed particles do not cause the emulsion to "break." This type of emulsifier produces, with or without soaps, "slow break" emulsions which are quite stable.

A study of the effects of particle size and of  $p_H$  values on storage and liability of asphalts and of methods used in determining these two criteria ends the paper. The bibliography contains 45 references.  
A. H. N.

**1123. Asphaltic Substances in Crude Oils.** G. W. Preckshot, N. G. DeLisle, C. E. Cottrell, and D. L. Katz. *Petrol. Tech.*, September 1942, 5 (5), A.I.M.M.E. Tech. Pub. No. 1514, 1-18.—Most crude oils contain asphaltic substances which may be naturally or artificially precipitated. Oil samples for examination by means of the electron microscope at magnifications of 1200-23,000, or even more under photographic enlargement, were placed on a collodion film either as a dilute oil solution from a small pipette or from an undiluted thin oil film on water. Evaporation of oil and solvent took place from the collodion film mount. Rounded asphaltic particles ranging 0.01-0.20 microns in diameter were obtained from various oils.

A Californian crude which had not been diluted or washed, but which was under a pressure of less than  $10^{-4}$  mm. of mercury, apparently did not show asphaltic particles. The particles seem to be precipitated by dilution or washing with solvents such as benzene. In the original crudes, the asphaltic substances must occur as dispersed molecules, or as an association of a relatively small number of molecules, dependent on the molecular weight of the asphaltic compounds.

A sample of the Greeley crude showed no signs of the precipitation of asphalt on reduction from reservoir pressure and temperature to surface conditions. Electrodeposition of asphaltic particles took place on the negative electrode. Very little bitumen was thrown out of solution on centrifuging. Streaming potentials arising from the flow of oil through a porous medium precipitated asphaltic particles from the Californian crude. Crude flowing through a sand developed a potential across the porous mass, and asphaltic particles appeared in the oil after passage through the sand.  
G. D. H.

**1124. Patents on Asphalt and Bitumen.** J. F. Sterling. E.P. 547,530, 1.9.42. Appl. 19.3.41. Method of hardening and improving bitumens, asphalts, and other bituminous materials, including asphalt mastics, tars, pitches, and/or mixtures thereof. The bitumen or other material is treated while in molten state with one or more metallic nitrates capable of acting as oxidizing agents.

S. S. Sorem. U.S.P. 2,295,974, 15.9.42. Appl. 29.6.40. Method of improving the bonding power of an asphalt towards a metallic surface normally corrodible by asphaltic acids. Added to the asphalt is a small amount of a salt combining a volatile organic acid with a metal. The soaps of the metal with the asphaltic acids are no more water-soluble than those of zinc. Finally, the asphalt is heated to expel volatile acids.  
H. B. M.

### Special Products.

**1125.\* The Development of Cutting Oils.** A. H. Stuart. *Petroleum*, June 1942, 5 (6), 100.—In assessing the performance of any machine-tool operation, a more than usually large number of variables has to be considered. These must all be standardized and kept constant if an investigation of the properties of different cutting fluids is under consideration.

No liquid can be found which will be equally satisfactory in all circumstances, but it is helpful to list the properties which such a fluid should possess.

(a) Since the pressure exerted by the tool is high (50–150 tons per sq. in.), such a force operating at cutting speed generates heat which must be conducted away quickly. Thus high specific heat and latent heat and good thermal conductivity are essential.

(b) Wetting ability is important, as otherwise the liquid may be prevented from acting as a coolant.

(c) Lubrication properties are essential, especially to reduce the friction between the hot strip of swarf and the raked surface of the tool.

Other properties which such an oil must possess are a sufficiently high flash point, stability to oxidation, non-corrosiveness, and low viscosity.

Cutting fluids have therefore to meet all or part of the above requirements. If cooling only is necessary, a blast of air may be satisfactory. For greater cooling, water or an aqueous alkaline solution may be used. When lubrication is important, soluble oils may be necessary. Finally, when even greater lubrication is required, straight oils containing E.P. additives must be used.

