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OILFIELD EXPLORATION AND EXPLOITATION.

Geology.

504. Andarko Basin Prospects. R. C. Tuttle. *Oil Wkly*, 22.7.46, **122** (8), 37.—In its broadest sense the Anadarko basin includes the Dodge City basin, and covers 140,000 sq ml in 4 States. It is bounded by the Barton Arch, Nemaha–Oklahoma City Ridge, Wichita–Amarillo uplift and the Sierra Grande Uplift of Colorado. Few wells have tested the Ordovician which will be over 10,000 ft deep throughout much of the basin. The reserves of recoverable oil have been estimated at 5,000–10,000 million brl.

Thick beds of evaporites make difficult the recording and interpretation of geophysical data. Possible reservoir rocks include the Clearfork, Wichita–Albany, Pontotoc, Deese, Hoxbar, Dornwick Hills, Springer, Strawn, Tonkawa, Layton, Cleveland, Cherokee, Chester and Lower Mississippian, Misener, Hunton, Viola, Simpson, and Arbuckle.

There are major unconformities in the section. A thick Mississippi limestone section will occur over much of the basin, and the same is true of the Hunton. Along the northern margin of the Wichitas is a relatively broad zone of complex block-faulting. This zone has given the Cement, Apache, and Gotebo fields. Several tests on the southeast flank of the basin have shown beds which could be productive in favourable structural positions farther out in the basin. The Bartlesville unconformity sand produces at South Moore. The Britton and West Edmond pools on the east flank of the basin have several producing zones which could produce further west. The Tonkawa and Layton sands show traces of oil, and the Chester produces in Blaine County. Gas and distillate have been obtained from a Middle Pennsylvanian sand in Harper County. Lenticular sands in the Clear Fork have shown oil and gas in Beckham County. The basal conglomerate of the Permian–Ordovician contact produces at Hobart and Gotebo.

The dominant trends of the basin run northeast–southwest, but there may be modifying cross-trends roughly parallel to the Wichita–Amarillo uplift. In the south the mountain trends are dominant.

Deep tests costing $100,000–200,000 will be needed in this area.

There are several maps and cross-sections. G. D. H.

505. California Basement Production Possibilities. W. R. Cabeen and H. H. Sullwood. *Oil Wkly*, 22.7.46, **122** (8), 17.—The first true schist production in California was found in the western part of the El Segundo pool where the fractured schist is overlain by shale. Initial outputs up to 4500 brl/day were obtained. In 1944 prolific basement production was found at Santa Maria Valley in the fractured partly metamorphosed "Knoxville" (uppermost Jurassic). Some wells penetrated the Knoxville for over 1000 ft, obtaining oil in cores at the bottom. In 1945 the basement schist at Edison was penetrated for 100 ft, oil being found in the cores, and production was obtained. Several schist production wells have been completed at Wilmington; there are about 90 at Edison.

So far as is known all the Californian oil-producing districts are underlain by products of the Nevadan orogeny (intrusions and metamorphics) or by Franciscan–Knoxville rocks (uppermost Jurassic) consisting of sandstones, shales, cherts, lavas, intrusives, and schists. There are probably other types of basement:

At El Segundo a schist ridge is buried by Miocene and Pliocene sands and shales in which the arching dies out upwards. Part of the area is covered by a mantle of schist debris up to 100 ft thick, and this produces in the eastern part of the field. This zone is thickest in a low area on the schist "high." In the "bald-headed" area wells found oil in fractures in the schist. Some wells produce from the schist or schist conglomerate alone, and others from both. Weathering and hydrothermal waters may have aided in the formation of the schist openings. The average schist penetration is 100 ft but some wells have gone in 300 ft.

At Santa Maria Valley a southwest-dipping monocline of Pliocene is truncated by more gently dipping Pliocene. The Miocene rests on basement sandstones, shales, serpentine dykes, and sills, all fractured, and possibly having a weathered mantle of detritus. The first basement well was a mistake, but obtained 10,000 Mcf/day and 2500 brl of oil. Some of the later wells have gone 1200 ft into the basement. Production is erratic. The oil is of Miocene origin. The top of the basement in the central part of the field is 1800 ft higher than the lowest Miocene production.

Wilmington is a broad, faulted, northwest plunging nose on which Pliocene and Miocene overlie the basement. The lower part of the Miocene is missing over certain high schist areas. 1200–2000 brl/day wells have been completed in the schist. In places the breccia overlying the schist is over 100 ft thick.

At Edison production was from Pliocene and Miocene sands in which trapping was by lenticularity, faulting, or buttressing against a schist basement "high." Some wells have penetrated the schist for more than 1000 ft. Oil and water distribution in the schist is erratic. The oil may have come from the Miocene and Pliocene. In some places weathered impermeable schist may seal the oil in the schist.

In each of the fields the schist oil resembles that of the upper zones.

Only 24 of California's 169 oilfields have wells which have reached the basement, and testing seems to have been restricted to 7. Santa Maria basin and the east side of the San Joaquin basin offer the best chances of basement production within reasonable drilling depths.

A table lists the fields where basement has been reached, and there are diagrams of some of the producing schist areas. G. D. H.

506. Drilling in California's West Newport Field. W. E. Dunlap and A. L. Hunter. *Oil Gas J.*, 10.8.46, **45** (14), 95.—The extent of the West Newport field is not yet fully established. Since 1904 some 53 wells have been drilled in this area, which has complex geology, but the discovery well was completed only in 1943. Some 74 wells give a total of 5800 brl/day. All but two of the wells produce from the "B" zone; two wells produce from the "C" zone. On the east of the Santa Ana River the wells are 1500–2050 ft deep, and have an average completion time of 5½ days; on the west the depths range 2300–3100 ft deep and are completed in 14–20 days. Costs average $17,000 per well in the former area, and $27,500–35,000 in the latter area. The proven "B" zone area is 490 acres. This zone averages 120 ft of sand with an estimated recovery of 522 brl/acre ft. The "A" sand has 80 ft of sand with a like estimated recovery.

Pico and Repetto overlie the Puente (Upper Miocene) which is the producing formation. A limited gas accumulation occurs in the "E" bed of the Middle Pico; trapping may be by faulting and by change in permeability. The "E" bed lies on the bevelled edges of the organic Repetto beds. The upper 400–500 ft of the Puente consists of brown shales and siltstone with occasional lenses of silty oil sand. Beneath this lie the oil sands.

There is a northwesterly plunging nose truncated by the Inglewood fault system. The main Inglewood fault is normal and downthrown to the south. The throw ranges 300–2000 ft in this area.

The oil sands are fine to coarse, with high porosity (over 30%) and permeability (average 1284 md). The sands are loose, and gravel packing is employed.

G. D. H.

507. Relationship of Crude Oils and Stratigraphy in Parts of Oklahoma and Kansas. Research Committee, Tulsa Geological Society. *Bull. Amer. Ass. Petrol. Geol.*, 1947, **31**, 92.—The Tulsa Geological Society has been carrying out an extensive investigation of the relationship of crude oil and stratigraphy during the past 10 years. Several hundred analyses have been made of crude oils from a number of Palæozoic zones, ranging from the Upper Arbuckle limestone of the Ordovician to Pennsylvanian sands.

The localities from which the oil samples have been drawn are northeastern Oklahoma and southeastern Kansas. This paper summarises the results obtained to date.

It is suggested that the environment of the source material may have determined the nature of the oil in each field. For example, the variable environment of deposition of the beds at the top of the Arbuckle limestone has given rise to a great variety of oils in this formation. On the other hand, the Burbank sand was deposited under relatively constant conditions, and its oil is consequently of the same type in all the Burbank pools.

Structural movements do not seem to have changed the character of the oils, nor is the present depth of burial significant in this respect. E. N. T.

508. TXL is Representative of New Pre-Permian Fields ; Promises Major Reserve. G. Weber. *Oil Gas J.*, 24.8.46, **45** (16), 81.—Oil was discovered in the upper chert of the Devonian in 1946, and this led to the discovery of Ellenburger oil in 1945. There are secondary production possibilities in three other pre-Permian and three Permian horizons. 69 Devonian wells and 32 Ellenburger wells have been completed, and 2,500,000 brl of oil produced.

There is an elongated north–south pre-Permian anticline. A major north–south fault marks the eastern edge of production. In late Pennsylvanian time there was erosion which exposed the Devonian. The Permian shows relatively little dip compared with the deeper beds. The crest has two pre-Permian domes and minor faulting. Devonian production is limited to the west by absence of fracture and permeability.

A thin section of black Mississippian shale occurs on the west flank. The bulk of the Devonian production comes from a dense highly fractured chert. A low-permeability Devonian limestone is oil-saturated but not commercially productive, while the lower Devonian chert is stained. The top of the mid-Silurian includes the oil-saturated Fusselman chert and limestone which produced in drill-stem tests. The McKee and Waddell sand members of the Middle Devonian show oil. The Ellenburger includes chert and dolomite and has a high potential where fractured. The Wichita and Wolfcamp of the Permian have been tested for oil. The Clear Fork is productive.

Devonian and Ellenburger production cover about 3500 acres. Porosity and permeability are erratic, and reserve estimates difficult to make. Using Big Lake as a yardstick the TXL reserves are placed at 100,000,000 brl.

Brief notes are given on drilling and production techniques. Pressures have fallen from 3234 p.s.i., to 2820 p.s.i., and the saturation pressure is believed to be about 2800 p.s.i. in the Devonian. Gas–oil ratios average about 968 cu ft/brl. The Ellenburger, on the other hand, has a pronounced water drive maintaining pressure at about 4060 p.s.i. The gas saturation pressure is 2633 p.s.i. Ellenburger wells average 1049 cu ft/brl. G. D. H.

509. Oil Discovery is Recorded for Central Alberta Plains. Anon. *Oil Wkly*, 1.7.46, **122** (5), 15.—Imperial Oil's Provost 1 has discovered oil in a Lower Cretaceous sand at 2534–2549 ft. Production is at the rate of 60 brl/day of 21–22° A.P.I. oil and 165 Mcf of gas. The well lies 60 ml southeast of the Viking–Kinsella gas area.

Imperial Oil's Kinsella 14 found oil in a drill-stem test of the Viking sand, but failed to shut off gas and water from an upper member of the Viking. G. D. H.

510. Colombia Wildcatting. G. O. Ives. *Oil Wkly*, 1.7.46, **122** (5), 3 (*International Section*).—Wildcat drilling in Colombia is increasing. In Velazquez 1 in the Upper Magdelena Valley a production test is to be made at 7254–7274 ft. The sand is similar to the Guadas Sans Tertiary sand, but it may be Cretaceous or transitional. Other production in the Magdalena Valley is from the Miocene, Oligocene, and Eocene.

Sardinata 1 and Zahina 1 are just south of the Yondo concession in which the Casabe field lies. Costarica 1 in the Lower Valley region has reached 8760 ft and is preparing to test Miocene and possibly older beds. Numerous sands have been reported from 2300 ft to the base of the Miocene at 6300 ft. Most of them have had oil or gas shows which have not been tested.

Tubara 1 is to be drilled just west of Barranquilla. Tibu 21-K is 10,555 ft deep and preparing to test the Cretaceous. Chorrea 4, northwest of Bogota, hit basement granite at 7025, and is now preparing to test upper formations. The Sinu field has two producers. Chafurray 4 was abandoned in basement at 2342 ft. San Martin 2 had 14-gravity oil in a 200-ft pay just above 6820 ft, but not in commercial amounts.

The Casabe field now has 42 producing wells. G. D. H.

511. Ecaudor : Two Firms Lead Oil Search. Anon. *Oil Wkly*, 1.7.46, **122** (5), 6 (*International Section*).—International Ecuadorean Oil Co. has drilled 7 wildcats. Bajada 1 went to 13,206 ft but failed to show gas or oil. All but two of the wells have exceeded 7000 ft in depth. Shell's Vuano 1 had non-commercial showings of heavy oil.

During the first quarter of 1946 the Ecuadorean oil production was 580,460 brl. G. D. H.

512. Guatemala Oil Possibilities. M. K. Adams. *Oil Wkly*, 1.7.46, **122** (5), 8 (*International Section*).—The first recorded geological study of El Peten, Itzabal, and associated areas on Guatemala was made in 1860. A limited survey was undertaken in 1925, and a comprehensive survey in 1935 and 1936. This work, associated with an aerial survey, also included a study of British Honduras. Shell, the organizer of this latest work, was unable to conclude concession negotiations and withdrew. In 1944, Standard sent in a party, but again concessions were not taken up.

El Peten has the same beds as occur in Tampico, Texas, and the Yucatan Peninsula. A series of northeast–southwest striking faults runs in an east–west line marked by Rio San Pedro, Lake Peten-Itza, and Lake Yasha. South of this line are folds. In the Alta Verapaz the sedimentary series of Peten is upturned against igneous rocks.

Nearly all the area is covered by limestones ranging in age from Carboniferous or Permian to Miocene. On the west there are marine and non-marine Tertiary shales. The oldest limestone is shattered and has a petroliferous odour. Seepages have been reported. Cretaceous limestones rest on the Carboniferous or Permian. They are possibly equivalent to the Tamasopa limestone of Mexico. Next follows the Oligocene limestone.

In El Peten closed structures are known near Santo Toribio and Chinajo. The former strikes southwest and is faulted on its northern flank. Source and reservoir rocks are believed to be present. The Chinaja structure is better closed but less accessible. Its strike is west, and its dips steep. Production of oil might be from the Cretaceous.

About a third of the Department of Itzabal has petroleum possibilities. The same formations occur as in El Peten and British Honduras. There are folds, but any production is likely to be deeper than in El Peten. G. D. H.

513. Socony-Vacuum Explores Barinas, Venezuela's Largest Concessions. P. Reed. *Oil Gas J.*, 10.8.46, **45** (14), 62.—Socony-Vacuum holds concessions covering 3,339,700 acres in Barinas and the adjacent states of Apure and Tachira. Early in 1946 five seismograph parties and one gravity meter party were working on these concessions. Two rigs are drilling and 3 wells have been completed. 1 San Vicente was drilled 105 km southeast of the town of Barinas. It was abandoned dry at 7082 ft. 1 Silvestre was abandoned dry below 10,000 ft; it lay 60 km southeast of Barinas. Previously Sinclair had drilled a well to 5525 ft between Barinas and Barinitas.

The Barinas basin is believed to be fairly narrow and deep near the mountains. To the southeast the formations thin towards the Guayana shield. A number of seeps are believed to be associated with questionable Eocene beds. In most of the area the younger Tertiary is covered by Quaternary.

Barinas is difficult of access and transport is expensive. A short description of the means of transport and of the drilling practices in this area is given. G. D. H.

514. Venezuelan Test Promising. Anon. *Oil Gas J.*, 17.8.46, **45** (15), 73.—2 West Tarra at Los Cerritos produced at the rate of 2100 brl/day of 47·5° A.P.I. oil at 6820–6855 ft. G. D. H.

515. Many Sands, Variety of Crudes Complicate Exploitation in West Guara, Venezuela. P. Reed. *Oil Gas J.*, 24.8.46, **45** (16), 66.—West Guara is in the Greater Oficina area where production is from the Oficina formation (Miocene) It is on the southern flank of the Eastern Venezuelan Basin. The reservoir rocks are broad sheet-like sand bodies rising to the south and southwest. Accumulation is due to faulting, wedging out, and reduction of permeability. All the Greater Oficina fields have lenticular sands with varying permeability and porosity, but most of the West Guara sands are blanket sands. Dips are 2–4°, and steeper at depth. East Guara has dips of 5–15°, and Oficina has dips generally under 2°. At Oficina gravity drainage seems to be effective in association with dissolved gas drive. At West Guara gravity drainage should also aid since the dips are higher, and there is high permeability.

Oficina has 33 producing sands, West Guara 31, and East Guara 21. In addition West Guara has 15 sands yet to be exploited, 8 tar sands and 3 dry and water sands. West Guara has light waxy crudes (37–58°), non-waxy crudes (20–42°), and tar oils (10–18°), the gravity generally decreasing with depth. The gravity may vary within a single sand and may decrease in going down the structure from the gas cap (in one case 36·9° to 23·2° 65 ft lower).

At Oficina there is complex faulting. Wells separated by faults may give different oils from a single horizon. The West Guara fault has a throw of 175–500 ft and the throw increased with depth. Production is found north of the faults whether they are downthrown or upthrown on that side. Some production occurs south of the faults, but it is spotty and relatively unimportant.

Mene Grande's portion of the West Guara field has a potential of 60,000 brl/day, and a current output of 48,000 brl/day. There are dual- and triple-zone completions. Wells were drilled on a 42·3-acre grid, but it is clear that this spacing is too wide for effective drainage. G. D. H.

516. Stratigraphic Palæontology of Camagüey District, Cuba. J. de Albear. *Bull. Amer. Ass. Petrol. Geol.*, 1947, **31**, 71.—In the Camagüey chromite district there are late Jurassic to Eocene sediments which fall into a southern shallow water group, and a northern deeper calcareous group. The northern facies has been thrust extensively over the southern sediments and their associated serpentines. Faunal lists are given for each formation present, and the lithologic units are described. E. N. T.

517. Pogue Places Future Oil Finds at 490 Billion Barrels. Anon. *Oil Gas J.*, 3.8.46, **45** (13), 59.—Pogue has estimated future Middle East discoveries at 150,000 million brl and Russia's future discoveries at 100,000 million brl. Future discoveries elsewhere are placed as follows : U.S.A. 50,000,000,000 brl ; Caribbean area 65,000,000,000 brl ; Far East 58,000,000,000 brl ; Europe (apart from Russia) 8,000,000,000 brl. The total future discoveries for the world are given as 490,000,000,000 brl. Currently proved reserves are estimated to total 65,800,000,000 brl, 27,000,000,000 brl being in the Middle East and 21,000,000,000 brl in U.S.A. G. D. H.

518. Important Commercial Field Indicated South of Suez. Anon. *Oil Gas J.*, 3.8.46, **45** (13), 61.—The SUDR wildcat and geophysical data are believed to point to an oilfield of considerable commercial possibilities. It lies 4 ml inland. G. D. H.

519. Additional Concessions are Given Anglo-American. Anon. *Oil Wkly*, 1.7.46, **122** (5), 48 (*International Section*).—The Anglo-American Oil Co. has recently been granted further prospecting licenses covering 1790 sq ml. Gringley 1 has passed 3000 ft. Belton 1 was abandoned at 5459 ft. Well 6 at Midlothian has been deepened to sands which were gas-bearing in Well 1, but the sands were thin, and gave little gas. G. D. H.

520. Stratigraphy of Western Australia. C. Teichert. *Bull. Amer. Ass. Petrol. Geol.*, 1947, **31**, 1.—The area of Western Australia is about 1 million sq. ml. Within this enormous area are found sediments of all the major geological systems except the Silurian and possibly the Triassic. These sediments occupy or underlie not less than one-third of the total area.

This paper describes and classifies the sedimentary occurrences and describes the three major basins with thicknesses of more than 10,000 ft of sediments. Of these three major basins, one is little known and the other two are geosynclinal in type. They are the Desert Basin, in which there is probably 14,000 ft of sediments ranging from Devonian to Jurassic ; and the North-West Basin with 14,000 ft of Permian to Tertiary strata.

There is an abundance of potential source, reservoir, and cover rocks in these sedimentary basins and they are interesting from the point of view of oil accumulation.
E. N. T.

Drilling.

521. Mobile Rotary Drilling Unit Proves Efficient in Rocky Mountain Operations. N. Williams. *Oil Gas J.*, 1.2.47, **45** (39), 50.—A portable unit is described. The unit as designed is capable of drilling an 8-in hole to a depth of 1000 ft and a smaller hole to a depth up to 1500 ft. It has drilled as much as 750 ft in a single day, and in one test it made 100 ft in 1 hr. During another series of tests it drilled 6380 ft of hole in 21 days' drilling time, or at the average rate of more than 304 ft daily including moving and shutdown time. The first 3100 ft of this was drilled in 11 days' drilling time. In another case, it drilled and completed a 134-ft water well with casing in 2½ hr. All equipment is truck mounted. Present units utilize a standard 1½-ton Ford truck with 158-in wheel-base, although almost any 1½-ton truck is adaptable. Various shop alterations are made, including installation of a special muffler, heavy-duty bumpers and running boards, safety-tread flooring, and a new-type radiator-hood cowling to provide maximum engine cooling effect. Screw-operated steady jacks are provided to support the rear of the drill and relieve the truck springs and tyres of load while the unit is on location. These are hinged to the truck frame under each side of the rear and fold up against the truck bed when the rig is in transport. Simplified control design, a hydraulically operated " pull down " for weight control on the bit and for lifting pipe, a new design for slips and break-out tongs, and utilization of standard Ford truck drives, differentials, and universal joints (Spicer) are among the more important innovations. Through utilization of the latter standard truck units, parts for replacements are available almost anywhere so that nearly all minor repairs can be made quickly. The entire rig is designed in unitized sub-assemblies which can be removed and replaced easily on location with new or rebuilt mechanism. These features combine to minimize shutdown time and permit drilling of more hole. Individual components are described in some detail. A. H. N.