Colloidal graphite dispersed in mineral oil is also stated to have applications in this sphere.

D. L. S.

**1126.\* Synthetic Rubber—A Bibliography.** Anon. *Petrol. Engr.*, June 1942, **13** (9), 45.—A bibliography dealing with the synthesis of rubber divided into the following sections: General, Acrylonitrile, Advagum, Ameripol, Buna, Butadiene, Butyl Chemigum, Chemistry, Flexitite, Gas Industry, Hycar O.R., Koroseal, and Neoprene.

D. L. S.

**1127. Five Steps for Making Butadiene in Thermal Cracking Furnaces.** Anon. *Nat. Petrol. News*, 5.8.42, **34** (31), 18, 38.—In the immediate programme for the production of butadiene five methods which can be carried out in existing equipment are being considered. Catalytic processes for the dehydrogenation of butane and butylenes are under consideration. The five methods are: (1) Direct thermal cracking in tubes; (2) preliminary heating in tubes with additional heat supplied by superheated steam; (3) as in (2) with hot flue gases replacing steam; (4) preliminary heating in tubes with additional heat supplied by air injection; (5) thermal cracking on heated brickwork after preliminary heating in tubes. In all cases the optimum temperature is approximately 1400° F. and, in general, operation is limited to those plants equipped with heat-resisting alloy steel. The average yield in one pass operation is approximately 5%.

H. G.

**1128. Patents on Special Products.** Standard Oil Development Co. E.P. 547,730, 9.9.42. Appl. 6.9.40. Method of separation and concentration of butadiene from a mixture of saturated and unsaturated hydrocarbons. After the mixture of gases has been contacted with an absorbent cuprous chloride solution, the absorbent with absorbed butadiene separated, and the butadiene recovered, the butadiene is contacted with another fraction of the same absorbent solution. The solution containing re-absorbed butadiene is separated and the butadiene recovered from it.

G. R. Gilbert and A. A. Peer. U.S.P. 2,295,035, 8.9.42. Appl. 20.5.39. Preparation of a petroleum oil dye by extracting a petroleum oil boiling in the range 360–540° F. with sulphur dioxide under conditions designed to form a solvent extract phase and a raffinate phase. The solvent extract phase is removed and the sulphur dioxide separated from it. The extract is cracked to produce a cracking coil tar having a gravity from 2° to 6° A.P.I. The cracking coil tar is de-asphalted by the addition of a diluent. Then the de-asphalted tar is separated and extracted with a selective solvent of the class having preferential selectivity for the more aromatic type compounds. Thus are formed a solvent phase and a raffinate phase. The latter is separated and the solvent removed from it. The solvent-free raffinate is distilled and an improved petroleum dye recovered as residue.

H. B. M.



## Detonation and Engines.

**1129.\* The War and Patents Relating to Internal-Combustion Engines.** S. T. Madeley. *Gas Oil Power*, October 1941, **36** (433), 191.—A graph is given showing the approximate number of patents granted for the period 1910–1940 relating to (a) carburetting, vaporizing, and heating apparatus, (b) ignition apparatus, (c) valve-gear and injection equipment.

Curves (a) and (b) show peaks caused by the booms of 1913 and 1932 and that due to the recovery after the 1914–18 war. The depressions of 1916 and 1927 are also very marked. Curve (c), which is illustrative of the compression-ignition engine development, is very consistently level between slight peaks.

A few recent examples of patents relating to different aspects of the internal-combustion engine are quoted. The position of patents during the war period is discussed.

D. L. S.

**1130.\* Response of Aircraft Fuels to Tetraethyl Lead.** A. G. Cattaneo and A. L. Stanly. *Industr. Engng Chem.*, 1941, **33**, 1370.—The lead tetraethyl blending chart which previously only enabled lead responses up to 100 octane number to be estimated has now been extended into the region above 100 octane number, and the basis of the extension is fully discussed. Charts are given which enable the lead response of aviation fuels to be estimated up to iso-octane + 3.0 c.c. T.E.L. per gallon from the octane number of the base fuel and a single lead response.