522. Lateral Drilling Project. Anon. *Oil Gas J.*, 21.12.46, **45** (33), 68.—A well bottomed at 1720-ft was used to drill lateral drainage holes into an oil sand using Zublin turbine bit on flexible pipes and curved joints to deflect the well. The turbine bit assembly consists of three main parts : (1) the housing which carries the nozzles of the turbine ; (2) the shank member carrying the turbine runner mounted on ball bearings within the housing, and (3) the cutter element which is mounted on ball bearings and is free to rotate about an axis which is inclined with respect to the axis of rotation of the shank. The cutting action of the bit is credited to the tendency of the bit to cut opposing teeth in the formation facing the teeth of the cutter. If the bit were hanging free, the cutter would rotate at approximately the speed of the turbine or about 4000 r.p.m. However, as the cutter face is forced against the formation, these " rock " teeth retard the rotation of the cutter by the ratio of 1 to 10. The cutter speed is thus about 400 r.p.m. about its inclined axis compared with 4000 r.p.m. of the turbine and shank. The cutter, however, " wobbles " at the rate of 4000 times/minute, owing to the inclination of the cutter axis. The 1-to-10 reduction is attributed to the placement of the cutter teeth, which are designed to remove one-ninth of the opposing " teeth " in the formation on each revolution of the turbine or the corresponding " wobble " of the cutter face. The cutting action of the bit depends in part on the tendency of the cutter teeth to lift and drop the bit. The entire bit has an overall length of 20 in to permit the drilling of curved holes. Fluid pumped down the hole inside the pipe is discharged near the cutter teeth. Construction of the bit provides for disassembly and reassembly to permit replacement of turbine parts if worn by abrasive action of the drilling fluid.

Orientation of the bit is made in two ways, one using a Zublin magnetic compass and the other by a surveying method. These are described. A. H. N.

523. Modern Portable Units in Drilling and Well Servicing. H. S. Norman. *Oil Gas J.*, 30.11.46, **45** (30), 77.—Portable drilling units designed for speed of erection, dismantling, and removal are described. Telescoping masts, available in various heights, form an integral part of the portable units. Hook capacity of the masts ranges from 70,000 to 250,000 lb. Racking capacity of the masts ranges from 4600 ft of 2½-in tubing to 13,000 ft, depending on length of stands and design of the mast. The Harbor company's new unit, for example, has a 90 ft mast and a net hook capacity of 200,000 lb. Racking capacity is 12,000 ft of 2½-in tubing in 60-ft stands. When collapsed for moves, the mast is 52 ft long. The mast is raised by hydraulic jacks or rams and travel block mounted on the semi-trailer unit. Bubble levels secured to the side and front of the mast are typical of attention given to small details which contribute to the speed of positioning the unit. Another similar facility is the use of pull-lift hoists in securing guy lines to the deadmen anchors. This ratchet arangement for securing the mast in plumb position permits speedy first installation and affords a simple means of correcting for stress conditions which may arise during drilling or servicing operations. A. H. N.

524. Drilling Barge Designed for 15 ft Water Operation. E. H. Short, Jr. *Oil Gas J.*, 23.11.46, **45** (29), 62.—Specifically designed for the job, a barge is being used to drill in 14 ft of water in Gulf Coast waters, which is believed to be the deepest barge operation without shell matting. The barge is 140 ft long, 50 ft wide, by 16 ft deep. The layout of the equipment and method of operation are described. A. H. N.

525. Big Diesel-Electric Barge Drilling Rig. Anon. *Oil Wkly*, 30.12.46, **124** (5), 28.—The most powerful diesel-electric barge drilling rig used by Humble Oil and Refining Co. is described. Details of size, power, and capacities are presented and the rig illustrated photographically. A. H. N.

526. Diamond-Bit Coring in the Rangely, Colorado Field. N. Williams. *Oil Gas J.*, 4.1.47, **45** (35), 48.—Results of several experimental uses of diamond coring in the field are presented and discussed. Actual cutting time (exclusive of trips, etc.) with diamond bits has run from 8 to 12 mins/ft as compared with an average of more than 45 min/ft for conventional coring. Conventional coring time ranges from around 20 min up to as much as 270 min/ft. Cuts have averaged from 150 to 175 ft/head against 6–8 ft, for conventional-type heads. In one case, the record, a total of 544 ft, was cut with a single head. With 25, 30, and 50-ft cores being cut, the high footage/bit has resulted in fewer round trips and consequent substantial savings in trip time (about 6–8 hr/trip) in addition to the reduction in actual coring time. Moreover, by using a 6⅛-in bit (full hole size), no reaming has been required which in itself is a substantial saving. So far experiments with employing reverse circulation with diamond-bit coring have not proved entirely satisfactory. Attempted in only one well, a total of 80-ft was cored by this method but the cores tended to clog up in the catcher after cutting 10 to 12 ft and could not be pumped out. When reverse-circulation coring is perfected it is expected that cores will be pumped to the surface as cut and the number of round trips further reduced, and possibly that the need of trips will be eliminated if one bit can core the entire section. Reverse circulation also is expected to make for faster and better coring by more effective removal of the cuttings from the bit. Conventional and diamond coring methods are studied side by side and compared. A. H. N.

527. Quick Freezing of Cores. J. D. Wisenbaker. *Oil Gas J.*, 25.1.47, **45** (38), 275; *Oil Wkly*, 20.1.47, **124** (8), 42.—To avoid loss of water, oil, and gas from cores when they are taken from the field to a distant laboratory for tests, a method of quick freezing was evolved. The application of quick freezing was believed to be a practical method of preserving the fluid content of cores, because freezing effectively anchors each particle of oil and water in the particular part of the core it occupies on being taken from the well. Some concern was felt, however, over the effect quick freezing might have on permeability, porosity, and other physical characteristics of oil- and gas-bearing rock. A drastic alteration of the sample was not expected because the particles of water are dispersed throughout the core and the expansion due to freezing is cushioned by the oil and gas content of the core. Porosity was not expected to change appreciably because even with considerable internal fracturing, which might cause a substantial change in permeability, no solid matter would be added or removed. Tests were conducted on cores fully and partially saturated with water. It was found that (1) Samples fully saturated with water and with permeability less than 10 md show an average increase in permeability of 47·5%. (2) The permeability of samples with less than 10 md and with 10·9% average gas saturation show an average increase of 1·86%. (3) Samples fully saturated with water with permeability of more than 10 md show an average increase in permeability of 0·35%. (4) Samples with more than 10 md and average gas saturations of 16·0 and 32·8% show an average increase in permeability of 3·06 and 2·54% respectively. The much smaller effect of freezing on samples with over 10% gas saturation may possibly be due to the fact that water expands approximately 9% on freezing.

Tests data are presented on fresh sand cores before and after quick freezing.

A. H. N.

528. Casing Perforating With Shaped Explosive Charges. R. H. McLemore. *Oil Gas J.*, 28.12.46, **45** (34), 268.—The principle of the shaped explosive charges consists of leaving a cavity, or air space, in the explosive, at the spot where maximum force is required. In the casing-perforating charges, the explosive is placed in a plastic container, leaving a cavity in one end. An air space is formed by the nose end of the container and the interior of a conical metal cavity liner, against which the explosive rests. The diameter, angle, thickness, and material of the liner all have a bearing on the size of the hole formed by the detonation, and on the total depth of penetration. In the tests described, the average diameter of the entrance hole for the normal charge was ½-in; for the heavy charge ⅝-in. The hole is made by an extremely high-velocity metallic jet caused by the detonation of the explosive. This jet is emitted from the conical liner as it is progressively collapsed by the detonation wave of the explosive. Following behind the jet is the collapsed cone, referred to as the "carrot."

Details of several tests on cemented casings perforated by these charges with different metal liners are given and discussed. Clean-cut holes are obtained.

A. H. N.

529. Coated Drill Pipe Proves Successful in Permian Basin. G. Weber. *Oil Gas J.*, 1.2.47, **45** (39), 40.—A plastic-coated pipe has been tested in drilling corrosive salt sections of the Permian basin for the past 14 months and appears to be successful in preventing drill-pipe failure from corrosion. Plastic coating, now widely used to protect metal surfaces from corrosive action, is possible only on the interior surface of drill pipe. No known plastic will resist the abrasion and shock applied to the outside of such pipe in service. However, such an external coating would add little further protection from corrosion, since the same abrasive action which makes such a coating impractical, also retards formation of corrosion pits by wiping them off the minute they get started. Therefore, a stable well-bonded internal plastic film, resistant to water, oil, mild caustic and other chemicals, and normal mud abrasion at temperatures up to 400° F will provide sufficient protection to warrant the additional cost. The tests on the newly developed internally coated pipe are discussed in some detail and a general analysis of the results shows it to be a successful practice. A. H. N.

530. Abnormal Gas Pressures Controlled. N. Williams. *Oil Gas J.*, 30.11.46, **45** (30), 60.—Gas pressures of 9200 to 9500 p.s.i. were encountered in 2 wells drilled in South Texas; they were controlled by mud weight. High pressures has been expected in drilling these wells but it was not anticipated they would be nearly as high as they were. Consequently, in drilling the first well their control necessitated adoption of some emergency measures and procedure devised as the conditions arose. A further complication in this well was occasioned by the fact that its drilling programme originally was designed for a depth objective of only 10,000 ft. When mud weight had to be built up to control pressures, running of an extra protection string of casing had to be resorted to in order to prevent loss of circulation in the upper formations. This forced such a reduction in hole size for the deeper drilling that operations were greatly handicapped. Knowledge of the excessive pressures and formational conditions gained in the first well prepared the company for what to expect in the second well. Accordingly, a somewhat different drilling programme was formulated for this well. Special practices were devised and extra precautions taken to insure maximum drilling control and safeguard the hole while negotiating the high-pressure zones. As a result, this well was drilled without undue incident and hole completed in a minimum of time, as compared with the first well. Details of the procedures are given. A. H. N.

531. Value of Continuous Mud Weight Records in High Pressure Drilling Operations. F. G. Sawtelle and W. E. Barnes. *Oil Wkly*, 6.1.47, **124** (6), 30.—A new mud-weight recording device now available provides both a continuous record and also a continuous indication of the mud weight on derrick floor. This new mud-weight recorder and indicator is remarkably simple in its principle of operation. The device consists of a vertical cylindrical tank through which the mud is pumped by means of a specially designed diaphragm pump. In the side walls of this tank are two neoprene diaphragms so placed that the mud contacts one side of each diaphragm, while the opposite side is enclosed by a fluid-filled diaphragm cap. The fluid chambers of the two diaphragm caps are connected by fluid-filled lines to opposite sides of the mercury chamber of a recording manometer of the type used to record the differential pressure on orifice meters. The vertical distance between the diaphragms is selected so that the differential hydrostatic head, as recorded by the manometer, will cover the full chart range of the meter, as the mud weight varies from that of water up to 20 lb/gal. The pulsations in mud flow through the recorder tank, caused by the reciprocating diaphragm pump, serve to break the gel of the mud so that no auxiliary stirring device is necessary. The continuous mud-weight recorder is furnished with a device for indicating mud weight on the derrick floor to insure that the drilling crew be immediately warned of any unusual fluctuations in mud weight. This device is electrical in nature, and draws its power from a small dry battery which operates the indicator for a period of 6 weeks to 2 months before replacement becomes necessary. The mud weight is indicated on a large meter, easily readable at 10 ft. The meter may be mounted in any convenient place near the driller's working position. The weight indicating mechanism is driven by the pen shaft of the mud-weight recorder, and is carefully designed so that it does not detract from the accuracy of the recorder system. The apparatus is photographed. A. H. N.

532. Recovery of Barite from Rotary Drilling Mud by Centrifugal Separation. C. A. Lindsay. *Oil Gas J.*, 14.12.46, **45** (32), 92.—The centrifuge described is for continuous feed and discharge of separated products. The usual heavy drilling mud contains three solid constituents : bentonite or clay, sands of 2·6 specific gravity, and barite or witherite (4·4–4·6 sp. gr.) which is usually available at a sp. gr. of only 3·9–4·2. Bentonite or clay normally consist of colloids and particles small enough to be held permanently in suspension. The + 200-mesh sands are largely removed by combined chemical conditioning and screening whereas the − 200-mesh barite is held in suspension by adjusting gel strength and viscosity to counteract the settling tendency. During drilling operations the mud is continually becoming contaminated with excess colloids, cuttings, sand, oil, gas, and salt, from the formation encountered. Where oil, gas, and salt-water contamination is excessive the barite consumption is usually excessive. By the simple expedient of fresh-water dilution to reduce the viscosity and decrease the gel strength, drilling mud can be conditioned for centrifuging after the cuttings and + 200-mesh sands have been removed. The centrifugal operation consists in separating barite as a heavy concentrate and rejecting lightened mud containing slimes and contaminating fractions. Efficiency of this separation varies from 85 to 95% recovery of the weighting material, depending upon variations in feed, weight of desired concentrate, and g.p.m. throughput. A certain amount of fine sand in the feed will find its way into the barite concentrate, but actual field experience discloses that the percentage is small and of slight consequence. The operation of the centrifuge and details of testing it are presented. A. H. N.

533. Sodium Chromate Used in Permian Basin Drilling to Combat Salt-Water Corrosion. G. Weber. *Oil Gas J.*, 7.12.46, **45** (31), 103.—Although laboratory immersion tests show that a sodium chromate concentration of 1000 p.p.m. reduces corrosion of steel samples in salt-water muds by 94% in practice, the proportion used in drilling muds ranges from 1800 to 3000 p.p.m. and averages 2000 p.p.m. Most drillers mix 50–100 lb of chemical to about 50 gal of water in a common oil drum or chemical mix tank. It is added slowly, in the amount calculated to give the desired proportion, at the rate of about 50 gal/hr into the flow line, either before or after the shale shaker. The proper concentration can easily be checked by colorimetric titration using dropper bottles, recording the results either directly in p.p.m. or lbs/brl. Once the mud has been brought to the desired concentration of sodium chromate, small daily additions will serve to maintain proper proportions. The principal mud service company in the Permian basin performs this service for many of the rigs using the inhibitor.

Cost studies are given for the U.S. A. H. N.

Production.

534. Clay Content of Oil Sands. T. F. Bates, R. M. Gruver, and S. T. Yuster. *Producers' Monthly*, Aug. 1946, **10**, 16.—It has previously been shown that the homogeneous fluid permeability of formation samples to air is often different to that of the same samples to water : this effect must not be confused with the relative permeability–saturation relations in heterogeneous fluid flow. It is believed that certain complex silicate clays present in sands undergo physico-chemical reactions with water in contact with them, causing them to swell and reduce the permeability of that sand to water. The reduction in permeability must therefore depend on : (1) The extent of swelling of the particular clay in contact with the particular type of water ; (2) The quantity of clay present in the sand ; (3) The distribution of the clay in the sand.

The three methods which are described for the analysis of clay content of sandstone are : (1) The differential thermal analysis method ; (2) The X-ray spectrometer method ; (3) The electron microscope method.

The samples are prepared in the same way for all three methods by extracting with naphtha, breaking down to grain size, and passing through a series of sieves of 400 mesh : the corse fraction is discarded. These samples are then mixed with water into a paste and elutriated in water to reduce the quantity of quartz minerals present.

The first method consists of measuring the temperature difference by means of a differential thermocouple between a clay sample and a thermally inert substance, both of which are being heated simultaneously at an equal and constant rate. Any chemical or physical changes in the clay involving a liberation or absorbtion of heat will create a temperature difference between the clay and the inert substance. This produces a differential temperature versus actual temperature curve which is a characteristic of the clay minerals present.

In the second method the sample is subjected to a stream of X-rays at a continuously varying incident angle. The intensity of the diffracted beam is measured simultaneously at the same angle as the incident beam with a Geiger counter. This produces a curve of scanning angle versus intensity of diffracted beam which is characteristic of the material being tested.

The third method consisted of taking highly magnified pictures with the electron microscope. The shape and size of the materials was studied as a means of identification of the minerals present.

The study of some particular samples from the Bradford sand by these methods indicates that Illite was the commonest clay mineral found in this particular sand with smaller amounts of Kaolinite and Montmorillinite also being present. Of these, Illite and Montmorillinite swell in the presence of water, and hence they could be responsible for a reduction in water intake rates in water flooding.

The strong exothermic peaks shown in the differential thermal curves are indicative of the presence of organic materials which may be polar compounds : these would have an effect on the wettability of the sand. They are strongly adsorbed and difficult to remove by simple extraction. Further studies on these substances are suggested in view of their importance in oil production. One reference is given. R. B. S.

535. Secondary Recovery Production Research (A Monthly Review) : Selective Shooting Research Needed. R. V. Hughes. *Producers' Monthly*, Aug. 1946, **10**, 10.—The most important tests which should be carried out to determine the most effective selective shooting method are : (1) To test the relative merits of solid, semi-solid, and liquid explosives under conditions of fluid tamping versus solid tamping and heavy tamping versus light tamping ; (2) To evaluate the benefits of being able to increase the shot volume by drilling holes of larger diameter ; (3) To determine the relative responsiveness of a given shot upon well consolidated and upon poorly consolidated sands.

One advantage of the solid and semi-solid explosives recommended for well shooting purposes is that they are safe to transport and to handle, even by relatively inexperienced persons. Solid and semi-solid explosives can be made in a wide range of rates of detonation, hence, when the relationship between rates of detonation and fracturing ability in sands of different degrees of consolidation is better understood than at present, the proper solid or semi-solid explosive to meet every well condition could be selected.

Whilst a light water tamp seems to be less efficient than a solid tamp, the cleaning out time is much reduced. In cases of low formation pressures, a hole full of water may drive dirty water into the sand immediately following the shot and thus result in some plugging of the sands. The filling of the hole with strong salt brine or a water slightly on the acid side is suggested for all water tamps. In such cases the clay and shale particles in the hole capable of causing plugging action, would be changed to and kept in a flocculated condition and could be easily washed off the sand face during the bailing operation.

The necessity of increasing research in the field of selective shooting is emphasized and the possibility of instituting new shooting methods is discussed. Eight references are appended. R. B. S.

536. Future Possibilities for Oil in New York State and the Appalachian Basin. E. T. Heck. *Producers' Monthly*, Sept. 1946, **10** (11), 25. (*Paper presented before Eastern District Division of Production, A.P.I., Pittsburg*, June 1946.)—The geological succession of rocks in central and western New York is presented and the oil prospects of New York State and the Appalachian Basin generally, are discussed. For convenience, New York is divided into three districts, each of which is studied separately. These three districts are: (1) the eastern district which includes those parts of the State where the crystalline rocks are at the surface; (2) the south-central district which includes all the oil- and gas-fields of the State at present known; and (3) the eastern district where the surface rocks are of Devonian age.

Nine references are given. R. B. S.

537. Research, Exploration, and Engineering Needs of the Penn Grade Producing Industry. J. P. Jones. *Producers' Monthly*, Aug. 1946, **10** (10), 38. (*Paper presented at annual meeting, Pennsylvania Grade Crude Oil Association, Pittsburg*, June 1946.)—The present state of the Pennsylvania petroleum industry is reviewed and suggested programmes of research, exploration, and engineering improvements are discussed. R. B. S.

538. Future of the Penn Grade Area. E. T. Heck. *Producers' Monthly*, Oct. 1946, **10** (12), 15. (*Paper presented before the Engineers' Society of Western Pennsylvania, Bradford*, Sept. 1946.)—The future of the Pennsylvania petroleum industry is briefly discussed: there seems to be a possibility that new reserves will be discovered, particularly if deeper drilling is practised. More important, however, are the large reserves of oil which can be made available by secondary recovery methods. The author believes that the oil saturations as shown by cores cannot always be used to determine the value of properties, especially outside the Bradford area, and he suggests that pilot operations give a better indication of secondary recovery possibilities. When old holes are used for input wells they should be thoroughly cleaned out, and the injection of several hundred gallons of gasoline ahead of the water is suggested, so as to remove paraffin from the vicinity of the hole and to aid in starting an oil bank in front of the water. R. B. S.

539. Laboratory Simulates Formation Condition. G. M. Wilson. *Oil Wkly*, 30.12.46, **124** (5), 33–34.—Description of laboratory apparatus for measuring sand characteristics such as porosity, permeability, etc., and of fluid characteristics such as P.V.T. data is presented. A. H. N.

540. Treatment of Gun-Perforated Wells. W. J. Jackson. *Oil Wkly*, 23.12.46, **124** (4), 52.—A thorough discussion is presented of the cleaning procedures necessary for wells which have been gun-perforated. Well treatment methods are primarily of the mechanical, hydraulic, chemical, and explosive type. The mechanical cleaners include perforation scrapers, washers, and bailers for the removal of material from the bottom of the oil string. The hydraulic methods depend on pressure differential opposite the zone to be cleaned while the chemical methods involve the breaking down or dissolving of the material deposited in and immediately surrounding the perforations. In the use of explosives, cleaning action results from the pressure caused by the explosion transmitted laterally through the perforations. When customary completion practices are performed, including washing, swabbing, circulation with oil, pressure drilling, and reverse circulation method, with no apparent results in formation response, it is evident that the harmful effect of mud fluid, water and the formation itself in sealing and restricting the free passage of oil through the sand pores, annular space, and the perforations themselves is of principal concern. The different methods are described. A. H. N.

541. Corrosion of Oil-Well Equipment in Air–Gas Drive Operations. H. A. Pray, H. F. Haase, and F. W. Fink. *Producers' Monthly*, Sept. 1946, **10** (11), 11. (*Paper presented at annual meeting, Pennsylvania Grade Crude Oil Association, Pittsburg*, June 1946.)—The data obtained in a study of brines and air–gas mixtures used in injection operations is discussed, and analyses of these are presented in tabular form together with analyses of the various scales and deposits within the tubing. The data suggest that as the brines enter the well they may be very corrosive because of the high chloride content, dissolved oxygen, and carbon dioxide and the acid character of the water : the chemical reactions which take place with iron equipment are discussed. The most corrosive constituents of gases are oxygen, carbon dioxide, and sulphur dioxide.

A number of different methods for reducing the amount of corrosion and scale formation in oil wells were examined in detail. The most important of these methods are : (1) inhibitor additions to the brine ; (2) inhibited rust preventive coatings ; (3) magnesium or zinc addition to the brine ; (4) galvanic (electrolytic) protection ; (5) galvanized steel ; and (6) alloy steels.

The most effective inhibitors for brine addition were found to be zinc or sodium chromate and sodium hexametaphosphate (Calgon), this latter also tends to inhibit scale formation. The simultaneous addition of zinc chromate and Calgon gave still better results. Inhibited rust-preventative coatings were found satisfactory and inexpensive for providing protection to those parts of well equipment which are exposed to a corrosive vapour phase : several proprietary compounds were studied. The addition of metallic magnesium to the brine increases the pH and thus slows down the attack on steel : unfortunately, this increase in pH causes calcium carbonate to be precipitated, but it was found that the simultaneous use of Calgon would keep this precipitate in such a flocculated condition that it would easily pass through the pumping system : compared with other methods, however, the corrosion rate is only slightly reduced. Zinc accomplishes as much as magnesium, but less metal is taken into solution and the precipitate of calcium carbonate is greatly reduced. Cathodic protection by the use of an external current cannot be readily adapted to an oil-well system, but the use of zinc and magnesium as sacrificial anodes was found to give protection in the immersed portions of the system adjacent to each anode. Both zinc and magnesium decreased the attack on steel, but magnesium is consumed much more rapidly than the zinc and also gives rise to a calcareous scale. Zinc was also found to reduce the attack on both brass and steel when all three were coupled together, whereas brass coupled to steel *increased* the attack on steel as much as 55%. This showed the value of insulating the brass barrel and valves of pumping assemblies from the rest of the well system, or, alternatively, providing sacrificial zincs at such places as the barrel to tubing joint. Galvanized steel was found to corrode in brines at only 25–50% of the rate for unprotected steel. Alloy steels containing 5–12% chromium resisted attack, but they are much more expensive : low alloy steels (less than 2% additions) did not outlast carbon steels. R. B. S.

542. Valuation of Gas-Condensate Reservoirs for Cycling. W. H. Justice. *Oil Gas J.*, 4.1.47, **45** (35), 72. (*Paper presented before A.I.M.M.E.* 18.12.46.)—The estimation of condensate recoveries by cycling and by straight production under pressure depletion is presented. A. H. N.

543. Gas-Condensate Reservoir Engineering. Part 1. The Reserve Fluid, its Composition and Phase Behaviour. C. K. Eilerts. *Oil Gas J.*, 1.2.47, **45** (39), 63.—There are ten basic engineering problems to be solved when a gas condensate field is to be developed. This paper deals with the following five problems (the others are to be discussed in subsequent 2 parts) : (1) Size of the fluid reserve ; (2) composition of the fluid and its richness in marketable hydrocarbons ; and (3) the original phase state of the fluid in the reservoir, particularly as it relates to the possibility of liquid in contact with the gas phase in some part of the formation. Depending largely on the size of the reserve and the phase state of the fluid in the reservoir, plans must be made for recovery of the hydrocarbons and answers must be found for questions relating to the following problems ; (4) the progressive changes in the phase state of the reservoir fluid as pressure declines when fluid is withdrawn through producing wells ; and (5) the effect of injected gas on the phases of the reservoir fluid under the practice of pressure maintenance and gas drive. Whilst the discussion, in parts, is a review of existing knowledge, it also includes original work on gas/liquid phase behaviour and on mixing of injected and original gas in the reservoir. A. H. N.

544. Gas Requirements in Gas Drive Recovery. S. T. Yuster and R. J. Day. *Producers' Monthly*, Oct. 1946, **10** (12), 21. (*Paper presented before Eastern District Division of Production, A.P.I., Pittsburg*, June 1946.)—The gas requirements in gas drive recovery are affected by pressure gradient, permeability, oil viscosity, and connate water saturation. Laboratory experiments on cores indicated that there was a linear relationship between the total liquid saturation and the logarithm of the volume of injected gas necessary to reach that saturation. These experiments also showed that : (1) less gas and less time is required to produce a given quantity of oil at high pressure gradients ; (2) gas requirements appear to be independent of permeability, but more work is suggested to verify this point, especially at low permeabilities ; (3) more gas is required at higher oil viscosities ; and (4) gas requirements depend only on the total liquid saturation and not on the relative amounts of connate water and oil, but the higher the connate water saturation, up to certain limits, the more complete is the recovery. Consequently, it seems desirable to increase the water saturation of a sand low in connate water, provided that the water wets the sand.

An equation for predicting field behaviour is derived mathematically, and this indicates that for steady state conditions (*i.e.*, with a constant rate of gas input) the reciprocal of the oil production rate should be a linear function of the cumulative time : this is verified by field data. From this equation is derived another which shows that the cumulative production is proportional to the logarithm of the ratio of the initial and final oil production rates over the period of time involved (provided that steady state conditions persist). Other equations are derived, again for steady state conditions, which show that the gas–oil ratio is a linear function of the time and a logarithmic function of the total liquid saturation : these equations can be used to deduce the required volumes of gas to be injected per barrel of oil. Four references are given. R. B. S.

545. Electrically Operated Jacks. C. E. Stout. *Producers' Monthly*, Oct. 1946, **10** (12), 12.—The type of electric pumping jacks used in the Washington–Taylorstown field of Pennsylvania is briefly described and the advantages of its operation in this field are reviewed. Two references are appended. R. B. S.

546. All British Invention Revolutionizes Deep-Well Pumping. Anon. *Petrol. Times*, 9.11.46, **50**, 1150.—The new "N.F.B." displacement pump is briefly described. This pump is particularly adapted to the operation of stripper wells—the operating costs for this type of well having been reduced as much as 50% in some cases. R. B. S.

547. Mechanically Rotated Scraper Blades Eliminate Paraffin Accumulation in Tubing of any Pumping Well. B. Kingston. *Oil Gas J.*, 14.12.46, **45** (32), 78.—The equipment described is reported to have been tested by over thirty independent operators and found successful in preventing paraffin accumulation. The principle used is to rotate the sucker rods at each stroke and to have scrapers on some of the rods so that wax is not allowed to accumulate. The scraper blades are made of flat $\frac{1}{8}$-in soft mild steel $1\frac{1}{2}$ in in width and 2 ft long, spaced 26 in apart longitudinal to the rod. The sucker rod is placed in a pneumatic jig which is equipped with pressure arms designed to force 3 U-shaped clips around the rod and to within $\frac{1}{32}$-in of the surface of the scraper. These clips are placed one at each end and one in the centre of the scraper. Welds are then made uniting the ends of the clips to the scraper, thus effecting a strong friction grip of the scraper to the rod without impairing in any way the quality or tensile properties of the material in the rod. Rotation of the rod string is accomplished by ratchet levers attached to the lower part of the hanger body engaging teeth on a horizontal toothed table flanged directly under the hanger. The actuating lever employed to engage the teeth on the table on each reciprocation of the pump is kept in motion by means of a flexible cord attached to the arm of the lever, and running to the beam of the unit. Action of the lever is controlled by changing the position of the flexible cord along the beam. The partial rotation of the scrapered rod string on each reciprocation of the pump prevents the accumulation of paraffin. The equipment is illustrated. A. H. N.

548. Power Distribution Systems for Oilfield Pumping Service. Part 1. W. C. Bloomquist and J. N. Poore. *Oil Wkly*, 23.12.46, **124** (4), 46.—The principles of electrical motor usage for oilfield pumping are presented. Of particular interest is a practical detailed discussion of the advantages ensuing on power factor improvement by use of capacitors and the presentation of tables giving the required sizes for different conditions. A. H. N.

549. Power Distribution Systems for Oilfield Pumping Service. Part 2. W. C. Bloomquist and J. N. Poore. *Oil Wkly*, 30.12.46, **124** (5), 54.—Comparative studies on cost basis are made of the use of 440-volt and of 762-volt systems. Practical details on posts and cables are presented. A. H. N.

550. Design and Construction of Water Pumping Plants. G. W. Holbrook. *Producers' Monthly*, Aug. 1946, **10**, 32. (*Paper presented before Eastern District, Division of Production, A.P.I., Pittsburg*, June 1946.)—In the design of any injection plant the prime factors are the quantities of water to be pumped, and the pressure to be attained. Sand thickness, sand permeabilities, gas, oil, and water saturations, and well spacings, all affect the quantities of water required.

The theoretical or water horse-power (*WHP*) can be computed from the formulæ :

$$WHP = \frac{WH}{33,000}$$

$P = 0{\cdot}434H$, where W = weight of water to be pumped in pounds per minute, H = head of water to be attained in feet, and P = pressure in lb/sq in.

Pressure at the sand face are limited to the highest pressure which can be carried without by-passing (usually 0·8–1·4 p.s.i./foot depth to the sand). In computing the pressure at the sand face the head of water in the well, the friction losses in the lines to the well, and the difference in elevation of the well head and plant location must all be taken into account.

Considerations involved in selecting the site, designing the buildings, installing auxiliary equipment and protective devices, and in selecting the types of storage tanks, pumps, prime movers, and piping, to be used, are each discussed. R. B. S.

551. Calculated Effect of Pressure Maintenance on Oil Recovery in Fullerton Field, West Texas. R. L. Hoss. *Oil Gas J.*, 4.1.47, **45** (35), 58. (*Paper presented before A.I.M.M.E.* 18.12.46.)—Summary of calculations is given here for the future performance of the Fullerton field, Andrews County, West Texas, under primary depletion and also for two programmes of pressure maintenance by gas injection. The only driving mechanism assumed to be active in this field is solution gas. The basic differential equations employed are those developed by Muskat for analysing reservoirs possessing this type of drive. A. H. N.

552. Unitization of Oil Pools for Secondary Recovery. W. A. Heath. *Producers' Monthly*, Aug. 1946, **10**, 28. (*Paper presented at annual meeting, Pennsylvania Grade Crude Oil Association, Pittsburg*, June 1946).—The benefits of unitization and the factors influencing such an agreement are discussed. Seven references are appended. R. B. S.

553. Secondary Recovery Research. D. T. Andrus. *Producers' Monthly*, Aug. 1946, **10**, 20. (*Paper presented before Interstate Oil Compact Commission, Michigan*, Aug. 1946.)—The economic advantages to oil producers of organized secondary recovery research are discussed in detail. R. B. S.

554. Secondary Recovery Production Research (A Monthly Review): Brines are Superior Input Water. R. V. Hughes. *Producers' Monthly*, Sept. 1946, **10** (11), 9.—The results of permeability tests and recent clay analyses show that every input water should possess such physical and chemical characteristics as keep the clay content of sands in a permanently flocculated condition. This tends to prevent swelling of these clays with consequent reduction in permeability. Brines possess these properties and corrosion resulting from their use can be reduced by the removal of oxygen. In such favourable circumstances brines are more suitable than fresh water for flooding operations because: (1) input rates are increased for the same pressure; or conversely (2) are maintained at lower pressures; (3) wider well spacing can often be permitted; (4) oil recoveries from tight sands are increased; (5) the brines do not then pollute surface waters; and (6) the principle of conservation of natural resources is upheld. R. B. S.

555. Secondary Recovery Production Research (A Monthly Review): Channeling and By-Passing. R. V. Hughes. *Producers' Monthly*, Oct. 1946, **10** (12), 9.—The very factors which are the chief cause of channeling and by-passing in water-flood operations are those about which little is known; they are: (1) variations in permeability in both the horizontal and vertical planes; (2) composition of the sands as regards degree of cementation and cementing material; (3) elastic properties (which affect the response to shooting operations); (4) systems of joints, fractures, solution channels, and planes of weakness. The effect of these factors on water-flooding operations is discussed.

When oil wells are shot for increasing production the best practice is usually regarded as that which produces the greatest amount of fracturing with the minimum of shattering. The author discusses this fact and concludes that the reverse is preferable in the case of water input wells if channeling is to be kept to a minimum: this is provided that shattering does not occur to such an extent that caving occurs. The deleterious effects of too high input pressures are already well known. It is suggested, as a precautionary measure, that the well-head pressure in pounds on any new input well be limited to approximately half the well depth in feet until after the fill-up period, when pressures may be gradually increased until the desired working pressure is reached, unless signs of channeling are noted. Until more is known about the compressibility, rigidity, and elasticity of the producing formations, operating pressures approaching the critical should be approached slowly and with caution. R. B. S.

556. Repressuring in Cunningham Pool, Kansas. C. Rae. *Producers' Monthly*, Oct. 1946, **10** (12), 18. (*Paper presented before Mid-Continent District Division of Production, A.P.I., Oklahoma*, June 1946.)—The history, geology, formation characteristics, and development of the Cunningham Pool in the Lausing Lime formation, Kansas, are briefly reviewed. Gas injection has been practised in this pool for 10 years; some 84% of the produced gas having been injected inot the formation. Prior to gas injection the pressure had declined from 1100 lb to 424 lb with the production of 1,009,000 brl of oil: the fact that 2,632,200 brl of oil have been produced since gas injection was started, whilst the pressure has only declined from 424 lb to 365 lb, indicates the value of repressuring in a field of this type. The ultimate recovery is estimated as 4,500,000 brl: if gas injection had not been practised the expected recovery would have been about 2,800,000 brl. R. B. S.

557. Proper Control of Oil Reservoirs. D. R. Knowlton. *Oil Gas J.*, 28.12.46, **45** (35), 273.—Elementary principles of reservoir fluid control are discussed and terms of fundamental significance are defined. A. H. N.

558. Channeling in Water Flooding. T. F. Lawry. *Producers' Monthly*, Sept. 1946, **10** (11), 29. (*Paper presented before Mid-Continent District Division of Production A.P.I., Oklahoma*, June 1946.)—By-passing in water flooding can be divided into three distinct classes: (1) movement of water through cracks or fissures containing very little oil (often referred to as channeling); (2) movement of water through layers of relatively high specific permeability; and (3) movement of water through layers of relatively low oil saturation. Remedial operations suitable for overcoming by-passing of types (2) and (3) are not suitable for overcoming channeling: hence it is important to distinguish between them. An easy way of doing this is to introduce a fluorescent dye into the injected water: this will be detected in the producing wells within about 100 hr if channeling is occurring, otherwise the period will be much longer; often the dye will never appear in the oil well when by-passing is occurring, but instead it becomes absorbed in the porous medium.

Channeling may be caused by injection at pressures greater than the critical (above which the overburden appears to be lifted): care should be taken to avoid this condition, since the detrimental effects in such a case are often permanent. Mixture of bentonite mud and some fibrous material were found effective in curing some cases of channeling, but in other cases a cementing job was necessary. When the channels are effectively sealed, it is necessary to clean up the sand face to prepare it for renewed injection of water. R. B. S.

559. Expansion and Free-Gas Saturation. Part 4 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 23.11.46, **45** (29), 71.—A decline in reservoir pressure down to saturation pressure is accompanied by expansion of reservoir liquid and frequently by some encroachment of water. The oil recoverable by expansion of reservoir liquid varies with compressibility, pressure decline, and volume of oil in place. The rate of water encroachment at a given time is proportional to pressure decline. At pressure less than saturation values, some oil is produced by free gas. The possible gain in recoverable oil by water at declined pressures is nominal even if a free-gas saturation as high as 10% of porosity is not displaced by water. The corresponding pressure decline is 15–25% of saturation pressure. A. H. N.

560. Producing Rate by Expansion. Part 5 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 30.11.46, **45** (30), 64.—The cumulative oil recovery by expansion may range from 5 to 17 million brl/100 million brl of oil in place. This recovery is available during the time reservoir pressure declines 15–25% of the saturation pressure for oil. The rate of production by expansion varies with the rate of pressure decline and may be of the order of several thousand brl/day. When oil is produced by expansion and water, the two producing methods interfere with each other. The oil produced by water cannot be produced by expansion and vice versa. This interference usually is not resolved in practice. Nevertheless, a breakdown for production by water and production by expansion is included here in order to illustrate the influence of declining pressures on producing rates and on ultimate recovery. A. H. N.

561. Interference Between Wells. Part 6 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 7.12.46, **45** (31), 92.—Oil production is by virtue of the drawdown between reservoir and bottom-hole operating pressures. The available drawdown for one well is 100%. But the available drawdown for two additional wells may be less than 90% even if they are located as much as 1000 ft on two sides of, and on strike with, the first well. This is interference between wells. Let n wells be located on a parallel to a water contact. Denote the available drawdown for the two by 100%. The available drawdown for another row of wells located updip from, and parallel to, the first row is only 37%, provided the wells on the second row have the same bottom-hole operating pressure as the wells on the first row and oil production is by edge water. The interference between two rows of wells is greater than between wells on one row. A. H. N.

562. Equivalent Well Systems. Part 7 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 14.12.46, **45** (32), 108.—A statistical approach to estimating the producing capacity of any number of wells is desirable from the viewpoint of the number of wells alone. In addition, statistical procedures are indicated by the many factors influencing well capacity. The approach suggested in this paper is based on equivalent 1-, 2-, and 3-row well systems. The application of average completion in pay, average permeability, and average drawdown to the wells on a first row is an approximation to actual values. Similarly, the application of interference factors is an approximation, depending on judgment whether a given group of wells constitutes 1-, 2-, or 3-row equivalent well system. A. H. N.

563. Well Capacity. Part 8 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 21.12.46, **45** (33), 77.—The producing capacity of wells varies with the number of wells, interference between wells, completion in pay, permeability, and drawdown. The required producing rate from a given reservoir varies primarily with the per-interval acre-ft of pay. The required rate of production from one sector in a given pay interval may be much faster than that from some other sector in the same interval. The factors controlling the required number of wells are considered from the sectional and areal viewpoints. Well capacity is also considered relative to variable reservoir and bottom-hole pressure which is less than the saturation pressure for oil may be accompanied by a rapid decline in well capacity. The drilling of additional wells does not increase well capacity for reservoirs already saturated with wells. Pressure maintenance by water injection is essential to maintaining well capacity. A. H. N.

564. Displacement and Invasion for Injection Wells. Part 9 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 4.1.47, **45** (35), 53.—Production of oil by injected water is similar to oil production by encroaching water. Dry-oil reserve is proportional to the product of displacement and breakthrough invasion factors. These factors plus interference between wells are considered here as a background for the next article in which injection-well requirements and water requirements will be discussed.
A. H. N.

565. A Radial Reservoir. Part 12 of Oil Production by Water. P. J. Jones. *Oil Gas J.*, 1.2.47, **45** (39), 57.—The characteristics of a radial reservoir and the capacity to produce undersaturated oil at MER by edge water are indicated. Location and spacing of producing and injection wells for the reservoir will be considered in the next article. A. H. N.

Oilfield Development.

566. World Production Approaching 8,000,000 Barrels Daily. W. W. Burns. *Oil Gas J.*, 27.7.46, **45** (12), 138.—Current world output is estimated at 7,805,800 brl/day, including an output of only 44,000 brl/day attributed to the Far East which in pre-war days gave 225,000 brl/day. At present Roumania yields 85,000 brl/day, about 50,000 brl/day less than before the war.

Outside U.S.A. the oil output is estimated to have averaged 2,766,700 brl/day in the first 4 months of 1946. The 1938 output averaged 2,119,000 brl/day, and in 1941 2,219,000 brl/day. Venezuela, Iran, and Saudi Arabia are responsible for most of the increase since 1941. Currently Venezuela gives 1,052,700 brl/day. 400,000 brl/day more than in 1941. Iran gives about 400,000 brl/day, nearly twice its pre-war figure. Saudi Arabia now yields 170,000 brl/day.

A table gives the estimated current daily output, and average daily output for the first 4 months of 1946, by countries outside U.S.A. G. D. H.

567. World Production : Gains Outside U.S. More than Offset Losses. W. W. Burns. *Oil Gas J.*, 25.1.47, **45** (38), 157.—An estimate of North (except U.S.A.) and South American, European, Egyptian, and Asiatic oil production possibilities is given, and the international situation reviewed. A table gives world crude oil production outside the U.S. and shows, for example, that oil production for Asia has been almost doubled. Russian production has been estimated at 500,000 brl daily late in 1946, as against 572,000 brl in 1938. It is calculated that the world total daily output in 1947 (excluding U.S.A.) will exceed the 1946 figure of 2,930,000 brl. G. A. C.

568. 14,522 New Wells Projected for Last Half of 1946. H. David. *Oil Gas J.*, 27.7.46, **45** (12), 140.—2006 wildcats were completed in U.S.A. in the first half of 1946, and 2561 are planned for the second half. A total of 13,742 wells were completed in the first half of 1946, and 14,522 are due to be drilled in the second half. 46,566,000 ft was drilled in the first half and 52,454,000 ft is expected to be drilled in the second half.

A table gives by States the numbers of wells of various types drilled in the first half of 1946, and expected to be drilled in the second half. G. D. H.

569. Completions up 7·2% First Half. H. David. *Oil Gas J.*, 27.7.46, **45** (12), 142.—13,746 wells were completed in U.S.A. in the first half of 1946. 2006 wildcats were completed in the same period. Texas had 3955 completions, Oklahoma 1240, and Illinois 1005. In most of the major areas there was a downward trend in average depths.

Tables summarize by States and districts the U.S. completions in the first half of 1945, and analyse the wildcat and development completion results. There are brief notes on the outstanding points in the principal areas. G. D. H.

570. 104 Major Fields Yield 54·34% of Nation's Oil. C. J. Deegan. *Oil Gas J.*, 27.7.46, **45** (12), 146.—Formerly a major field was defined as one which attained an output of 100,000 brl/day. Due to improved production technique and policies comparison of old and new fields is not practicable on this basis, and accordingly a major field is defined as one with an ultimate of 100,000,000 brl.

It is estimated that U.S.A. has 15,000 oilfields, but only 104 can be termed major. These account for 54·34% of the total oil produced to date, and had 58·06% of the proven reserves at the end of 1945. Many consider that practically all the profit in the oil industry comes from the major fields.

The major fields of Texas and California have given 11,931,000,000 brl of oil, out of a total of 17,571,000 brl for all the major fields of U.S.A. The proven reserves of the major fields in these 2 States is 10,905,000,000 brl out of a U.S. major field total of 12,654,000,000 brl. The major fields of Texas accounted for 40·5% of the total U.S. proven reserves at the beginning of 1946; on July 1, 1946, they had produced only 32·5% of the total output of all U.S. major fields, but they possessed 65·8% of the proven reserves of such fields.