J. W. H.

**1131. Effect of Ignition Timing and Anti-Knock Quality of Fuel on Engine Performance.** C. W. Phelps, R. C. Heidner, and M. L. Smithy. *Nat. Petrol. News*, 15.4.42, **34** (15), R.117.—The article describes a road test in which the relation between ignition timing and tendency to knock was investigated for a number of fuels. It was concluded that the anti-knock quality demand and the wide-open-throttle performance of modern automobile engines are dependent on the ignition timing. Fuels of low ignition quality may be used without excessive detonation if the ignition is retarded sufficiently, but a corresponding reduction in power output results. Some differentiation is made as between engines with low compression ratio heads (6.5/1) and high C.R. heads (7/1 to 7.5/1).

H. G.

**1132.\* Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines.** Part I. O. Adams. *Petrol. Engr*, June 1942, **13** (9), 33.—The question of air-flow in ducts raises many problems which are puzzling unless certain fundamentals are understood. The general laws of fluid flow are applicable to both liquids and gases. In this case the relationships and conditions that occur in the mechanical form of energy, such as pressure, volume, velocity, and temperature, are concerned, the thermal or chemical form of energy not being important in this connection.

Certain broad general equations for energy relationships of various processes are discussed.

D. L. S.

**1133.\* Spring Tension Balance for C.F.R. Bouncing Pin.** P. Draper. *J. Inst. Petrol.*, September 1942, **28** (225), 209–213.—The development of the balance is given. Detailed instructions for its use are included in the paper, which gives a full description of the apparatus.

A. H. N.

## Economics and Statistics.

**1134. Refineries Operating in the U.S.A., Mexico, and Canada.** Anon. *Oil Gas J.* 26.3.42, **40** (46), 152, 156, 158.—The refineries operating in these countries are alphabetically listed, according to the state in the U.S.A. and to the province in Canada, and the location, type of refinery, and cracking plant, together with their capacities in barrels, are given. A similar list is given of the shut-down plants in the U.S.A.

J. C.

## BOOK REVIEWS.

**Annual Reports of the Society of Chemical Industry.** Vol. XXVI, 1941.

The size of the annual volume of the S.C.I. *Reports of the Progress of Applied Chemistry* is a good yardstick for measuring the number and importance of the technical developments made public during the year under review. Under present conditions much work necessarily remains unpublished and yet this latest volume is almost as bulky as its forerunners. Much of the work reported was carried out in the U.S.A., though Russian, German, and Swiss journals add their quota, and Japanese sources have not passed unnoticed.

While every professional man will find some portion of the book of interest and value, the chapters "Mineral Oils" by W. W. Goulston, "General, Plant and Machinery" by F. Rumford, "Fuel" by J. Hiles and R. A. Mott, and "Gas, Destructive Distillation, Tar and Tar Products" by H. Hollings and W. A. Voss are of special interest to those engaged in the petroleum industry.

Mr. Goulston surveys the literature dealing with internal corrosion of pipe-lines, the permissible content of certain toxic gases such as hydrogen sulphide in the atmosphere of work-places, and the examination of Californian crude oils by distillation methods, as well as with developments in refining processes and plant, analytical methods, petroleum substitutes, and special products.

Gasoline sweetening by mixed solutizers and by caustic-soda solution-methyl alcohol mixture, improvement of ignition quality of diesel fuels by solvent extraction and reduction in sludging tendency of fuel oils by treatment with sulphuric acid and alkali are among the refining processes mentioned, while new types of plant which have been described include distillation columns containing Stedman triangular pyramid type of packing, a catalytic cracker in which the powdered catalyst is injected into the oil vapour stream and subsequently recovered in a cyclone separator (this principle is applicable also to polymerization, dehydrogenation, and other catalytic processes), and a "hydroforming" unit. The isomerization of normal butane by means of aluminium chloride and the mechanism of the alkylation reaction have received attention, while the oxidation of lubricating oil has been studied and a laboratory method of measuring the tendency to sludge formation developed.