The U.S. major fields are listed, with the estimated ultimate recovery, remaining reserve and cumulative production at the beginning of July 1946, and other production data. G. D. H.

571. Production by Bolivia Shows Decline in January. Anon. *Oil Wkly*, 1.7.46, **122** (5), 51 (*International Section*).—In January 1946, Bolivia produced 30,215 brl of oil (Camiri, 11,897 brl; Bermejo, 10,168 brl; Sanandita, 8150 brl). G. D. H.

572. Decline in Ecuador Oil First-Quarter Production. Anon. *Oil Wkly*, 1.7.46, **122** (5), 51 (*International Section*).—During the first quarter of 1946 Ecuador produced 580,460 brl, 11% less than in the same period of 1945. G. D. H.

573. East Central Peru Test Drilling Around 800 ft. Anon. *Oil Gas J.*, 31.8.46, **45** (17), 59.—A new well is being drilled in the Agua Caliente field, some 1000 ft south-east of No. 5 producer. Before the war 6 producers had been drilled. 45° A.P.I. oil is obtained from the Cretaceous at 1200–1350 ft. G. D. H.

574. Austria Claims Third Rank in European Oil Production. Anon. *Oil Wkly*, 1.7.46, **122** (5), 55 (*International Section*).—It is claimed that Austria is third to Russia and Roumania in oil production in Europe.

Natural gas has been developed by several wells drilled at Aderklaa on the outskirts of Vienna. It is probable that there is gas underneath the centre of Vienna. G. D. H.

575. First Quarter Iran Output Totals 33,488,000 Brl. Anon. *Oil Gas J.*, 3.8.46, **45** (13), 60.—Iran's 1945 production was 117,876,430 brl, and the 1944 production 92,919,701 brl. For the first quarter of 1946 the output was 33,488,000 brl.

In 1945 Anglo-Iranian's U.K. production was 500,794 brl while the 1944 figure was 661,990 brl. G. D. H.

576. Iranian Production Reaches New High. Anon. *Oil Gas J.*, 24.8.46, **45** (16), 65.—During April and May 1946, the Iranian oil output was 12,201,000 brl and 12,285,000 brl respectively. G. D. H.

TRANSPORT AND STORAGE.

577. Widespread Pipe-Line Expansion Under Way. P. Reed. *Oil Gas J.*, 25.1.47, **45** (38), 165.—Total pipe-line construction in the U.S.A. for 1946 totalled 7400 miles; and projects for 1947 and later total 9672 miles.

Pipe-lines construction in other countries, for example, 225 miles in Bolivia, is also under way.

Tables give mileage, diameter, status, and location of domestic crude-oil projects, large domestic products—line and principle domestic natural gas projects for 1946 and 1947. G. A. C.

578. Butt-welded Pipe-line for Natural Gas. Anon. *Engineering*, 1947, **163**, 97.—A description, with illustrations, is given of the building of a 24-in diameter natural gas pipe-line from Corpus Christi, Texas, to Cornwell, W. Va., a distance of 1265 miles. Two types of piping, seamless and electric-welded, were used, with wall thicknesses of $\frac{9}{32}$ in and $\frac{1}{4}$ in respectively. In the main, arc-welding was employed, but for 320 miles a butt-welding or " pressure welding " process was employed. Joints were made by grinding the ends of the 2 pipes which were to be connected, butting them together under pressure and heating the joint with oxy-acetylene flames. During heating the pressure is increased, resulting in a complete merging of the granular structure. The finished welds are homogeneous and on testing for tensile strength have proved to be perfectly satisfactory. G. P. K.

REFINERY OPERATIONS.

Refineries and Auxiliary Refinery Plant.

579. Disposal of Refinery Wastes. L. C. Burroughs. *Refiner*, 1946, **25**, 299.—In a general discussion on this problem it is indicated that two conditions dictate close study of the subject (1) the pressing necessity of more economical operation, and (2) the fact that political bodies continue to demand more from industry in the protection of both surface and underground waters. Particular aspects discussed are: removal of substances insoluble in water, handling of emulsions, the use of filters following the main refinery separator, objectionable solutes, their nature and recommended methods of disposal, methods of disposing and reducing the volumes of spent soda, disposal of acid sludges, disposal of spent $AlCl_3$ catalyst, and disaposal of waste gases.
G. R. N.

580. Desalting of Petroleum. C. G. Kirkbride. *Refiner*, 1946, **25**, 313.—A record of a pilot plant investigation to determine the feasibility of using beds of relatively fine glass fibres for desalting petroleum. The process consists of (1) washing the crude oil with water at a minimum temp. of 250° F, (2) passing the oil and water through beds of glass fibres averaging 0·00028 in. in diameter to coalesce the emulsified water, and (3) separating the desalted oil from the wash water. The wash water may be recycled in most cases to conserve heat and fresh water. Only sufficient fresh water is needed, if recycling is done to maintain the salt content of the wash water at a maximum of 3% by wt. Life of the Fiberglas packing is in excess of 2 months. It has been found that salt content can be reduced to less than 10 lb/1000 brl oil by proper control of temp, superficial velocity, and glass surface in the beds. In general, the temperature should be at least 275° F for best results. A superficial velocity of 1·0 ft per minute seems feasible for commercial units, provided the temperature remains sufficiently high to give a pressure drop of not over 5 lb/sq. in. through a single bed. A total of five individually supported beds each of 2 in depth at 6·5 lb/cu. ft. density appears to be a reasonable basis for commercial designs to provide desalting to not over 10 lb/1000 brl. G. R. N.

581. Selection and Application of Break Inducing Reagents in Doctor Treating. C. M. Blair, Jr. *Refiner*, 1946, **25**, 379.—In some experiments on the breaking of gasoline-doctor solution mixes, sodium stearate, sodium oleate, sodium abietate, and certain

Tretolite organocolloids were compared as surface-active or break-inducing agents. As a result of these tests it is observed that when a properly selected surface-active chemical is employed operational improvements include (1) quicker break; (2) lower sulphur requirement; (3) more complete wetting and subsidence of lead compounds; (4) less emulsification and loss of gasoline; and (5) less foaming during regeneration of doctor solution. The use of break-inducing agents does not, however, lessen the desirability of good control and proper adjustment of plant variables, such as degree of agitation and sedimentation time. G. R. N.

582. Sulphur in Light Petroleum Products. E. J. Scafe. *Refiner*, 1946, **25**, 413.—War-time production was responsible for accelerating the processing of high sulphur crudes and preference by major oil companies has been directed towards conversion of entire refineries for this purpose. Slaughter–Duggan (West Texas) crude has been studied from this standpoint as a representative high sulphur crude. The fractions contained from 0·19% by wt sulphur for light straight run to 4·15% by wt for the residuum. The first method used was based on the elimination of sulphur as H_2S by use of cold catalyst. From results with the gas–oil fraction of 1·6% sulphur the following was observed: (1) An alumino-silicate cracking catalyst without any oxide promotor is one of the most effective desulphurization catalysts. Under optimum conditions a yield of over 90% by vol product was obtained. (2) Zinc oxide type catalyst appears to give the lowest sulphur-content product of the catalysts tested. (3) The most effective carrier for the metallic oxides is one with cracking activity. The second method tried was solvent extraction using anhydrous liquid HF as the solvent. Data showed a 70% sulphur reduction with a yield of 85% by vol product of sulphur content 0·5% by wt. HF desulphurization improves the yield, O.N., and sulphur reduction of motor gasoline in the catalytic cracking of gas-oil, but there is a net volumetric loss from the two operations. The use of H.F. is restricted to virgin stocks. G. R. N.

583. Corrosion and Pitting in Boiler Systems. Anon. *Oil Gas J.*, 18.1.47, **45** (37), 87.—No. 269 of the *Engineering Fundamentals* series gives an account of the causes of pitting and corrosion of boiler metals. The dissolved gases, oxygen, carbon dioxide, ammonia, and hydrogen sulphide are the most common causes, electrolysis the least, and acidity of boiler water a third agent. The use of proper-type feed-water heaters eliminates all the gases except ammonia. Maintenance of feed water at a pH above 10·5 eliminates corrosion due to acidity. Pitting and corrosion due to electrolysis is similar in appearance to that caused by dissolved oxygen. G. A. C.

Distillation.

584. Pipe-Still Outlet Temperature. W. L. Nelson. *Oil Gas J.*, 25.1.47, **45** (38), 285.—No. 128 in the *Refiner's Notebook* series gives 4 tables showing the approximate temperature drop from pipe-still outlet to vaporizer, for 20%, 40%, 60%, and 80% vaporization in tower with seven conditions enumerated. G. A. C.

Solvent Extraction and Dewaxing.

585. Kellogg Announces Solexol. Anon. *Chem. Eng. News*, 1946, **24**, 3188.—A new Kellogg process is described for the separation and recovery of the ingredients of non-mineral oils by continuous countercurrent propane extraction at relatively low temperatures and pressures. The conditions (not specified) are so mild that no polymerization of the highly unsaturated glycerides or destruction of the vitamins occurs. The process is applicable to a whole variety of oils, among which may be mentioned soyabean, cottonseed, corn, linseed, tall, fish liver, and fish body oils. An important application is the recovery of quick-drying oils from sardine, herring, and menhaden oils as linseed oil substitutes. A 25% fraction with an iodine value approaching that of tung oil can be produced from sardine oil. Another product is a sterol fraction containing tocopherols and stigmasterol. The application of the process to animal fats is being studied, and it is expected that it will be possible to remove the colour bodies in this material completely and inexpensively. The ability to recover free

fatty acids from the mixed glycerides is also a feature. By way of illustration, the results from pilot plant extractions of sardine body oil and soyabean oil are quoted.
L. B.

Cracking.

586. Isomerization Unit Converted to a Polymer Unit. W. R. Newman. *Refiner*, 1946, **25**, 475.—A war-time butane isomerization unit at Frontier Refining Co. was converted to a U.O.P. non-selective catalytic polymerization unit at low cost, it being necessary to install only one piece of new equipment, viz. a new filter pot. The net result of the conversion was to increase total gasoline production by 5–7% and effect substantial savings in the amount of tetraethyl lead employed. G. R. N.

587. Naphtha Polyforming. W. C. Offutt, P. Ostergaard, M. C. Fogle, and H. Beuther. *Refiner*, 1946, **25**, 554.—The Polyform process offers two important advantages for the upgrading of naphthas and low octane straight-run gasolines : (1) attractive yields of motor gasoline having A.S.T.M. O.N. of 75–80 and research O.N. of 84–93, without tetraethyl lead addition, and (2) flexibility of operation which permits either production of a maximum yield of Polyform gasoline or maximum production of a C_4 fraction rich in olefins, in addition to a good yield of debutanized gasoline. The research sensitivity, lead response, road performance, and blending properties of Polyform gasoline are evidence of its high quality. Recent data is given on the effects of the operating variables and properties of the naphtha charge upon yields and product quality, as well as a brief discussion of some of the reactions which occur in the Polyform furnace. A nomograph is presented for predicting the relationship yield and ASTM O.N. of Polyform distillates from the characterization factor and O.N. of the naphtha charge.
G. R. N.

588. Naphtha Polyforming with Outside Gas. W. C. Offutt, P. Ostergaard, M. C. Fogle, and H. Beuther. *Refiner*, 1946, **25**, 563.—The Polyform process offers the means of simultaneously converting low octane naphthas and surplus refinery gas, both paraffins and olefins, into high octane gasoline. Detailed studies are presented of naphtha Polyform operations charging extraneous refinery gases. The effects of varying amounts and compositions of outside-gas charge are discussed with respect to yields and quality of products obtained with a wide range of naphtha stocks. The flexibility and simplicity of the process are emphasized especially for manipulating seasonal refinery butane balances. A maximum yield of highly unsaturated C_4 fraction can be recovered from naphtha polyforming with or without outside gas or excess refinery. C_4 fraction can be charged to the Polyform unit for maximum production of high quality gasoline. Extent of the conversion of the outside gas streams can be varied widely for optimum utilization of the available charging stock. G. R. N.

589. Operating Variables in the Polyform Process. J. H. Hirsch, P. Ostergaard, and W. C. Offutt. *Refiner*, 1946, **25**, 570.—A procedure is given with suitable examples for calculating yields, O.N., and required operating conditions in the Polyform process.
G. R. N.

590. Uncatalyzed Reaction of Natural Gas and Steam. A. S. Gordon. *Industr. Engng Chem.*, 1946, **38**, 718.—The uncatalyzed reaction of natural gas with steam has been studied between 1225° and 1516° C with steam-natural gas ratios of 1·5 and 5, and time of contact between 0·21 and 4·6 sec. Even at high temperatures, long contact times, and steam-natural gas ratio of 5 there is some carbonization of the natural gas. The extent of carbonization is shown to be a function of the ratio of steam to natural gas, and to vary erratically with temperature and time of contact. As the temperature is increased, the percentages of natural gas undecomposed in one pass through the furnace become less dependent on contact time (in the range of contact times studied), until at about 1500° C there is little or no effect. At any temperature the percentage of undecomposed gas shows little if any dependence on the ratio of steam to natural gas. A. W.

Alkylation.

591. Mechanism of Catalyzed Alkylation of *iso*Butane with Olefins. M. H. Gorin, C. S. Kuhn, and C. B. Miles. *Industr. Engng Chem.*, 1946, **38**, 795.—Supporting evidence is presented for a simple mechanism which explains the products of the primary alkylation reaction of *iso*butane with olefins, catalyzed with acids and aluminium halides. This mechanism excludes certain products which are not experimentally detected in important quantities. Primary alkylation products are defined as those alkanes which are formed preferentially and in high yields at low temperatures and short residence times. Formation of these products and the secondary isomeric products is ascribed to the simple addition of methyl and *iso*propyl fragments (from *iso*butane) to the various permissible forms of an olefin-catalyst complex.

A. W.

Isomerization.

592. On the Participation of Methane in the Synthesis and Transformation of Aliphatic Hydrocarbons. M. Prettre, C. Eichner, and M. Perrin. *Compt. Rend. Acad. Sci.*, 1947, **224**, 278.—It was shown in previous work by Prettre (*Cahiers de Physique*, 1941, **1**, 73) that the catalysts used in certain processes of the petroleum industry gave rise to isomerization resulting in the formation of hydrocarbons with numerous methyl side-chains. It was considered that the yield of such products would be increased by introducing a source of methyl radicles into the reaction system, and the conditions under which methane could act in this way, without the use of high pressures, were derived with the aid of free energy calculations. The results indicated that methane should participate in the Fischer process carried out at approximately 200° C and normal pressure to an extent comparable with the carbon monoxide of the ordinary synthesis gas mixture ($CO + 2H_2$). This conclusion was tested experimentally using a catalyst of reduced nickel on kieselguhr, a space velocity of 100, temperatures of 190° and 175° C, reaction mixtures with the composition $CO + 2H_2 + nCH_4$ ($n = 1, 3, 10$), and operating times up to 144 hr. The extent to which methane was consumed in the reaction was determined from the volumes and ratio of the methane contents of the product and reactant gases. This ratio was determined for each 24-hr period in five experiments, and the results obtained indicated that for all the reaction mixtures containing at least 50% methane, this gas was utilized either from the start of the synthesis or after some delay. The consumption of methane was slight at 190°, but at 175° 1 volume of methane reacted for 2 volumes of carbon monoxide, despite the excess of hydrogen in the reactants. G. H. B.

593. Isomerization of *n*-Butane Catalyzed by Aluminium Bromide. A. G. Oblad and M. H. Gorin. *Industr Engng Chem.*, 1946, **38**, 822.—Previous studies of the isomerization of *n*-butane with aluminium bromide as catalyst showed that oxygen was an outstanding promoter for the isomerization reaction. These studies have continued and have been mainly concerned with the effect of oxygen. The rate of isomerization is first order with respect to *n*-butane concentration and, at a given temperature, depends on aluminium bromide concentration, oxygen concentration, and amount of surface. The rate of isomerization decreases with time because of oxygen consumption. The factors which influence oxygen and catalyst consumption were determined, and the promotional effect of oxygen is compared to that of other substances. The mechanism of the promotion of aluminium bromide as an isomerization catalyst is discussed. It is suggested that surface is necessary to assure a polar medium in which the reactions involved can take place. A. W.

Chemical and Physical Refining.

594. Sulphuric Acid Refining in the Production of Aviation and Motor Fuel. F. Sager. *Refiner*, 1946, **25**, 275.—Sulphuric acid has two functions in connection with the catalytic cracking of petroleum : the drastic removal of olefins for the preparation of aviation base stock and the light finishing treatment of either aviation base stock or motor gasoline. Two types of treatment are of interest (1) acid washing, where there is a possibility of using spent alkylation acid, and (2) polytreating with U.O.P. catalyst

and sulphuric acid refining. Advantages of the acid treatment are said to be simultaneous desulphurization with high sulphur stocks and simplification of equipment. With motor gasoline acid treatment aims at desulphurization. A comparison of this method with catalytic refining for sulphur removal shows that the latter method is not often used for cracked stocks because the thiophen type compounds seem to be unaffected. Hydrogenation is recommended as an alternative to acid treatment for high sulphur stocks. Control of contact time and treating temperature together with centrifugal separation make it possible to limit the action of sulphuric acid to desulphurization. Data on a lignite gasoline are given to support this view. The use of sulphuric acid in refining benzol and light shale oil fractions is also discussed.
G. R. N.

595. Calculation of Number of Theoretical Plates for Rectifying Column. A. E. Stoppel. *Industr. Engng Chem.*, 1946, **38**, 1271.—By extending the equilibrium curve and operating line of the typical McCabe–Thiele distillation diagram beyond their usual limits, the operating line will be found to cut the equilibrium curve at two points, once on the chart proper, and again somewhere outside the chart. The number of theoretical plates required to operate the column may be expressed as a simple power function of these two points of intersection. A. W.

596. Heat Transfer Coefficients for Condensing Hydrocarbon Vapours. D. A. Donohue. *Industr. Engng Chem.*, 1947, **39**, 62.—A simplified form of the Nusselt equation $h_m = C(L/w)^{1/3}$ is presented for calculating heat transfer coefficients for hydrocarbon vapours condensing on horizontal tubes. This simplification results from the observation that the term $0{\cdot}955(k_f^3 \rho_f^2 g/\mu_f)^{1/3}$ in the Nusselt equation is approximately constant over the usual condensing temperature range for the hydrocarbons considered. Consequently, the solution requires only that the condensate loading, w/L, be known. Application of the equation to commercial design is illustrated. A. W.

597. Azeotropic Purification of Styrene. L. Berg, J. M. Harrison, and C. W. Montgomery. *Industr. Engng Chem.*, 1946, **38**, 1149.—The azeotropic separation of styrene from ethylbenzene can be accomplished using as entrainers 1-nitropropane, the lower aliphatic monobasic acids, a number of alcohols of more than two carbon atoms, methyl Cellosolve, or water. Methods of recovery of entrainers include phase separation, solvent extraction, and pressure rectification. A comparison between the amount of the styrene recovered and the column capacity and heat requirements indicates that these factors are renitent. The low-boiling entrainers, such as water or acetic acid, had the effect of increasing the column capacity and heat requirements, whereas those boiling higher, such as 1-butanol or methyl Cellosolve, gave a poorer yield of styrene. The optimum entrainers appeared to be intermediate boiling compounds, such as *iso*butanol or 1-nitropropane. Azeotropic methods enhance the separation of styrene from ethylbenzene with respect to the quantity of styrene recovered in a given column, or with respect to the saving of column capacity and heat requirements for a given purity. By a combination of ordinary rectification and azeotropic distillation, probably any hydrocarbon impurity may be removed from styrene. A. W.

598. Octane Rating Improvement of Olefinic Gasolines by Isomerization. L. Berg, G. L. Sumner, and C. W. Montgomery. *Industr. Engng Chem.*, 1946, **38**, 734.—The olefines in an olefinic gasoline can be isomerized with a minimum of such side reactions as cracking, hydroforming, treating, aromatization, and cyclization. Optimum results are obtained at 375–425° C reaction temperature and 0·3–1·3 volume per volume catalyst per hour space velocity. The process is characterized by liquid yields in excess of 95%, usually 97–99%. The most suitable catalyst is alumina, maintained at the proper degree of activation by impregnation with anhydrous hydrogen chloride. The life of this catalyst appears to be long if the burn-off is carefully controlled so that the catalyst is thoroughly cleaned but never sintered. O.N. improvement averages approximately four units when a charge stock such as debutanized stabilized distillate is subjected to isomerization. Thermally cracked distillates are the best charge stocks because of their high olefinic content and relatively low O.N. A. W.

Special Processes.

599. Production of Ammonia from Natural Gas. G. S. Mitchell. *Refiner*, 1946, **25**, 245.—At the plant of Lion Chemical Co., El Dorado, Ark., natural gas is reformed by subjection to the methane-steam reaction. Raw hydrogen so produced is mixed with hydrogen obtained by the CO–steam reaction and purified by scrubbing with copper liquor and caustic soda. Air is introduced with the natural gas to the reforming stage to provide the requisite nitrogen for the manufacture of ammonia, which is carried out in a catalytic converter at 500° C and 5000 lb pressure. After separation from the unreacted gases and purification, the ammonia in part is oxidized by burning in admixture with air in the presence of a platinum alloy gauze catalyst to nitrogen oxides which are absorbed in water to give nitric acid. Ammonium nitrate is also manufactured. Comprehensive details are given with diagrams and photographs of the various stages of manufacture. G. R. N.

600. Pilot Plant Production of 2 : 3-Dimethylbutane. C. Holloway and W. S. Bonnell. *Indust. Engng Chem.*, 1946, **38**, 1231.—The pilot plant development for the production of 2 : 3-dimethylbutane is outlined. The alkylation of *iso*butane with ethylene by the catalyst, aluminium chloride is accomplished with the minimum of side reactions by precise regulation of the degree of catalyst-hydrocarbon contacting in a jet mixer.