New specifications for aviation fuel have been adopted by the A.S.T.M., and two methods of testing knock-rating of these fuels standardized, one by the A.S.T.M. and one by the I.P. The A.S.T.M. method includes means for control of the humidity of the inlet air, and has just been adopted by the I.P. While on the subject of knocking, reference may be made to a recently patented apparatus which automatically corrects any tendency to knock by adjusting the fuel mixture.

The A.S.T.M. has also published recommended specifications for diesel fuels. The improvement of ignition quality of diesel fuels by means of additives has been studied and compared with solvent extraction methods. Work on diesel fuel additives is also noticed in the chapter on "Fuel."

Research on the nature of the hydrocarbons present in products ranging from the gasoline fraction to asphaltic bitumens has been carried out in U.S.A., where the A.P.I. has also initiated work on the synthesis and examination of hydrocarbons in the range  $C_{25}$ - $C_{60}$ . Several quinoline homologues have been isolated from sulphur dioxide extracts of Californian kerosine and gas oil and identified.

Besides the advances in analytical methods already referred to, Mr. Goulston mentions a new laboratory fractionating column, claimed to be equivalent to seventy-five plates for a height of 35 cm., a "mixed aniline point" method for evaluating solvent power, the determination of unsaturateds by titration with a standard bromine solution, new viscometers, including Fenske's modification for opaque oils, methods for determining free sulphur and organically combined phosphorus in lubricating oil, the revised I.P. distillation test for cut-back asphaltic bitumen, and the estimation of paraffin wax in asphaltic bitumen by an extraction method.

The growing importance of natural gas as a raw material for chemical industry is emphasized by Mr. Goulston and by Dr. Hollings and Mr. Voss, while Mr. Dawson, in his contribution on "Rubber," refers to the production of carbon black and



synthetic rubbers. Production of toluene from petroleum is also dealt with by the former contributors: Dr. Hollings and Mr. Voss summarize the U.S. Bureau of Mines investigation of azeotropic distillation.

Mr. Rumford's chapter deals with many subjects of interest to petroleum engineers: these include recent studies of flow, heat transfer, distillation and absorption processes, and boiler-water treatment, which is also covered by Dr. Elsdon and Mr. Gibson in "Sanitation and Water Purification."

This cursory review has of necessity left much unnoted: it behoves everyone who wishes to keep abreast of current developments to study the volume in its entirety.

E. P. DRISCOLL.

**Fuel Testing—Laboratory Methods in Fuel Technology.** By Godfrey Himus. Published by Leonard Hill, Limited, 17, Stratford Place, London, W.1. Second Edition, 1942. Price .

The first edition of this book was issued in 1932, and in the revised edition just published the methods of analysis and testing originally dealt with have been brought up to date. In this second edition the original introduction and a chapter on coal classification have been omitted, while a chapter on combustion calculations has been added.

The book deals largely with the sampling, testing, and examination of coal, nine out of the fifteen chapters being devoted to this end. Two chapters deal with gas analysis and the calorific values of gases respectively, and one chapter only describes the testing of liquid fuels. The remaining chapters deal with calorific values of solid and liquid fuels, technical pyrometry, and combustion calculations.

The chapter on the testing of liquid fuels is designed to meet the needs of the fuel chemist who may be called upon from time to time to examine fuel oils and allied materials with a view to ascertaining their compliance with specifications. Standard tests for specific gravity, viscosity, flash point, sediment, water content, carbon residue, asphalt, pour point, ash, calorific value, and sulphur content are described.

In the chapter on "Gas Analysis" the description of the Improved Hempel Apparatus might well have been omitted. The analysis of hydrocarbon gases by fractionation by liquid air in the Burrel, Seibert, and Robertson equipment which is included has been out-of-date for nearly twenty years. This is the only fractionation method described, and no mention of the modern Podbielniak apparatus is included.

The book appears to be designed primarily for students taking a course in fuel technology, and will be of little value to either the expert fuel or oil technologist.