The effects of hydrogen chloride concentration, catalyst activity, space velocity, mixing power, reaction temperature, *iso*butane/ethene ratio, and diluents in the feed, on ethene conversion, yields, yield efficiency, and catalyst life are discussed.

Data showing the value of the alkylate as a rich mixture blending agent are also presented. A. W.

601. Ethyl Benzene. A. W. Francis and E. Reid. *Industr. Engng Chem.*, 1946, **38**, 1194.—The ethylation of benzene with ethylene by the Friedel–Crafts reaction has been controlled so as to give yields of monoethylbenzene about 15% higher than those reported in most other investigations at corresponding mole ratios of reagents. The conditions are 100° C and ethylene pressures of 100–300 p.s.i. applied above the catalyst. These conditions also increase the reaction rate nearly a hundred-fold over some industrial processes, so that they are better adapted for a continuous operation. Yields of ethylbenzene reported in 60 investigations are correlated, and relations to mole ratios of reagents and to reaction conditions are shown. They are compared with theoretical curves for multiple-stage reactions with a common reagent. Evidence is presented that, contrary to a common opinion, the ethylation of benzene takes place at the same rate as that of ethylbenzene and other partly ethylated benzenes. Some observations are best explained by supposing that under suitable conditions the ethylation reactions are practically instantaneous. Conditions are given for making pure ethylbenzene from ethylene mixed with paraffin gases, or from a low concentration of benzene in a mixture with non-aromatic hydrocarbons. A. W.

602. The Fischer–Tropsch Process : Present and Future. C. C. Hall. *Engineering*, 1947, **163**, 54.—This article continues with a description of the preparation of the synthesis catalyst which was used in all the German plants : Co 100, ThO_2 5, MgO 8, Kieselguhr 200. Two types of plant were in general use for converting the synthesis gas, one operating at atmospheric pressure and the other at 10 atms pressure and both were designed with sufficient cooling to keep the reaction temperature between 180° and 200° C. The process was divided into two or three stages, the heavier oil products being separated in between stages and recovered by either direct cooling with water sprays or by indirect cooling in tubular condensers; the low-boiling fractions were adsorbed in active carbon. Operation under pressure gave an increase in the proportion of higher hydrocarbons to lower hydrocarbons and in the proportion of paraffins to olefines in the primary products. The rate of passage of the synthesis gas varied between 50 to 70 volumes at N.T.P. per volume of catalyst space per hr, and the annual yield of primary products for four of the more efficient plants was 2¼ tons per cu ft of reaction space. Tables are given of performance data, average composition of reaction products, thermal balance for the process and working costs. Usually 23–30% of total heat input was recovered as primary products but was as high as 55% for the most efficient plant. A description of the fractions and their varied use is given; it is worth noting that a small amount of the soft wax product was esterified with glycerine and sold as edible fat. 72% of the total products were used as fuels and 28% as chemical and special products. G. P. K.

603. Manufacture of Hydrogen. R. M. Reed. *Refiner*, 1946, **25**, 367.—Descriptions are given of hydrogen manufacturing processes that are in use in U.S.A. at the present time. These include (1) the electrolysis of water, (2) the steam–iron process, (3) the steam–water gas process, (4) the steam–hydrocarbon process, (5) the steam–methanol process, and (6) the thermal decomposition of hydrocarbons. The present production of hydrogen in the U.S. amount to about 6 billion cu ft per month of which about 50% is produced and utilized in the manufacture of synthetic ammonia. Flow diagrams and plant photographs are included. G. R. N.

604. Styrene Production by Catalytic Dehydrogenation. J. M. Mavity, E. E. Zetterholm, and G. L. Hervert. *Industr. Engng Chem.*, 1946, **38**, 829.—Laboratory data are presented on the catalytic dehydrogenation of ethylbenzene over a chromia–alumina catalyst in the presence of benzene. Reduction of the partial pressure of ethylbenzene by the diluent has the same favourable effects as sub-atmospheric pressures; in addition, the benzene serves as a heat carrier for the endothermic dehydrogenation reaction. Benzene is relatively stable under the conditions used and has no deleterious effect on the catalyst. Weight ratios of benzene to ethylbenzene varying from about 10 to 0 were investigated. Dilution decreased conversion at high ethylbenzene space velocities and increased it at low space velocities. At a given conversion, dilution improved styrene ultimate yield and reduced carbon formation. Reduction of pressure below atmospheric, in addition to the use of benzene diluent, further improved the selectivity of the dehydrogenation reaction. Under preferred conditions (benzene to ethylbenzene weight ratio of 5, atmospheric pressure, 3·8 ethylbenzene space velocity, and 581° C at the catalyst bed inlet) the average conversion in a series of simulated recycle runs was 34·8%; styrene ultimate yield, 89·7 weight-%. A. W.

605. Superfractionation Studies. C. C. Ward, R. M. Gooding, and B. H. Eccleston. *Industr. Engng Chem.*, 1947, **39**, 105.—One hundred gal of naphtha representing 12% of Oklahoma City crude oil were super-fractionated in a pilot plant unit having the equivalent of 80 to 90 theoretical plates. One hundred and fifty fractions, each representing 0·5% of the naphtha, were collected between 73° and 258° F. The hydrocarbon composition of each of these fractions was determined by use of specific dispersions and refractivity intercepts, and the F-3 octane number of each fraction with 4·0 ml of tetraethyl lead was obtained. Graphs indicate the relations of composition to distillation temperatures, densities, and octane numbers. A. W.

PRODUCTS.

Chemistry and Physics.

606. The Kinetics of the Reaction of the Steam–Carbon System. J. Godsby, C. N. Henshelwood, and J. K. W. Sykes. *Proc. roy Soc.* (*Series A*), 22.10.46, **187**, 129.—The kinetics of the various reactions which may occur in the steam–carbon system are discussed. The steam–carbon reaction, the primary product of which is carbon monoxide, is of fractional order with respect to steam and strongly retarded by hydrogen. The carbon dioxide reaction is strongly retarded by carbon monoxide and is of fractional order with respect to carbon dioxide. The rates of both reactions can be represented by

$$\text{rate} = \frac{k_1p_1}{1 + k_2p_2 + k_3p_1}$$

p_1 and p_2 are respectively, the pressures of steam and hydrogen for the steam reaction, and of carbon dioxide and carbon monoxide for the carbon dioxide reaction.

The water–gas reaction $CO + H_2O = CO_2 + H_2$ takes place predominantly on the charcoal surface. The forward reaction is of approximately the first order with respect to carbon monoxide and of fractional order with respect to steam; it is retarded by hydrogen and to a lesser extent by carbon dioxide. The reverse reaction is of fractional order with respect to both carbon dioxide and hydrogen, retarded by steam and unaffected by carbon monoxide. Both components combine to give the thermodynamically correct form of equilibrium constant. H. C. T.

607. Sodium Reduction of Fatty Acid Esters. V. L. Hansley. *Industr. Engng Chem.*, 1947, **39**, 55.—An improved general method has been developed for reducing esters by means of metallic sodium. Practically quantitative yields of alcohols, based on both sodium and ester, are obtained, especially from fatty acid esters of higher molecular weight. In the classical sodium reduction procedure an excess of sodium is ordinarily added to a solution of the ester in ethyl alcohol, which functions both as solvent and as reducing alcohol. The improved method described in this paper uses theoretical amounts of both sodium and reducing alcohol, and the reaction is carried out in an inert solvent, such as xylene or toluene. The method is especially applicable to the preparation of unsaturated alcohols not easily made by catalytic hydrogenation. It compares favourably with the catalytic hydrogenation of saturated, higher fatty acid esters because of the simplicity of operation and equipment. The process can be carried out at ordinary pressure; the laboratory technique is fully described and an extensive bibliography provided. A. W.

608. Viscosities of Pure Hydrocarbons. J. M. Geist and M. R. Cannon. *Industr. Engng Chem., Anal.*, 1946, **18**, 611.—The viscosities were determined with a modified type of Cannon–Fenske U-tube viscometer. The design was such that velocities were kept low enough to prevent the kinetic energy correction from exceeding 0·2%. All samples were tested with two separate viscometers and stopwatches. The accuracy of the data was dependent upon the accuracy of the viscosity at 20° C of water which was the primary calibrating liquid; a value of 1·007 c.s. was used. The precision of the data recorded was $\pm$ 0·1% so that absolute viscosities might be in error by as much as 0·5%. The viscosities of 18 isomeric octanes are listed in tabular form according to decreasing absolute viscosity at 20° C. Many of the compounds have widely different viscosity temperature coefficients; *e.g.*, at 20° C the absolute viscosity of 3 : 4-dimethylhexane is higher than that of 3-methylheptane but at 0° C the reverse is true. In general, cyclic compounds have higher viscosities at a given temperature than paraffinic compounds with the same number of carbon compounds. The *cis* compounds have higher viscosities than the *trans* and generally the alkyl *cyclo*hexanes are more viscous than the corresponding alkylbenzenes. Viscosities have been correlated with temperature by means of the equation $\eta = A(e)B/RT$. A and B being constants for a given hydrocarbon. G. R. N.

609. Inter-Polymerization of Butenes. G. C. Johnson and F. S. Fawcett. *J. Amer. chem. Soc.*, 1946, **68**, 1416.—The inter-polymerization of *iso*butene with 2-methyl-2-butene in the presence of an alumina-silica catalyst at 110° C and 500 lb pressure gave a mixture of nonenes which on hydrogenation yielded 29% 2 : 2 : 4-trimethylhexane, 30% 2 : 4 : 4-trimethylhexane, 31% 2 : 2 : 3 : 4-tetramethylpentane, 9% 2 : 3 : 3 : 4-tetramethylpentane and about 1% of unidentified compounds. These nonanes are the same as those produced by the reaction between *tert.*-butyl alcohol and *tert.*-amyl alcohol in the presence of 60% by wt sulphuric acid at temperatures below 80° C. The b.p. d_4^{20}, n_D^{20}, and η^{20} were determined on the four nonanes. G. R. N.

610. Low Temperature Thermal Data on the Five Isomeric Hexanes. D. R. Douslen and H. M. Huffman. *J. Amer. chem. Soc.*, 1946, **68**, 1704.—Thermal studies on the five hexanes have been made over the range 13–300° K employing an adiabatic calorimeter system. Experimental values of the specific heat, heats of transition, heats of fusion, transition temperatures, and triple points were obtained. The entropies at 298·16° K of four of the liquid hexanes were calculated. G. R. N.

611. The System *cyclo*Pentane–Neohexane–Aniline. K. T. Serijan, R. A. Spurr, and L. C. Gibbons. *J. Amer. chem. Soc.*, 1946, **68**, 1763.—The need to purify *cyclo*pentane lead to a study of the ternary system *cyclo*pentane–neohexane–aniline at 15° and 25° C using sp. gr. and refractive index as criteria. G. R. N.

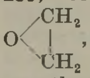
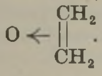
612. *ortho-* and *para*-Diethylbenzenes. J. V. Karabinos, K. T. Serijan, and L. C. Gibbons. *J. Amer. chem. Soc.*, 1946, **68**, 2107.—As part of a project involving the synthesis and purification of 26 aromatic hydrocarbons 6 gal quantities of *o*- and *p*-diethylbenzenes were produced by the condensation of the appropriate ethylphenylmagnesium bromide with diethyl sulphate. The physical properties of the two hydrocarbons were recorded as well as those of the corresponding halides. G. R. N.

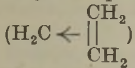
613. Solubility of Boron Fluoride in *n*-Pentane. G. N. Cade, R. E. Dunn, and H. J. Hepp. *J. Amer. chem. Soc.*, 1946, **68**, 2454.—The solubility of boron fluoride in *n*-pentane was determined with an average error of about ± 5% at 49°, 66°, and 93° C and total absolute pressures ranging from 3·8 to 14·8 atmospheres and was found to be of the order of 1 to 12 cc (S.T.P.) of boron fluoride per gram of *n*-pentane. At constant partial pressure of boron fluoride the solubility is a minimum at about 70° C. G. R. N.

614. Phase Equilibria in Hydrocarbon Systems. H. H. Reamer, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1947, **39**, 77.—Five mixtures of the ternary system consisting of methane, *n*-butane, and decane were studied volumetrically at seven temperatures from 100° to 460° F and at pressures up to 10,000 p.s.i. The mixtures were chosen so as to have a fixed molal ration of *n*-butane to decane of about 2 to 1, whereas the mole fraction of methane varied from 0·3785 to 0·9775. The experimental results establish the volumetric properties of these mixtures in the single-phase region at pressures above that of the bubble point and, in the two-phase region, near the bubble-point boundary. A. W.

615. Primary Process in Pyrolysis of Pentenes. E. Gorin, A. G. Oblad, and R. F. Schmuck. *Industr. Engng Chem.*, 1946, **38**, 1187.—The optimum conditions for the production of diolefins by the pyrolysis of various pure pentenes and of pentane–petene mixtures were investigated. Butadiene is the major diolefin from the pyrolysis of 1-pentene and 2-pentene. Small amounts of 1 : 3-pentadiene are simultaneously produced in the pyrolysis of 2-pentene. The largest yields of butadiene are from the pyrolysis of 2-pentene at 750–800° C and at pressures below 0·2 atmosphere. The main side reaction in the pyrolysis of the normal pentenes is cracking to light olefins. Isoprene is the principal diolefin from the pyrolysis of the tertiary pentenes. A small amount of butadiene is simultaneously produced. The best yields of isoprene are obtained by pyrolysis of trimethylene at 800° C. The paraffinic constituents in pentane–pentene mixtures did not contribute appreciably to the production of diolefins in the cracking of these mixtures. The primary reactions in the decomposition of the pentanes were obtained by extrapolation from the experimental results. These are compared with the reactions predicted by the Rice free-radical chain hypothesis. It is shown that the Rice theory must be modified to account for all of the primary reactions observed. A. W.

616. Physics in Hydrocarbon Research. Anon. *Petrol. Times*, 21.12.46, **50**, 1326.—The work done by the Physics Division of the Universal Oil Products Co., and the new laboratories of this company are briefly described. Some notes are given on the research projects which are being carried out : these are ultra-violet spectrophotometry, infra-red, Raman, and emission spectroscopy, mass spectrometry, X-ray diffraction, electron microscopy, and general physico-chemical work. R. B. S.

617. Structures of Ethylene Oxide and Cyclopropane. A. D. Walsh. *Nature*, 1947, **159**, 165.—The instability of ethylene oxide, whose formula is generally given as  $\mathrm{O}<\begin{matrix}\mathrm{CH_2}\\|\\\mathrm{CH_2}\end{matrix}$, is usually explained by the presence of molecular strain ; but if this is the case the corresponding propylene oxide would be more stable, which it is not. Polymerization and addition reactions suggest a structure similar to that of ethylene. Evidence is advanced showing that the two electrons of the original λ-bond in ethylene bind the three nuclei C, C, O, in ethylene oxide, giving a structure which may be represented as  $\mathrm{O}\leftarrow\begin{matrix}\mathrm{CH_2}\\\|\\\mathrm{CH_2}\end{matrix}$.

*cyclo*Propane is likewise regarded as having a perturbed ethylenic structure  $(\mathrm{H_2C} \leftarrow \overset{\mathrm{CH_2}}{\underset{\mathrm{CH_2}}{||}})$; for (1) substances containing a *cyclo*propane group adjacent to a double bond have absorption spectra characteristic of conjugated compounds, and (2) the dipole moment of *cyclo*propyl chloride is lower than that of *iso*propyl chloride.
H. C. E.

618. Physical Properties of 2- and 3-Methylthiophene. F. S. Fawcett. *J. Amer. chem. Soc.*, 1946, **68**, 1420.—The methylthiophenes were prepared from pentane and sulphur by the Socony Vacuum process. After purification by distillation the following properties were determined : f.p., b.p. over the range 500–900 mm, n_D, d_4, viscosity at 0°, 20°, 25°, and 30° C, specific dispersion at 20° C, f.p. depression for three solutes and some derived constants.
G. R. N.

619. The Heat Capacity of Gaseous Naphthenes. R. Spitzer and K. S. Pitzer. *J. Amer. chem. Soc.*, 1946, **68**, 2537.—The heat capacities of gaseous *cyclo*pentane, *cyclo*hexane, and methyl*cyclo*hexane were measured in a Pitzer vaporization apparatus from slightly above the boiling point to about 250° C. A few measurements made at reduced pressures indicated that the heat capacities of the ideal gas are given to good approximation by the Berthelot correction.
G. R. N.

620. Alkyl*cyclo*propanes. J. D. Bartleson, R. E. Burk, and H. P. Larkelma. *J. Amer. chem. Soc.*, 1946, **68**, 2513.—1 : 1 : 2-Trimethyl*cyclo*propane was prepared in good yield from 2-methyl-2 : 4-dibromopentane by the Freund reaction at low temperatures. 1 : 2-Dimethyl-3-ethyl*cyclo*propane was prepared in the same fashion from 3-methyl-2 : 4-dibromohexane. In purification of these hydrocarbons by fractional distillation infra-red spectra were employed as criteria.
G. R. N.

621. Alkylation of Thiophene by Olefins and Alcohols. W. M. Kutz and B. B. Corson. *J. Amer chem. Soc.*, 1946, **68**, 1477.—Thiophene was alkylated by propene, butene-1, amylene, *cyclo*hexene, *iso*propyl, and *tert.*-butyl alcohols. Several new alkyl thiophenes thereby were prepared. Filtrol X-143 proved to be a satisfactory alkylating catalyst. Phosphoric acid can be used but other typical alkylation catalysts were unsatisfactory, *e.g.*, $AlCl_3$, $FeCl_3$, stannic chloride, hydrogen fluoride, boron trifluoride-dimethyl ether complex, and sulphuric acid. It was not possible to alkylate thiophene with ethylene.
G. R. N.

622. Alkylation. J. D. Gibson, R. C. Cole, and M. P. Matuszak. *J. Amer. chem. Soc.*, 1946, **68**, 2728.—A short record of the alkylation of *iso*butane and *iso*pentane with *tert.*-butyl alcohol at room temperature and with *iso*propyl alcohol at 50° C using hydrogen fluoride as catalyst. The main product in each alkylation was of the expected number of carbon atoms per molecule. *tert.*-Butyl alcohol resembled a butene in activity.
G. R. N.

623. Isomerization of Alkanes. III. R. C. Wackher and H. Pines. *J. Amer. chem. Soc.*, 1946, **68**, 1642.—A high-vacuum study of the effect of water on $AlCl_3$ and $AlBr_3$ showed that the amount of hydrogen halide produced depends upon the molal ratio of water to aluminium halide used. The effect of this reaction on the catalytic isomerization of *n*-butane was investigated and it was found that the amount of hydrogen chloride formed and the degree of isomerization decrease with the increase of the molal ratio of water to $AlCl_3$ used. In the case of $AlBr_3$ an active catalyst was produced by the action of two moles of water on one mole of the halide.
G. R. N.

624. Isomerization of Alkanes. IV. H. Pines and R. C. Wackher. *J. Amer. chem. Soc.*, 1946, **68**, 2518.—Very little exchange reaction and no isomerization occurred when butanes were treated with deuterium bromide–aluminium bromide. In the presence of 0·1 mole-% butenes isomerization occurred and 82–92% of the deuterium was exchanged for hydrogen. Deuteroxyaluminium dibromide acted as a catalyst for butane isomerization ; less than 6% of the deuterium underwent an exchange reaction.
G. R. N.

625. Vapour Pressures and Saturated Liquid and Vapour Densities of the Isomeric Hexanes. W. B. Kay. *J. Amer. chem. Soc.*, 1946, **68**, 1336.—The critical constants of all the isomeric hexanes and the standard boiling points of all except 2 : 2-dimethylbutane were determined while the values of the liquid density at 20° C were obtained by the interpolation of the density temperature curves. The vapour pressures and saturated liquid and vapour densities were determined from near their atmospheric boiling points to their critical points, employing the static method of vapour–pressure measurement and the pyknometer. Separate empirical equations were derived from the vapour pressure and density data. G. R. N.

626. Effects of Radioactivity on a Naphthenic Acid. I. A. Breger and V. L. Burton. *J. Amer. chem. Soc.*, 1946, **68**, 1639.—Irradiation of a naphthenic acid, *cyclo*hexane carboxylic acid, by alpha particles and deuterons transformed it into *cyclo*hexane and *cyclo*hexene. It was demonstrated that this atomic bombardment did not open the *cyclo*hexane ring. The mechanism of the transformation is as yet undefined. G. R. N.

627. Fischer–Tropsch Syntheses with Ketene. B. R. Warner, M. J. Derrig, and C. W. Montgomery. *J. Amer. chem. Soc.*, 1946, **68**, 1615.—Ketene in the presence of hydrogen reacts on a CO–ThO_2–kieselguhr catalyst to yield hydrocarbons and oxygenated compounds which are similar to the products of the Fischer–Tropsch synthesis. G. R. N.

628. A Precision Capillarimeter. J. J. Jasper and K. D. Herrington. *J. Amer. chem. Soc.*, 1946, **68**, 2142.—After briefly reviewing the errors in the capillary rise method and the measures taken to minimize them, a description is given of a capillarimeter which conforms to the structural and dimensional specifications of a precision instrument offering the advantage of small volume requirement and convenience of manipulation. The instrument was tested with liquids of known purity and surface tension at three temperatures. G. R. N.

629. Preparation of a Raney Nickel Catalyst. A. A. Pavlic and H. Adkins. *J. Amer. chem. Soc.*, 1946, **68**, 1471.—A detailed procedure is given for preparing Raney nickel from nickel aluminium alloy is described. This catalyst is more active than other forms particularly at temperatures below 100° C. G. R. N.

Analysis and Testing.

630. Preparation of Synthetic Samples of Low-Boiling Hydrocarbons. R. H. Busey, G. L. Barthauer, and A. V. Metler. *Industr. Engng Chem. Anal.*, 1946, **18**, 407.—The design and operation of an apparatus for the blending of low-boiling hydrocarbons are described. The apparatus is so designed that standard samples containing any number of components may be prepared in a reasonable time in any size and with a degree of accuracy superior to present methods of analysis. Data are presented for samples in the C_4 and C_5 range. The need for accurate preparation of synthetic mixtures had arisen because of the emphasis placed on newer methods of hydrocarbon analysis, such as infra-red and mass spectroscopy. G. R. N.

631. Specific Dispersion of Hydrocarbons and Petroleum Fractions. M. R. Lipkin and C. C. Martin. *Industr. Engng Chem. Anal.*, 1946, **18**, 433.—An equation is presented for the calculation of specific dispersion of pure hydrocarbons and petroleum fractions from density, refractive index, and approximate mol wt, which may be estimated from mid-boiling point and density or the viscosities at 100° and 210° F. The accuracy of the calculated specific dispersion for petroleum fractions is comparable with the accuracy of measurements obtained on the Abbé instrument ± 3 units. Tabulated data on grouped pure hydrocarbons and on a variety of petroleum fractions are given. G. R. N.

632. Determination of Alkyl Disulphides. I. M. Kolthoff, D. R. May, P. Morgan, H. A. Laitinen, and A. S. O'Brien. *Industr. Engng Chem. Anal.*, 1946, **18**, 442.—The method described can be used whether mercaptans are present or absent. The disulphides are reduced to mercaptans by means of amalgamated zinc and titrated amperometrically with silver nitrate. If the relative amount of mercaptan present is not large, the disulphide is determined by difference by titrating portions of the solution before and after reduction. To determine a trace of disulphide in a mercaptan the latter is removed as precipitated silver mercaptide before the reduction treatment. G. R. N.

633. Molecular Weight and Mercaptan Content of Mercaptan Mixtures. H. A. Laitinen, A. S. O'Brien, and J. S. Nelson. *Industr. Engng Chem. Anal.*, 1946, **18**, 471.—The mercaptan sulphur content of a mixture of primary mercaptans is determined by titration with silver nitrate and the weight of silver mercaptide formed during the titration is determined. From these data the average mol wt of the mercaptans and the percentage of mercaptans are calculated. The percentage of non-mercaptan material is found by difference. G. R. N.

634. Analysis of Oil Soluble Petroleum Sulphonates. F. Brooks, E. D. Peters, and L. Lykken. *Industr. Engng Chem. Anal.*, 1946, **18**, 544.—A new method is presented in which the sulphonic acids, carboxylic acids, and mineral oil are separated from the inorganic salts by extracting an acidified aqueous suspension of the sample with chloroform. The inorganic salt content is calculated from the sulphated residue obtained from the aqueous phase-making correction for the alkali residue contributed by the sulphonate, carboxylate, and free alkali. A portion of the residue obtained from the chloroform extract is titrated potentiometrically for strong and weak acids to determine the respective equivalents of sulphonic and carboxylic acids present. Another portion of the chloroform-soluble residue is neutralized and the mineral oil isolated by adsorbing the sulphonates and carboxylates on Attapulgus clay. A schematic diagram of the method is given. G. R. N.

635. Vapour–Liquid Equilibrium Still for Miscible Liquids. D. T. C. Gillespie. *Industr. Engng Chem. Anal.*, 1946, **18**, 575.—A new apparatus is described which consists of an electrically heated glass still fitted with a Cottrell pump, a vapour–liquid disengagement chamber, and a condensate trap. Both the boiling liquid and vapour circulate within the apparatus and boiling points may be determined with accuracy as the system ensures complete equilibrium between the two phases. A simple test for the entrainment of liquid in the vapour is described and it is shown that in the new apparatus less than 0·05% entrainment occurs with negligible effect upon equilibrium data. G. R. N.

636. Determination of Basic Nitrogen in Hydrocarbon Feed Stocks. L. Donn and H. Levin. *Industr. Engng Chem. Anal.*, 1946, **18**, 593.—Ammonia is not retained when very dilute gaseous concentrations are bubbled through dilute sulphuric acid. Storage of such dilute gaseous mixtures in iron cylinders results in loss of appreciable basic nitrogen content. Ammonia and amines in concentrations between 0·000015 and 0·008%, calculated as ammonia, have been successfully determined in normal gaseous hydrocarbon feed stocks by a method that involves passage of a cooled (about − 60° C) hydrocarbon sample into a substantially non-aqueous standard solution of sulphuric acid (in acetone), evaporation of the hydrocarbon, and titration of the excess acid with standard alkali. G. R. N.

637. Aids to Computation in Spectrophotometric Analysis of Binary Mixtures. M. Fred and F. W. Porsche. *Industr. Engng Chem. Anal.*, 1946, **18**, 603.—Several methods are described for facilitating the computation of concentrations of binary mixtures from the observed spectrophotometer data. The methods are especially useful for cases of Beer's law failure. One is a graphical method in which the observed optical densities of a mixture determine the location of a point inside a co-ordinate network reading directly in concentrations. The other method utilizes a specially constructed slide-rule on which concentrations are read when the position is adjusted according to the densities. Illustrative data for benzene toluene mixtures. The graphical method can be extended to three component mixtures. G. R. N.

638. Determination of Conjugated Diolefins with Chloromaleic Anhydride. S. T. Putnam, M. L. Moss, and R. T. Hall. *Industr. Engng Chem. Anal.*, 1946, **18**, 628.—A new method of determining conjugated diolefins in hydrocarbon mixtures utilizes chloromaleic anhydride as the dienophilic reagent. The method is based on the quantitative addition of chloromaleic anhydride to conjugated dienes to form an adduct containing a highly reactive chlorine atom which can be determined by the Volhard method after refluxing with aqueous silver nitrate; the vinyl chlorine of the reagent is completely unreactive under the same conditions. G. R. N.

639. Infra-Red Analysis of Hydrocarbon Mixtures. J. H. Lee. *Industr. Engng Chem. Anal.*, 1946, **18**, 659.—Infra-red analysis of gaseous hydrocarbon mixtures involves determination of extinctions from the individual components. Experimental data must be corrected for second-order effects due to energy scattered within the instrument, the structure of the absorption band and intermolecular action. A simple relationship permits correction for these deviations. The equation is $E_{\text{corrected}} = E_{\text{observed}} (1 + aE_{\text{observed}})$. The numerical value of a is determined experimentally for each instrument. The method simplifies the work connected with the calibration or recalibration of a spectrophotometer. Use of a reference substance is suggested as a diluting agent in cases where molecular interaction influences absorption.

G. R. N.

640. Conversion of Organic Sulphur to Hydrogen Sulphide for Analysis. E. Field and C. S. Oldach. *Industr. Engng Chem. Anal.*, 1946, **18**, 668.—Organic sulphur compounds are quantitatively converted to hydrogen sulphide by passing with hydrogen over alumina at 900° C. The technique of this operation has made possible the analyses of traces of organic sulphur compounds in gases or liquids when used in conjunction with sufficiently sensitive methods for hydrogen sulphide analysis. G. R. N.

641. Determination of Carbon and Hydrogen. D. D. Tunnicliff, E. D. Peters, L. Lykken, and F. D. Tuemmler. *Industr. Engng Chem. Anal.*, 1946, **18**, 710.—A dual unitized combustion apparatus and improved procedure are described for the determination of carbon and hydrogen in macrosize samples. The dual feature, absence of rubber connections, provisions for adequate combustion control, and well-defined procedure all combine to give accurate results in the minimum of time. Other features are control and indication of all gas-flow rates, adequate and convenient pyrometer temperature indication, addition of extra oxygen between the sample and catalyst, use of carefully determined combustion and operating conditions, and a method for accurate analyses of volatile samples. Using the long precision procedure a skilled operator can make two determinations in an 8-hr day with a precision of ± 0·008% hydrogen and ± 0·009% carbon and a probable accuracy of 0·011% hydrogen and 0·015% carbon. Using the short routine procedure an operator can make eight determinations daily with a probable accuracy of 0·05% for each element. Both procedures are applicable in presence of sulphur, halogens, and nitrogen. G. R. N.

642. Quantitative Analysis of Hydrocarbon Mixtures by Means of Raman Spectra. E. J. Rosenbaum, C. C. Martin, and J. L. Lauer. *Industr. Engng Chem. Anal.*, 1946, **18**, 731.—Raman spectra of various aromatic hydrocarbon mixtures and trimethylpentane mixtures were measured with a Steinheil spectrograph. After discussion of the time-consuming photographic method a description is given of a semi-empirical procedure involving a calibration for each system based on a few mixtures of known composition made up from pure compounds. The procedure makes it possible to take into account the mutual interference of close lying Raman lines. G. R. N.

643. Detection of Elementary Sulphur in Gasoline. G. E. Mapstone. *Industr. Engng Chem. Anal.*, 1946, **18**, 498.—The Sommer colour test for free sulphur in pyridine solution has been applied to gasoline by mixing the latter with pyridine then adding caustic soda solution. The presence of elementary sulphur is shown by the blue colour of the intermediate pyridine phase. This test has been compared with the inverted doctor test and is shown to be more sensitive. The mercury test is more sensitive than the Sommer test, but is too sensitive for plant control. G. R. N.

644. Determination of Aromatic Content of Aviation Gasoline. C. M. Gambrill and J. B. Martin. *Industr. Engng Chem. Anal.*, 1946, **18**, 689.—The difference in solubility of picric acid in aromatic and non-aromatic hydrocarbons has been utilized to develop a method for determining the aromatic content of aviation gasoline. The method has been modified to increase its accuracy, precision, and rapidity. The solubility of the picric acid in gasoline is determined at some temperature between 20° and 30° C. Applying a temperature correction to obtain the solubility at 25° C the percentage of aromatics is obtained by reference to a standard curve. The presence of olefins and naphthenes necessitates a slight correction: $-1{\cdot}4\%$ for each 10% of olefin and $-0{\cdot}6\%$ for each 10% of naphthenes. The method is accurate to $\pm 1\%$ in the range of 0–25% aromatics. G. R. N.

645. Determination of Olefins in Gasoline. G. R. Bond, Jr. *Industr. Engng Chem. Anal.*, 1946, **18**, 692.—Nitrogen tetroxide reacts with olefins to convert them into oily addition products or nitrosates. Two methods are described which employ this reaction to measure the olefin content of a gasoline. In method A after completion of the reaction at around 70° F the unreacted gasoline is steam distilled from the nitrosates, freed of impurities, and measured. In method B, after completion of the reaction as in method A, the mixture of unreacted gasoline and nitrosates is so treated that a clean separation of the former is obtained and its volume measured. The two methods are under experimental review by Sub-Committee XXV of ASTM Committee D-2. G. R. N.

646. Electronic Detonation Indicator. D. R. de Boisblanc, H. M. Trimble, and L. A. McReynolds. *Oil Gas J.*, 18.1.47, **45** (37), 50.—This paper presents a description of three instruments which have been developed for determining the detonation behaviour of fuels in full scale and laboratory engines. One instrument is designed for full-scale flight uses, and the other two for laboratory use.

The test-meter Model No. 101 employs a magneto-strictive type of pick-up incorporated in a circuit which responds to the detonation waves and quantitatively indicates the maximum rate of change of pressure in each detonating cycle.

The pick-up output voltage is first amplified and then divided into two paths. The first is a low frequency channel, in which the voltages are integrated to yield a low frequency pulse which has the same time variation as the pressure. The voltage is again amplified and clipped to produce a rectangular pulse for each combustion cycle.

The second channel consists of a tuned amplifier which selects high frequency components of the detonation wavelet and rejects the low frequency wave due to the normal combustion pressure variation. The output of this amplifier passes through a mixer or switch which is made operative during the combustion-cycle interval by the rectangular pulse output of the low-frequency channel. The output voltage of the mixer is converted into an exponential pulse which is modified by a second pulse generator to give a sustained pulse whose height is proportional to the peak amplitude of the detonation wavelet. The duration of this pulse is sufficiently great to permit the high-speed internally damped meter to rise to the peak value.

The two instruments for laboratory use Model 102A and the Steady reading meter are much simpler in design. The first has already been described in Abstract No. 288 (1947), and the second is modified to include a multivibrator and integrator which have the effect of giving steady readings of average knock intensity. J. N.

647. Determination of Hydrogen Sulphide in Gases. E. Field and C. S. Oldach. *Industr. Engng Chem. Anal.*, 1946, **18**, 665.—Two colorimetric methods were developed for the analysis of traces of hydrogen sulphide in gases. The hydrogen sulphide is first absorbed in a caustic solution and in the more sensitive method is converted to bismuth sulphide. The concentration of the resulting suspension is determined by means of a spectrophotometer. In the absence of this instrument the sulphide is reacted with a uranyl cadmium reagent and analysed by visual comparison in a chromometer. With the spectrophotometric method as little as 7 micrograms of hydrogen sulphide may be determined with a precision of $\pm 10\%$. For larger samples the precision improves to $\pm 3\%$. The chromometer technique requires five times as much sulphide for equal precision but still is far more sensitive than titration. G. R. N.

648. Identification of Sulphur Compounds in Gas Mixtures. C. S. Oldach and E. Field. *Industr. Engng Chem. Anal*., 1946, **18**, 669.—A sensitive method for identification and quantitative determination of sulphur compounds present in gas mixtures depends on differences in solubility of the sulphur compounds in an inert solvent. A complete analysis usually involves both an absorption and a stripping run in a multiple-plate saturator. The total sulphur content of the gas leaving the saturator is plotted against gas volume. A stepwise curve results, wherein the gas volume at which the sulphur concentration changes abruptly is characteristic of a specific sulphur compound and the magnitude of the change is a measure of the concentration of that compound. Identification runs on manufactured gas and coke-oven gas are presented. G. R. N.

649. Automatic Determination of Aniline Point. C. W. Brown. *Industr. Engng Chem. Anal*., 1946, **18**, 739.—An apparatus is described for the automatic determination of aniline point of petroleum products. The basic principle involved comprises the use of the electric eye as a substitute for visual observation. The test sample is internally heated or cooled, the temperature is maintained uniform by stirring and temperature equilibrium is automatically accomplished by a relay system. The latter is activated by directing a light beam through the sample on a photocell, the light beam being interrupted periodically as the sample clears or clouds with slight temperature change. G. R. N.

650. Determination of *pp′*-D.D.T. in Dusts and Oils. J. B. LaClair. *Industr. Engng Chem. Anal*., 1946, **18**, 763.—A method is described for the determination of *pp′*-D.D.T. in commercial dusts and oil solutions. It is based on the dehydro chlorination of the sample at 25° ± 0·1° C, in 95% ethyl alcohol solution for dust mixtures and in kerosine solution for oil blends, for 15 minutes using 20 ml of *N*-ethanolic sodium hydroxide. Comparative results are given for the crystallization method. G. R. N.

651. Proportional Flow Controllers for Liquids. W. R. Wilkinson and H. A. Beatty. *Industr. Engng Chem. Anal*., 1946, **18**, 725.—An apparatus is described to effect the accurate control of reflux ratio with variable throughput in fractional distillation. It operates on the principle of directing a downflow of liquid into a uniform free-falling sheet or curtain which is split into two parts by a movable divider. G. R. N.

652. Adsorption Apparatus. C. B. Wendell, Jr. *Industr. Engng Chem. Anal*., 1946, **18**, 454.—A high vacuum apparatus without stopcocks is described which permits efficient handling of hydrocarbon gases in adsorption work. Positive control of the gases has been achieved through " mercury stopcocks " which involve simply hypodermic syringes and ground-glass valves. G. R. N.

653. Evaluation of Laboratory Distillation Apparatus. F. C. Collins and Y. Lantz. *Industr. Engng Chem. Anal*., 1946, **18**, 673.—Test methods have been developed for evaluating laboratory distillation apparatus under conditions approximating actual operation, rather than under ideal conditions for maximum separation. In particular, the effect of reflux ratio on efficiency and separation has been studied. Test methods for evaluating the other principal characteristics of distillation apparatus are also described in detail. The Oldershaw glass-bubble plate column has been improved and studied using these test methods. The column was very satisfactory for analytical distillations of hydrocarbon mixtures because of uniformity of its operating characteristics. Automatic stillheads and other accessory equipment have been developed which contribute to the unformity of the column performance. G. R. N.

654. Product Withdrawal from Distillation Columns. D. M. Oldroyd and L. A. Goldblatt. *Industr Engng Chem. Anal*., 1946, **18**, 761.—It has generally been assumed that the best way to operate high efficiency distillation columns is with as nearly a continuous product withdrawal rate as possible. The relative effectiveness of intermittent versus continuous withdrawal was tested with a heligrid-packed, a helices-packed, and a gauze plate column. Especially with the heligrid-packed column distinctly better separation was obtained by product withdrawal once every hour than once every 30 sec. G. R. N.

655. Fractionating Column. E. A. Naragon and C. J. Lewis. *Industr. Engng Chem. Anal.*, 1946, **18**, 448.—An improved small glass centre tube fractionating column which can be easily reproduced is described and construction details are given. The fractionating section, which is surrounded by a silvered vacuum jacket, is 30·5 cm long and consists of an 8 mm inside diameter outer tube and a 6·5 mm outside diameter centre tube. Above this section a distributor is used which distributes the reflux from the head half to the outer tube and half to the centre tube. The column is equipped with an automatic take-off valve. It has an efficiency of over 75 theoretical plates with an H.E.T.P. of less than 0·4 cm. G. R. N.

656. New Head for Laboratory Fractionating Column. J. D. Bartleson, A. L. Conrad, and P. S. Fay. *Industr. Engng Chem. Anal.*, 1946, **18**, 724.—This take-off head is a totally condensing head to give the advantages of high throughput and low hold up. The feature of it is a steel ball bearing encased in glass. This assembly is seated by a joint ground into the throat of a glass funnel leading to the receiver. For alternate use with the head a double-type condenser utilizing dry ice cooling in addition to the conventional type is described. This condenser gives efficient and complete condensation of C_4 fractions. It avoids the troublesome change from dry ice to liquid coolant and eliminates the need for expensive cooling systems. G. R. N.

657. Rapid Analysis of Fischer Synthesis Catalyst. C. H. Hale. *Refiner*, 1946, **25**, 265.—Rapid methods for the determination of cobalt and thorium in Fischer kieselguhr catalysts are described. Cobalt is determined by titrating with ferricyanide to a "dead-stop" end-point, while thorium is precipitated as the iodate and determined volumetrically. Details of the methods and results obtained with actual and synthetic catalysts are given. G. R. N.

658. Analysis of Furfural Water Solutions. J. Griswold, M. E. Klecka, and R. V. O. West. *Industr. Engng Chem. Anal.*, 1946, **18**, 696.—Dependable analyses of furfural-water solutions are needed in connection with furfural solvent refining and extractive distillation processes. Two accurate methods are described, the first being a cloud point method for the determination of water in furfural, and the second being electrometric titration with bromine to determine furfural in water. G. R. N.

Gas.

659. Natural Gas. Steady Expansion to Continue in 1947. D. M. Duff. *Oil Gas J.*, 25.1.47, **45** (38), 169.—Revenues, sales, customers, and production of the natural gas industry showed gains in 1946, but expansion was hampered by lack of materials. Completion of new lines would increase supply nearly 20% of total 1945 sales.

By using adapted Fischer–Tropsch process 15 thousand million brl would be added to oil reserves in U.S.

Two charts give Gas Sales and Revenue. G. A. C.

Gas and Fuel Oils.

660. Fuel-Oil Properties. W. L. Nelson. *Oil Gas J.*, 18.1.47, **45** (37), 89.—No. 127 in the *Refiners' Notebook* series relates the properties of the various fuel oils to their uses.

For example, flash points of over 100° F are required for safety, and below 230° F for ease of ignition of oils used in vaporizing-type burners. A table relating viscosity and burner oil temperatures is given, also one showing heating value of fuels.

G. A. C.

661. Liquid Fuel for High Temperature Processes. T. C. Bailey, F. J. Battershill, and R. J. Bressey. *Petrol. Times*, 7.12.46, **50**, 1284.—The specific gravity, flash point, calorific value, and viscosity characteristics of the three fuel oil grades at present available are first discussed. The advantages of liquid fuels which are then discussed are: (1) uniformity of quality, (2) cleanliness, (3) ease of storage, (4) saving of labour, (5) control ability and flexibility, (6) facility of handling, (7) absence of ash, (8) high flame temperatures, (9) luminous flames, (10) high furnace efficiencies, and (11) greater

outputs from furnaces. Some notes are then given on the use of oil-fuel for the following industrial applications : (1) open-hearth furnaces, (2) oil as an auxiliary to steelworks gases, (3) rotary melting furnaces, and (4) rotary calcining furnaces.
R. B. S.

662. Coal-Tar Fuel 200 was 40% of Wartime Industrial Consumption. E. B. Davies. *Petrol. Times*, 21.12.46, **50**, 1318.—The name " Coal-Tar Fuel 200 " (which is often abbreviated to " CTF 200 ") signifies that the fuel must be heated to 200° F before it can be properly atomized : this fuel has also been called " Creosote Pitch Mixture " and " 50/50 Mixture."

The specifications and the physical and chemical properties of CTF 200 are described. The use of any viscous fuel requires the reduction of viscosity by heating, and the maintenance of the necessary temperature up to the point of atomizing. So that this shall be properly accomplished it is imperative that (1) local overheating be avoided, (2) pipe blockage be prevented, (3) flow control be adequate, (4) installation of burners and controls be correct, and (5) corrosion be reduced to a minimum. Each of these points is discussed insofar as the application of CTF 200 is concerned. R. B. S.

Lubricants.

663. Physical Chemistry of Lubricating Oils. A. Bondi. *Refiner*, 1946, **25**, 259.—The first of a series of three articles on the assembly of scattered data on the physical properties and physicochemical behaviour of lubricating oils. In this article the following topics appear : P.V.T. data, density and molar volume, coefficient of expansion and temperature coefficient of density, compressibility, surface tension, interfacial tension, and emulsification and foaming. G. R. N.