T. G. HUNTER.

## BOOKS RECEIVED.

**Consideracoes sobre as Propriedades Anti-Detonantes do Alcool e seu Emprego como Combustivel.** By Fernando Alfonso Baster Pilar, Armando Silva de Araujo. Instituto Nacional de Tecnologia. Rio de Janeiro.

**Transactions of the Geological Society of Glasgow.** Volume XX, Part II, 1938-1942.

# INSTITUTE NOTES.

DECEMBER, 1942.

## CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership. 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 parenthesis.

FLEMING, Peter, Research Chemist. (*Dr. A. E. Dunstan.*) (Application for transfer from Member to Fellow.)

FLETCHER, Robert Mason, Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; Maurice A. Ockenden.*) (Application for transfer from Member to Fellow.)

OCKENDEN, Maurice A., Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; R. M. Fletcher.*) (Application for transfer from Member to Fellow.)

CHAPMAN, George Norman, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

CHRISTIAN, John Bell, Assistant Manager, Trinidad Leaseholds, Ltd. (*B. G. Banks ; E. J. M. Tait.*)

JAMIESON, John, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

PATMAN, Frederick John, Analytical Chemist, Ministry of Supply. (*A. R. Stark ; E. P. Driscoll.*)

PEPPER, Albert Cecil, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

RICHARDS, Alan Roy, Research Chemist, Trinidad Leaseholds, Ltd. (*F. Morton ; Arthur G. V. Berry.*)

ROY, Clarke, Works Manager. (*S. Elliman ; L. Mills.*)

WIZZELL, Albert Orsborn, Works Chemist, A. Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

### *Students.*

BADDELEY, Alan Rowland Walsworth	} All proposed by <i>Prof. F. H. Garner.</i>
FAULKNER, Brian Alex.	
MARTYN, John Robert	
SHELDON, James Hervey	} Proposed by <i>Prof. V. C. Illing.</i>
SUGDEN, Walter	

---



## NEWS OF MEMBERS.

Information has been received that Mr. W. M. Wright, who was reported in the October *Journal* to be missing, believed killed, is alive and well. He was one of the party who, under the leadership of Admiral Chang Chak, escaped into Free China when Hong Kong fell, and was awarded the D.S.C. for his part in the escape. He subsequently served for a time in Rangoon, and is now in Calcutta.