664. The Effect of an Electric Field on the Viscosity of Liquids. E. N. De C. Andrade and C. Dodd. *Proc. roy. Soc., Series A*, 5.11.46, **187**, 296.—The effect of an electric field on the viscosities of a range of non-polar and polar liquids has been investigated and it has been confirmed that with non-polar liquids the influence of an electric field transverse to the flow shows no viscosity effect. The non-polar liquids examined were transformer oil, carbon disulphide, carbon tetrachloride, and benzene—all of which when dry were found to be very poor conductors by comparison with polar liquids. When saturated with water, these compounds became conducting to a degree comparable with polar substances but showed no viscosity change with applied electric field.

A range of polar liquids examined included dimethylamine, ethylene dichloride, methyl, ethyl, propyl, and amyl acetates, all showed good conduction together with a large increase in apparent viscosity, the limiting viscosity increase being proportional to the conductivity at high fields. Other polar compounds, such as acetone and acetonitrite, showed decreasing conductivity with increase in the degree of purification indicating that a specimen so pure as to be non-conducting would probably show no change in apparent viscosity with electric field. Polar liquids which gave no viscosity or conductivity include toluene, metaxylene, and methyl phenyl ether.

It is concluded, therefore, that for marked viscosity effect the presence of both conduction which implies ionization and polar molecules are essential. Without the former there is no local concentration of ions, while in the absence of polar molecules clustering of the latter are prevented, since the ions act as centres around which the polar molecules segregate.

Substitution of an alternating for a direct field does not produce viscosity variations.

An apparatus for measuring the apparent viscosity is described, this is based on employing plane metal boundaries between which the liquid passes, the metal boundaries serving as electrodes.

When the electric field is applied parallel to the lines of flow no viscosity effect was observed. H. C. T.

665. Failure of Plain Bearings. B. C. Kroon. *Ingenieur*, 1947, **59**, 1.—Starting from the generally accepted view that failure of plain bearings is caused by insufficient cooling, an attempt is made to formulate an equation relating the heat load of a bearing and the cooling capacity of the lubricant. The heat load of the bearing is expressed in terms of the coefficient of friction, the bearing dimensions, the average pressure, and the speed of revolution. The cooling capacity of the lubricant is calculated as a function of oil flow, dependent on bearing design, viscosity characteristics of the oil and pressure drop. Calculations of the bearing pressure for 2- and 4-stroke engines are represented in the form of polar diagrams showing the load at any position during the rotation of the crankshaft. Sudden changes in load occur, resulting in a small displacement of the shaft in the bearing. The effect of this displacement is to create locally sub-normal pressures in the oil film. Upon restoring the pressure to normal, "implosion" phenomena occur, causing cavitation of the bearing surface. In the course of time this cavitation may lead to the complete disintegration of the bearing metal. M. B.

666. Secrets of German Lubricating Oil Technology Revealed. Part VI.—Finished Lubricating Oils—Storage and Distribution. C. I. Kelly. *Petrol. Times*, 9.11.46, **50**. 1156.—The Germans' war-time organization responsible for the storage, distribution, blending, and packaging of lubricants is briefly reviewed.

This instalment concludes the present series, the others of which were published in the issues of the *Petroleum Times* of March 2, 16, and 30, April 13, May 11, June 8 and 22, July 20, and August 17 and 31: see Abstracts Nos. 629, 690, 691, 698, 814, 984, 895, 1136, and 1136A (1946), and 278 (1947). R. B. S.

Bitumen, Asphalt and Tar.

667. Asphalt Road Work. E. R. Knight. *Rds and Rd Constr.*, 1947, **25**, 3.—This article deals with progress in the use of asphalt macadam for road surfacing. Clinker asphalt has been used both as a thin carpet of topping directly on a base and as a carpet superimposed on clinker asphalt base courses (or "binder" coats) of various thicknesses. Surfacing coats from 1 to 2 in thick over worn wood-block paving and over waterbound macadam roads have proved generally satisfactory, providing no interference by trench excavation, etc., occurred. Experiments are described in which cubical granite was spread over the surface of the asphalt after raking, but before consolidation, to obtain a mosaic surface and increase the surface resistance to skidding; complete success was obtained with granite from 1½ in upwards. Differentiation in colour (*e.g.*, to mark pedestrian crossings) was obtained by using stone of distinctive colour. During the war defective areas of wood-paving blocks were replaced with asphalt up to 6 in in thickness, and even thicker in cases where it was necessary to avoid delays, either in concreting or in adjustment of adjoining foundation levels.
G. P. K.

668. Concrete Flooring with Asphalt Admixture. F. O. Anderegg. *A.S.T.M. Bull.*, Dec. 1946, **143**, 11.—Work is described on the development of flooring material containing Portland cement, asphalt and aggregate: material of this type produces floors which resist indentation much better than asphalt floors, but at the same time reduce markedly the spine-jarring impact found with cement concrete floors. In this type of system the asphalt is the discontinuous phase. Experimental mixes were made containing from 5 to 12½% of cement and from 0 to 5% of asphalt emulsion, and it was found that floors of satisfactory strength were obtained in the range of 7½ to 12½% of cement and with 2 to 3% emulsion. Details of methods used in laying floors and results obtained on testing samples for compressive and flexural strength are given. A recommended mixture which has given excellent results requires 3½ bags of cement and 7 gal of asphalt emulsion per cu. yd of concrete, the ratio of sand to stone being determined by the necessity of maintaining workability. A discussion follows the article. G. P. K.

669. Cotton Fabric in Bituminous Construction. P. F. Critz. *Public Roads*, Oct.–Dec. 1946, **24** (10), 251.—An investigation in the U.S.A. of the use of cotton fabric in bituminous highway construction and maintenance is described.

Laboratory tests showed that the material, when impregnated with bitumen or tar, might have some value in forming a waterproof membrane to prevent surface moisture reaching the base, but in practice this was not so. The fabric deteriorated even when surface and base failures did not occur, thus cotton fabric would not compensate for inadequate base support or allow for construction of cheaper bases. The fabric was found beneficial under certain conditions when used on wooden floors.

The cost of construction, when using cotton fabric, was materially increased, with little or no practical value. On bridge floors the increased cost may be warranted if the condition of the structure is taken into account. G. A. C.

Special Hydrocarbon Products.

670. Napalm. L. F. Fieser, G. C. Harris, E. B. Herhsberg, M. Morgana, F. C. Novello, and S. T. Putnam. *Industr. Engng Chem.*, 1946, **38**, 768.—The thickening agent employed by the Chemical Warfare Service, U.S. Army, for the preparation of gelled gasoline fuels used as filling for incendiary bombs and in flame-throwers, was an aluminium soap derived from a combination of acids of the types exemplified by lauric acid and by naphthenic or oleic acid. A description is given of early work on the problem. A. W.

Derived Chemical Products.

671. Copolymers of Dimethylstyrene Vinyl Fatty Esters with Butadiene. P. O. Powers. *Industr. Engng Chem.*, 1946, **38**, 837.—A series of synthetic rubbers made by emulsion polymerization of butadiene and *a*, *p*-dimethylstyrene in various ratios have been prepared. These rubbers are comparable to copolymers with styrene but are apparently superior in tensile strength, and more nearly resemble natural rubber in processing characteristics. Synthetic rubbers have also been prepared from butadiene and vinyl esters of fatty acids from vegetable oils. These synthetics are somewhat softer than GR-S. Tricopolymers of butadiene, vinyl fatty acid esters, and a monovinyl compound exhibit interesting properties, notably improved resistance to cut growth. A. W.

672. Preparation of Technical D.D.T. H. S. Mosher, M. R. Cannon, E. A. Conroy, R. E. Strien, and D. P. Spalding. *Industr. Engng Chem.*, 1946, **38**, 916.—A study has been made of the effect of time, temperature, acid strength and excess chlorobenzene on the condensation of chloral and chlorobenzene in the presence of sulphuric acid to give D.D.T. When 98–99% sulphuric acid is used with 4 moles of chlorobenzene per mole of chloral and at a temperature of approximately 15° C for 5 hrs, 95–98% yields of D.D.T. can be obtained. A. W.

Miscellaneous Products.

673. Secrets of German Fuel Technology Unearthed. Anon. *Petrol. Times*, 7.12.46, **50**, 1270.—The following C.I.O.S., B.I.O.S., and F.I.A.T. Reports and Final Reports are briefly reviewed.

C.I.O.S. XXXII–17. " Underground Factories in Central Germany " (154 pp.).

B.I.O.S. Report No. 572. " Investigation into the Manufacture and Use of Carbon-Blacks and Lamp-Blacks in Germany " (119 pp.), H.M.S.O., 10*s*. 6*d*. (post 2*d*.).

B.I.O.S. Final Report No. 586. " Ernst Schliemann's Oelwerke und Export-Cerecin-Fabrik, Hamburg, Germany. Lubricants and Miscellaneous Products " (32 pp.).

B.I.O.S. Final Report No. 597. " Interrogation of Dr. C. H. N. Bensmann, October 10, 1945 " (3 pp.).

B.I.O.S. Final Report No. 598. " Oelwerke Julius Schindler G.m.b.H., Hamburg, Germany " (15 pp.), H.M.S.O., 1*s*. 6*d*. (post 2*d*.).

B.I.O.S. Final Report No. 635. " Mineralolwerke Albrecht, Lubricants " (32 pp.), H.M.S.O., 2*s*. 6*d*. (post 2*d*.).

B.I.O.S. Final Report No. 636. " Mineralolwerke F. Harmsen, Kiel, Germany. Lubricants " (11 pp.), H.M.S.O., 1*s*. 6*d*. (post 1*d*.).

B.I.O.S. Final Report No. 637. " Olex Deutsche Benzin und Petroleum Gesellschaft. Fuels and Distribution " (13 pp.), H.M.S.O., 1*s*. 6*d*. (post 1*d*.).

B.I.O.S. Final Report No. 638. " Deutsche Erdol A.G., Hamburg, Germany. Crude Oil and Products " (12 pp.), H.M.S.O., 1*s*. 6*d*. (post 1*d*.).

B.I.O.S. Final Report No. 639. " Deurag-Nerag Gewerkeschaft Deutsche Erdol Raffinerie und Neue Erdol Raffinerie, Fuels and Lubricants " (30 pp.), H.M.S.O., 3*s*. (post 2*d*.).

B.I.O.S. Final Report No. 697. " Fire Protection of Oil Installations in Germany " (44 pp.), H.M.S.O., 4*s*. (post 2*d*.).

B.I.O.S. Final Report No. 704. " Mechanical Foam Liquid and Equipment " (13 pp.).

B.I.O.S. Final Report No. 748. " Manufacture of Fatty Acids by Oxidation of Paraffins : Hydrogenation of the Fatty Acids at I.G. Ludwigshafen-Oppau " (15 pp.), H.M.S.O., 2*s*. (post 1*d*.). Divided into three sections, viz. :

I. Manufacture of Fatty Acids ;
II. Hydrogenation of Fatty Acids, Oppau ;
III. Hydrogenation of Soap Acids, Ludwigshafen.

F.I.A.T. Report No. 698. " Photographing a Single-Fuel Injection " (2 pp.).

F.I.A.T. Report No. 709. " Verbreunungsmoteren : Thermodynamische und Versuchsmässige Grundlagen under Besonderer Berucksichtigung der Flugmoteren " (345 pp.). A photo-lithographic reproduction of Professor Dr. Ing. habil Fritz A. F. Schmidt's book on I.C. Engines. Divided into several sections, viz. :

Part AI. General Motor Problems.
I. Thermodynamics of Idealized Engine Cycles.
II. Actual Cycle Processes.
III. Essential Factors for Efficient Motor Operation.
Part AII. Motor Supercharging.
Part B. Special Problems of Aircraft Engines.
I. Non Supercharged Motors.
II. Supercharge Systems driven by Motor.
III. Exhaust Driven Turbo-superchargers.
IV. Suitability of Different Motor Systems.

There are also extensive supplements giving examples of numerical calculations and a treatise on thermodynamic functions, a report on the results of researches between 1940 and 1945 (mainly on ignition), and a literature and subject index.

F.I.A.T. Final Report No. 741. " Catalysts for Coal Hydrogenation " (3 pp.), H.M.S.O., 1*s*. (post 1*d*.).

F.I.A.T. Final Report No. 810. " Activated Clay. Bleaking Adsorbents."

R. B. S.

ENGINES AND AUTOMOTIVE EQUIPMENT.

674. The De Havilland Ghost. Anon. *Aeroplane*, 7.2.47. **72**, 158.—For the first time the details are released of this engine and a cutaway drawing presents the leading features of the design.

Leading particulars are : Dimensions : Max. diameter 53 in (1·3 mm) ; overall length 115·5 in (2·9 mm) (to rear flange of standard exhaust cone) ; Weight : Dry, bare, 1910 lb (865 kg) ; normal dry, 2011 lb (910 kg), without aircraft accessories ; gross dry weight, 2073 lb (940 kg) ; in running order, 2096 lb (950 kg) ; Performance : Take-off and combat 5000 lb S.T. (2270 kg) at 10,000 r.p.m. and 1·06 lb/lb thrust/hr specific consumption ; maximum climbing, 9500 r.p.m. ; maximum cruising, 8500 r.p.m. ; idling, 3000 r.p.m. I. G. B.

675. Vogue of the C.I. Engine and the Future of Fuels and Lubricants. E. S. Shrapnel-Smith. *Petrol. Times*, 23.11.46, **50**, 1218.—The use of the compression ignition engines for commercial road transport and the sources of fuels and lubricants are very briefly discussed. The operational merits of the C.I. engine include high performance measured in ton–miles per gallon of fuel, good power per stroke at starting and at low r.p.m., and absence of carbon monoxide in the exhaust gases. R. B. S.

MISCELLANEOUS.

676. United Kingdom Petroleum Import and Export Trade. Anon. *Petrol. Times*, 9.11.46, **50**, 1160.—Statistical data on imports and exports of crude oil and refined products for September and the first three quarters of 1946 are presented, together with comparative figures for 1945 and 1938. R. B. S.

677. United Kingdom Petroleum Import and Export Trade. Anon. *Petrol. Times*, 7.12.46, **50**, 1274.—Statistical data are presented on imports and exports of crude oil and refined products (including oil fuel bunkering of shipping) for October and the first ten months of 1946 : comparative figures for 1945 and 1938 are also given. R. B. S.

678. Decline in Roumanian Oil Production. E. C. Masterson. *Petrol. Times*, 7.12.46, **50**, 1260.—The decline in Roumanian production is discussed : the author concludes this is chiefly due to the lack of any systematic exploration programme rather than to the complete exhaustion of Roumanian reserves. R. B. S.

679. Refinery Yield Patterns Determined by Shifting Demand Cycle. R. B. Tuttle. *Oil Gas J.*, 25.1.47, **45** (38), 146.—A review of refining yields over a number of years at U.S. refineries is given. Gasoline demands decreased, but there were substantial increases in yields of burning oils and distillates.

Catalytic cracking and reforming methods allow for flexibility of operation and economic production of intermediate oils, and there is a trend towards greater production of intermediate oils. Flexibility of the modern processes enables the operator to meet local market conditions.

Charts show yields of products and crude runs to stills, together with yields % of crude runs, over a number of years in U.S. Refineries. G. A. C.

680. Some Novel British Patents on Fuel and Power. C. Ridley. *Petrol. Times*, 21.12.46, **50**, 1337.—Six recent British patents are briefly discussed : they are Nos. 574, 535 ; 573, 190 ; 574, 119 ; 574, 667 ; 574, 608 ; and 576, 777 ; dealing, respectively, with improved lubricating pads, burning gaseous fuel under water, selective lubrication of gears, continuous centrifugal sludge separation, a self-lubricating valve, and pipeline repairs. R. B. S.

BOOK REVIEWS.

Petroleum Engineering (Oilfield Development). L. C. Uren. 3rd Edition (1946). New York and London: McGraw-Hill, 1946. Pp. xiii + 764. $6.50.

Professor Lester Charles Uren, of the University of California School of Petroleum Engineering, in this work brings up to date one section of his well-known treatise on petroleum engineering.

His object, as stated in the Preface, has been to provide a text or work of primary reference for petroleum engineering students in that part of their curriculum which pertains to the technology of oilfield development.

The opening chapters are devoted to the properties and occurrence of petroleum in nature, petroleum exploration methods, and the principles to be observed in planning the development of an oilfield.

A major portion of the book deals with drilling methods and equipment, and with oil well completion practices.

The final chapters concern the keeping of drilling records, well logs, data on cores and samples; also the records of electrical logging, deviation, and temperature surveys, etc. These subjects, as compared with the second edition published ten years ago, have been considerably expanded, and in particular demonstrate how necessary it is to re-edit such a primary reference work at frequent intervals in order to keep pace with modern development and invention.

The author has succeeded in presenting a work which deals clearly and adequately with almost every phase of the subject, without it being unmanageable in size. At the end of each chapter is a selected bibliography which will be of great value to those wishing to pursue a particular branch in detail. E. C. S.

Essentials of Petroleum. Dr. P. H. Frankel. London: Chapman and Hall, 1946. Pp. 173. 15*s*.

The sub-title of "Essentials of Petroleum" is "A Key to Oil Economics," and in this book an attempt is made to determine the underlying economic factors on which the petroleum industry is based.

The book is divided into four sections: Part I dealing with oil and public opinion, Part II with the economics of liquid, Part III with price structure, Part IV the shape of the industry, and Part V with policies for the Industry.

Dr. Frankel analyses a series of other industries, textile, coal, steel, and rubber, in so far as the relation between variable and fixed costs are concerned. He quotes figures to show the high capital investment per worker in the petroleum industry where the labour cost is only 10–15% of the total cost, and refinery workers are amongst the most highly paid of any employees. The large capital investment in unit plants leads to the economic necessity of maintaining throughputs as high as possible, and in consequence to price reduction. Dr. Frankel states that the technical factors involved inevitably lead to intense competition and to the necessity of regulating the market.

In Part II, dealing with the economics of liquid, a statement is given in italics "It is perhaps an appropriate speculation that the particular value of liquid hydrocarbons derives from their being easily gasified." Nevertheless, some of the more important problems in connection with the utilization of petroleum products as fuel are due to the fact that they are not always easily gasified. This applies to gasoline, kerosine, diesel fuel, and fuel oil. The essential difference between petroleum and solid fuels lies in their higher calorific value and the liquid character of the former.

In Part IV, some details are given of the rise of various groups in petroleum, and the whole book is writen in a conversational style, and at the end of each chapter references are given to a wide range of publications. The book is well produced, although it has the appearance of being subdivided into too many sections. A Bibliography is provided, together with a good index.

Dr. Frankel points out that the transport of petroleum has always presented problems peculiar to the petroleum industry, in that large-scale transportation of a liquid involves the establishment of pipe-lines, tankers, and tank installations, which by and large can only be used for petroleum products.

In the final section on policies for the industry, the influence of national policy on the petroleum industry is discussed, and the position of " majors " and " minors " in the petroleum industry. He states the justification for the majors lies in their being so big that they cannot help being leaders in the true sense of the word. Whilst Dr. Frankel considers that, in the international field, governments are fulfilling the function of organizing the petroleum industry, he feels that such a procedure can only be successful if it leaves intact industrial enterprises of the industry's component parts.
F. H. G.

Hydrofluoric Acid Alkylation. Bartlesville, Okla.: Phillips Petroleum Co., 1946. Pp. vi + 366 + Index. $7.50.

Fluorine is a relative newcomer to the list of elements which, either in themselves or in the form of their compounds, are used in industry to a major extent. The lead in the development of hitherto relatively rare fluorine compounds for industrial application was given by the introduction, some ten to fifteen years ago, of the " Freon " compounds, first as refrigerants and subsequently for wider applications. Since then the field of industrial fluorine chemistry has widened rapidly and the use of hydrofluoric acid as an alkylation catalyst is one of the newer developments.

This publication may be said to fall into an intermediate class between a scientific monograph and a plant operation manual. It is compiled from a series of reports, made to the petroleum industry, dealing with operating technique, maintenance problems, and general data regarding the first HF alkylation plants that were built. The book is written primarily from the practical aspect—that is, from the point of view of the plant operator—the amount of theoretical information and basic principles that is given regarding the HF alkylation process is reduced to the bare minimum of a few introductory pages. Whilst it is not suggested that further information of this type should necessarily be included in a manual of this nature it would not have been amiss to have given references to the many original papers that have appeared on the subject of HF alkylation, so that those who seek additional information on the theoretical and funamental aspects would have found a bibliography within the covers of this comprehensive guide to the practical angle.

After the brief introduction, mentioned above, dealing with the chemistry of HF alkylation, the general principles of the design of units for carrying out this process are discussed in an adequate manner. Both schematic and detailed flow diagrams are given and individual mention is made of many of the details of certain of the special features concerned with the use of hydrofluoric acid, which is a novel substance from the chemical engineering standpoint, requiring particular attention to be devoted to constructional materials.

The next sections, which are the core of the book, deal with the operation of HF alkylation units; the effect of different variables and of changes of feed stock on the operation of the plants is discussed with considerable thoroughness. In addition to details of the operation of full-scale units, results and experimental procedure for pilot plant tests are also given.

A chapter on analytical methods deals very fully with the special laboratory procedures, involving tests on the catalyst and the determination of fluorine compounds in plant products, which are required in connection with the control of HF alkylation plants. The test methods are fully described and, in cases where special equipment is recommended, full details of this are given, together with reference to the original sources where applicable. The appendix includes a schedule showing the plant control tests necessary and the intervals at which they should be performed.