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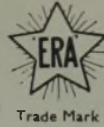
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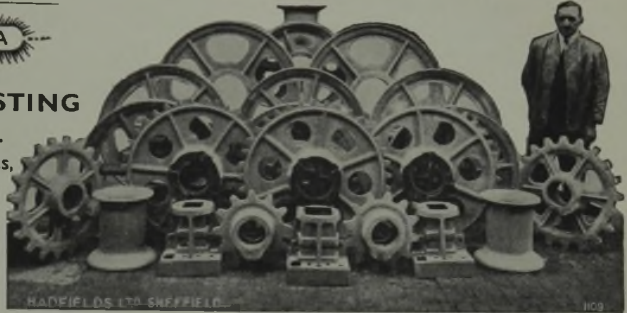
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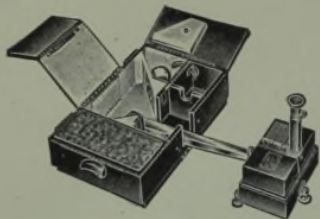
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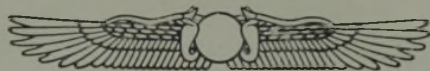
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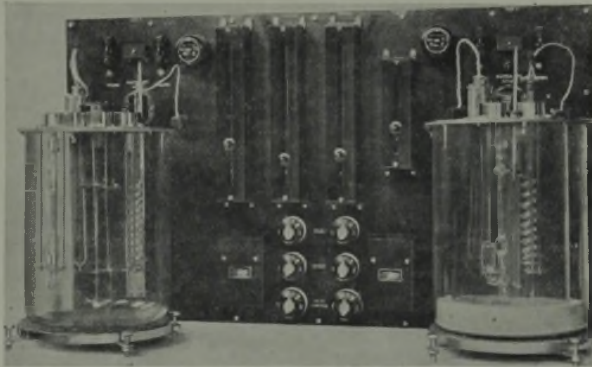
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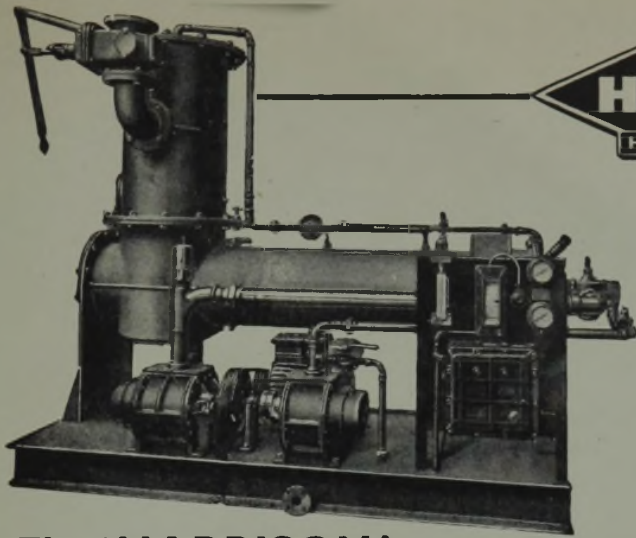
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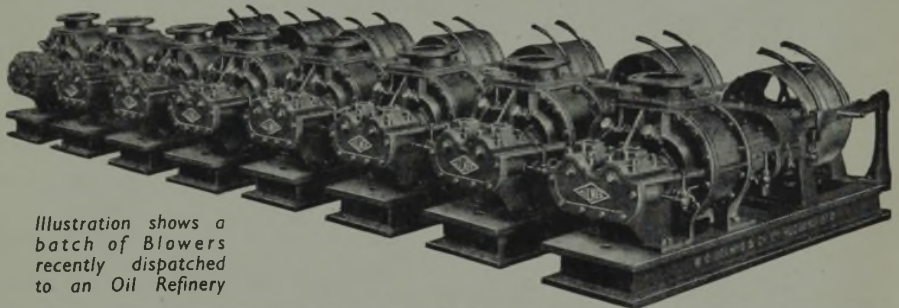
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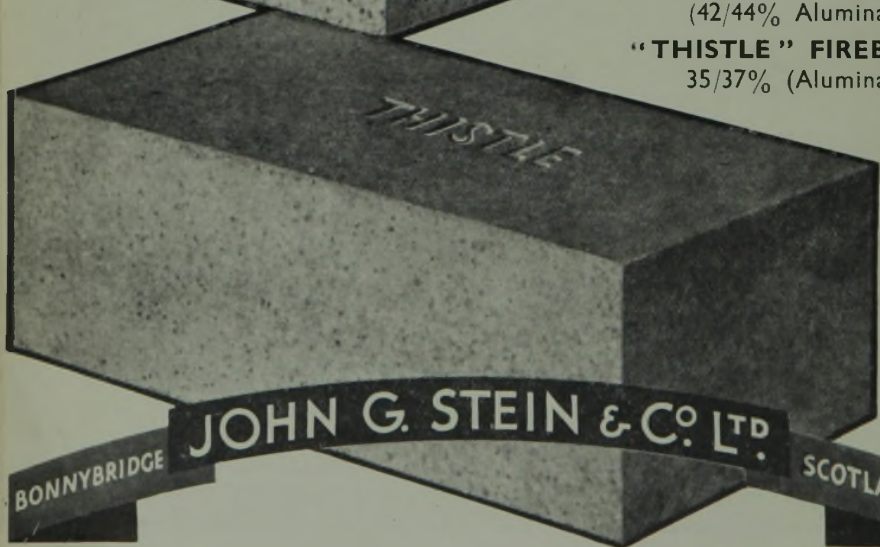
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