As might be expected in an American publication, considerable stress is laid on safety precautions, and the procedures which have been shown by experience to be necessary in working with such a potentially hazardous material as hydrofluoric acid are outlined in full. The safety clothing recommended is both described and illustrated and the first-aid treatment of burns from HF, should these occur despite the safety precautions, is prescribed, together with some suggestions for the medical treatment of HF poisoning. In this connection there has evidently been a slight error in the arrangement of the sections inasmuch as a paragraph on the treatment of HF burns is included in the chapter dealing with the properties of HF, whereas it should obviously have been placed in the previous chapter where other first-aid treatments are given.

The chapter dealing with the fundamental data on HF is compiled both from published sources (to which references are given) and also includes material obtained by the Phillips laboratories in their work with this substance, and its mixtures with the lower hydrocarbons.

Information on plant troubles, and corrosion observations, are given both in the text and also in a comprehensive appendix which incorporates the essential information from shut-down inspection reports on a number of commercial HF alkylation plants.

It is of interest to note that in the production of vessels for such plants very modern techniques, including the radiographic examination of the parts to detect welding flaws, have been employed.

The publication of a manual such as the one under review can be used as an argument in favour of the present patent system, which both here and in the U.S.A. has lately come under a considerable fire of criticism. If it were not for the protection afforded by patents, it would not be practicable for a large organization to make public in this way the very considerable body of information, both technical and operating, which is contained in this publication. In fact the publication of work of this type is an answer to those who decry the present patent system, since, if there were no patent protection those who had, at a very considerable cost, developed processes such as these would obviously not be willing to share them with the world at large, and by keeping them secret would deprive industry as a whole of valuable fundamental data and " know-how," the free propagation of which is essential to the advance of science generally.

The style in which the book is written is concise and laconic, such a rendering being eminently suitable for imparting information of this type. The printing has been carried out by a photo-reproduction process, the resulting effect, whilst clear, cannot be said to be very pleasing to the eye.

The book can undoubtedly be considered as essential to all who are operating HF alkylation units or who are proposing to carry out any type of work involving the use of hydrofluoric acid as a catalyst in a petroleum processing method. V. B.

Chemicals from Methane. J. P. Lawrie, Ph.D. London : Science Services, Ltd., 1947. Pp. 21. 3*s*. 0*d*.

Seven years ago a larger book was published in London by Dr. Lawrie, reviewing the natural sources, production, nature, and uses of methane. The present booklet is much less pretentious. In the preface the author states that the purpose is " to give a rapid survey of the current methods of utilizing a gas of which very considerable supplies exist in this country." He wants to see every possible home manufacture developed, and he cites carbon-black as a material which " could and should " be manufactured in the United Kingdom, and particularly in Scotland, instead of importing it.

Dr. Lawrie outlines the processes in use in other countries for the production of chemicals from methane. He claims that the opportunity for similar industries based on methane exists in this country. He states that coal and coal-gas offer unlimited supplies of methane, but he does not recommend the use of any existing fuel in short supply, as sources of methane, whilst methane exists in the country in the form of natural gas.

He outlines briefly the processes used abroad for the production from methane of the following chemicals : carbon-black ; hydrogen for use in the synthesis of ammonia ; acetylene ; chlorinated hydrocarbons like chloroform ; nitromethane ; methanol ; formaldehyde ; formic acid ; and hydrogen sulphide. All of these, he says, serve to show that in other countries methane is well exploited on the commercial scale.

No attempt is made to compare the enormous quantity of natural gas available in the big oil and natural gas-producing countries, like the United States, with the comparatively small quantity known to be available in Great Britain.

The author does not disguise his indignation that it was necessary to import carbon-black during the war years. He claims that it should have been manufactured from the natural gas existing in the United Kingdom.

On page 5 he states that " the utilization of natural gas constitutes a challenge to applied science and the economy of the nation—particularly Scotland—which possesses vast supplies of methane, the use of which would materially assist her industries and provide steady employment for a large number of skilled men and technicians."

On page 6 he again refers to the considerable amount of natural gas in Scotland where, he says, one such source is stated to supply 12 million cu ft of practically pure methane per day, and he quotes the reserves of natural gas as being some 600 million cu ft. In the Wartime Pamphlet No. 45, published by D.S.I.R., Geological Survey of Great Britain, in April 1945, the greatest authority on the Mineral Resources of the Lothians, Dr. A. G. MacGregor, M.C., D.Sc., states that between 1937 and 1940 over half-a-dozen wells were sunk in the D'Arcy–Cousland area (Midlothian), as a result of which at least 15 million cu ft of gas and about 1 ton of oil per day were made available as the combined yield of two of the wells. Neither Dr. MacGregor, nor the Oil Industry, has given any figure, even tentatively, for possible reserves, for the obvious reason that no natural gas well has been on production long enough in Great Britain to enable a reliable estimate to be made.

Assuming that a steady yield of 15 million cu ft of natural gas could be made available at a suitable site for a sufficient number of years to justify the capital expenditure for a carbon-black plant to be installed in Scotland, the total yield of carbon-black would amount to less than one-quarter of that imported into Great Britain from U.S.A. in 1945 for the Rubber Industry alone.

The latter half of the booklet, which deals with the production of various chemical products from natural gas is disappointing. For the most part it is scrappy and incomplete. It is difficult to see what useful purpose this rapid survey of the subject will serve other than as condensed revision notes for University students. It will be of little practical use to an industrial chemist or chemical engineer in planning for the production of chemicals from methane.

Nearly one-fourth of the booklet is devoted to a digest of recent C.I.O.S. reports describing the German Arc Process for the production of acetylene from natural gas. This is out of proportion to the space given to other chemicals from methane, and may be the reason why some have been omitted altogether.

The booklet is well printed on the whole and is in clear type. The printed descriptions which appear in some of the greatly reduced diagrams (notably Figs. 1 and 3) are much too small to be legible without the use of a magnifying glass.

Attention should be called to a serious mistake on page 21, where it is stated that natural gas in U.S.A. usually contains up to 2% of helium. This is incorrect because a helium-rich natural gas in the United States is the exception and not the rule. Most of the natural gas contains no helium at all, or at most only a trace.

The author rightly states in his concluding paragraph that a considerable amount of research into the use of natural gas has obviously been proceeding. His final remark is that " one fact is patent—a potential industry of considerable importance is literally on our doorstep. It must not be ignored."

Dr. Lawrie is evidently unaware of the fact that the possibility of utilizing natural gas in the United Kingdom for this and other purposes has already been thoroughly explored by the oil industry, and also by the Special Wartime Committee on the utilization of methane appointed by the Government. W. H. C.

APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

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

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

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

Applications for Membership.

Austin, Alan Edwin, Chemist, Messrs. W. B. Dick & Co., Ltd. (*P. W. L. Gossling ; J. Romney.*)

Barth, Edwin Jos., Petroleum and Asphalt Technologist, Wood River Oil Refining Co., Illinois. (*G. Egloff ; G. H. Coxon.*)

Bennett, Henry Arthur, General Manager, Trinidad Petroleum Development Co., Ltd., Trinidad. (*G. W. Halse ; C. C. Wilson.*)

Chamberlain, Sydney, Student, University of Birmingham. (*T. G. Hunter ; A. H. Nissan.*)

Coles, Gordon Lemuel, Assistant Manager, Chemical Dept., Petroleum Board. (*F. N. Harrap ; C. Chilvers.*)

Gibali, Salah El Din El, Engineer, Shell Co. of Egypt, Ltd. (*H. A. Blackmore ; D. R. Howgill.*)

Gilmour, Hugh, Production Superintendent, Apex (Trinidad) Oilfields, Ltd. (*A. H. Richard ; H. W. Reid.*)

Gupta, Kishori Lal, Lubrication Engineer, The Delhi Cloth & General Mills Co., Ltd.

Hodgson, Maurice Stuart, Assistant Chemist, " Shell " Refining & Marketing Co., Ltd. (*D. Morten ; K. L. Butcher.*)

Kelley, John Douglas, Editorial Consultant. (*G. H. Coxon ; F. B. Thole.*)

Kinner, George Henry, Chemist-in-charge, Covent Garden Outstation, Ministry of Supply. (*D. Clayton ; D. M. Duckworth.*)

Korra, Kamal El Din, Engineer, Shell Co. of Egypt, Ltd. (*H. A. Blackmore ; D. R. Howgill.*)

Mackilligin, Robert Guy Walter, Exploitation Engineering Trainee, United British Oilfields of Trinidad, Ltd. (*J. E. Smith ; F. C. Hamilton.*)

Maclachlan, Ronald Ian, Production Engineer, Apex (Trinidad) Oilfields, Ltd. (*H. W. Reid ; A. H. Richard.*)

Mills, Robert Benjamin, Chemist, Shell Petroleum Co., Ltd. (*W. R. P. Hodgson ; J. Parrish.*)

Murray, Frederick, General Manager, Anglo-Dutch Petroleum Co. (Western), Ltd. (*J. H. Maltby ; N. D. Roughsedge.*)

O'Donoghue, Denis John, Exploitation Engineer, United British Oilfields of Trinidad, Ltd. (*J. E. Smith ; F. C. Hamilton.*)

Padfield, Reginald John, Installation Manager, Shell Wharf, Fulham. (*A. H. Stephenson ; E. P. Lancashire.*)

Piercy, William Edwin Keith, Manager, Development Dept., Messrs. Albright & Wilson, Ltd. (*A. E. Hope ; F. H. Garner.*)

Pinfold, Ernest Sheppard, Consulting Geologist, Messrs. Steel Bros. & Co., Ltd. (*J. Mitchell ; G. W. Lepper.*)

Reed, Geoffrey Woolmer, Assistant Installation Manager, Shell Co. of Egypt, Ltd. (*H. A. Blackmore ; D. R. Howgill.*)

Smith, Albert, Plant and Production Chemist, Sternol, Ltd. (*A. L. Read ; G. E. Shelbrooke.*)

Wardle, Mrs. H. M. L., Experimental Officer, Scientific Civil Service. (*D. Clayton ; D. M. Duckworth.*)

Applications for Transfer.

Capper, Max, Technical Representative and Importer in Brazil. (*Member to Fellow.*)

Frankel, Paul Herzberg, Managing Director, Raven Oil Co., Ltd. (*E. J. Dunstan ; C. W. Wood.*) (*Member to Fellow.*)

Frost, James, Exploitation Geologist, Trinidad Leaseholds, Ltd., Trinidad. (*Student to Associate Member.*)

Taylor, Paul Arthur, Exploitation Engineer, United British Oilfields of Trinidad, Ltd. (*J. E. Smith ; F. C. Hamilton.*) (*Student to Associate Member.*)

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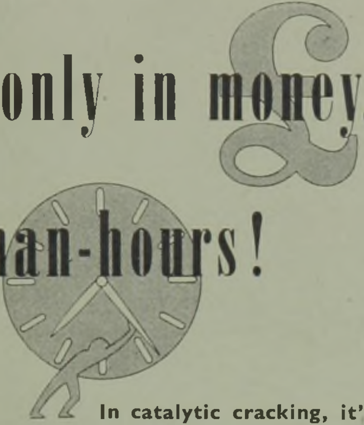

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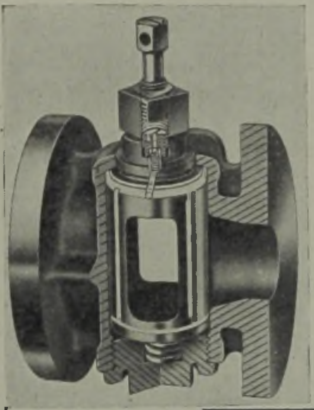

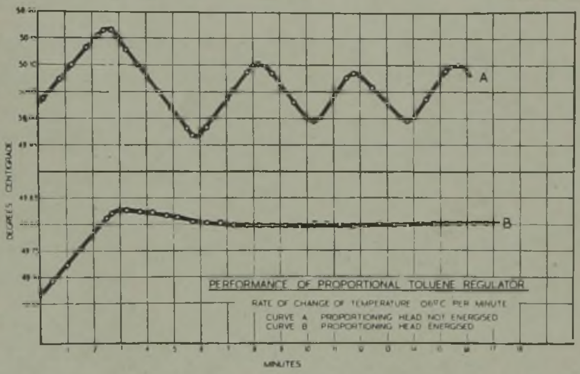

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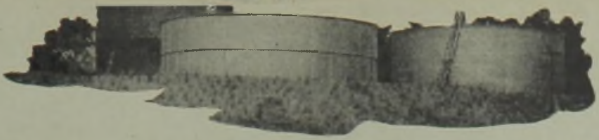

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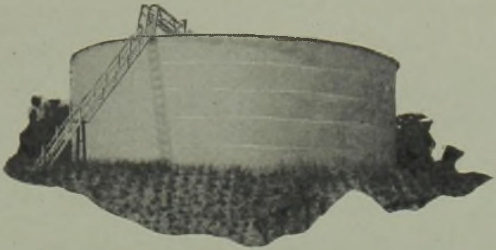

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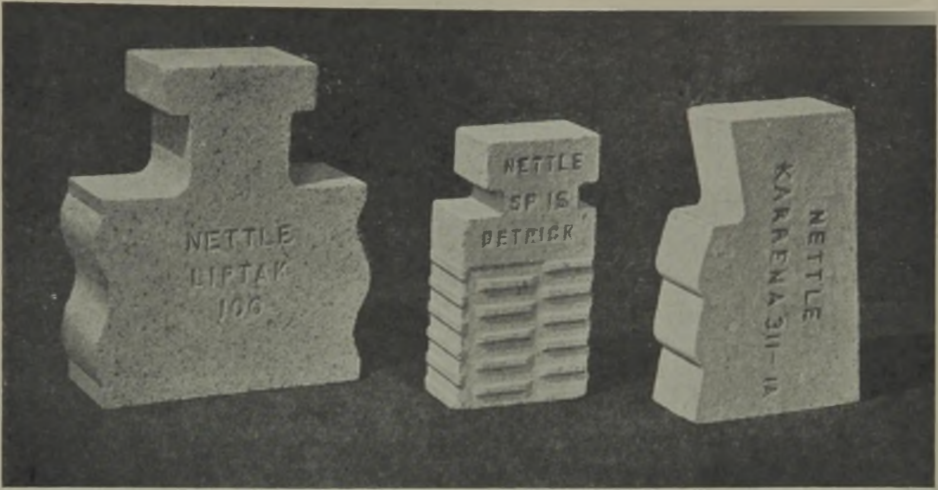
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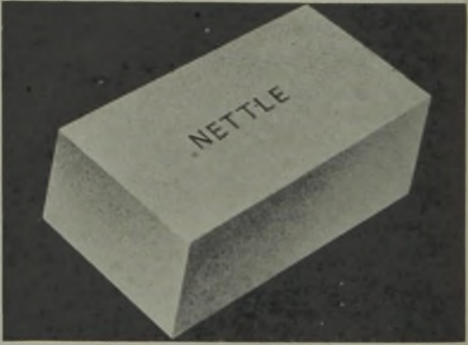
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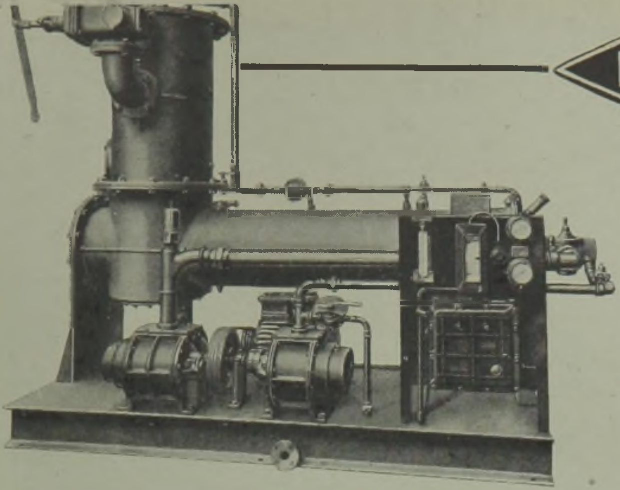

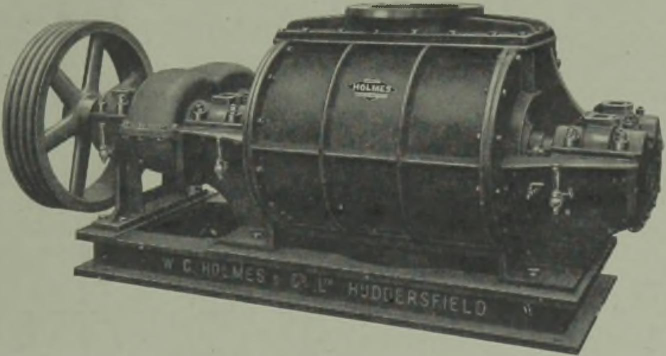
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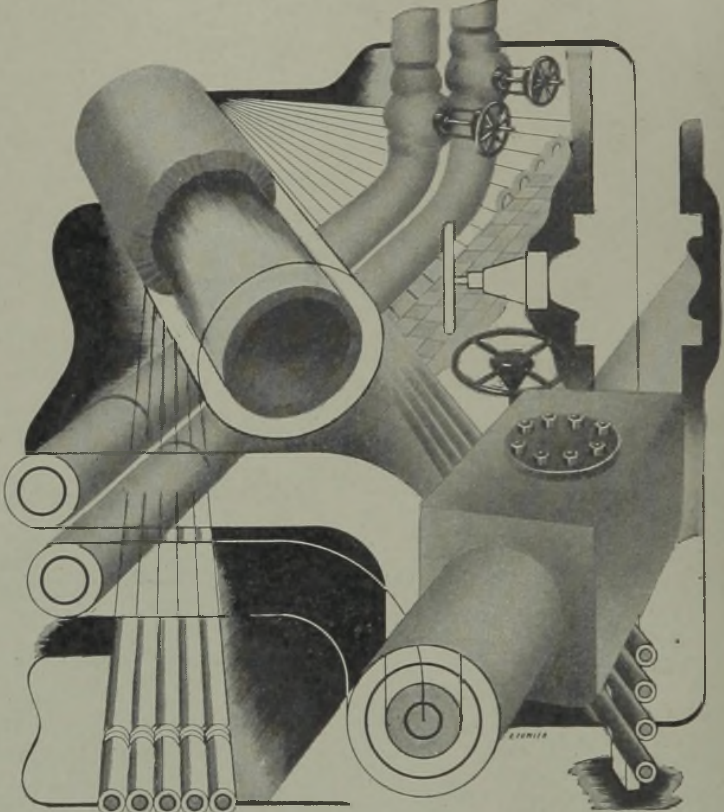

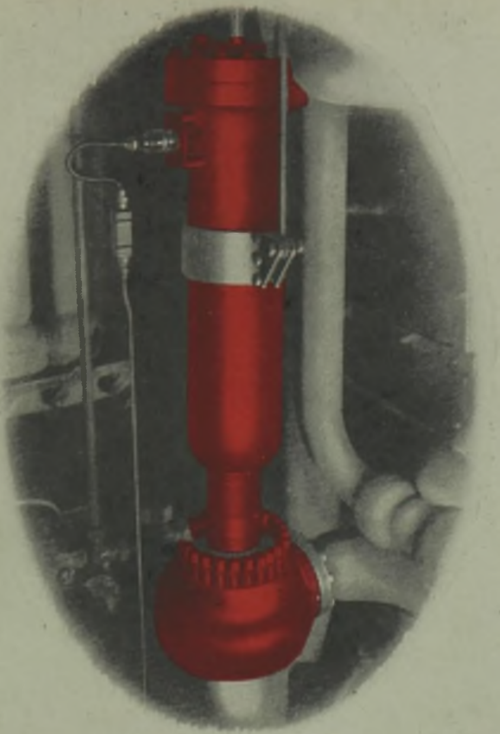

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Motor subjected to full boiler pressure, in this instance, 650 lbs. per sq. inch.

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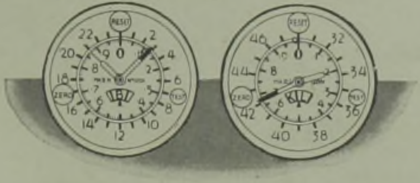

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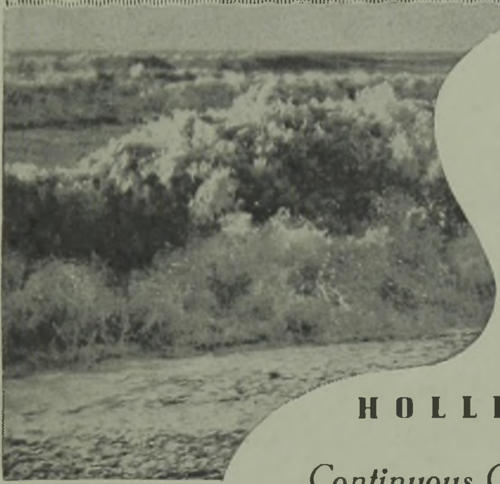

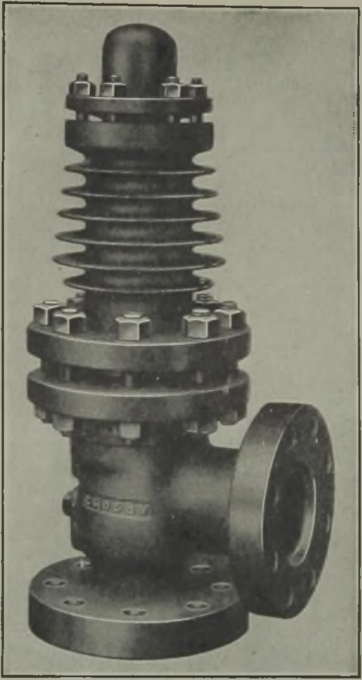
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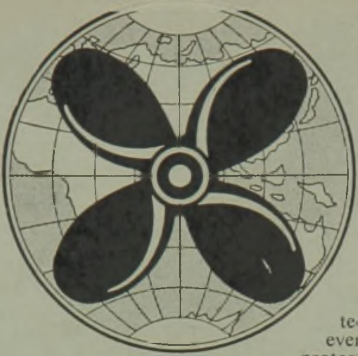

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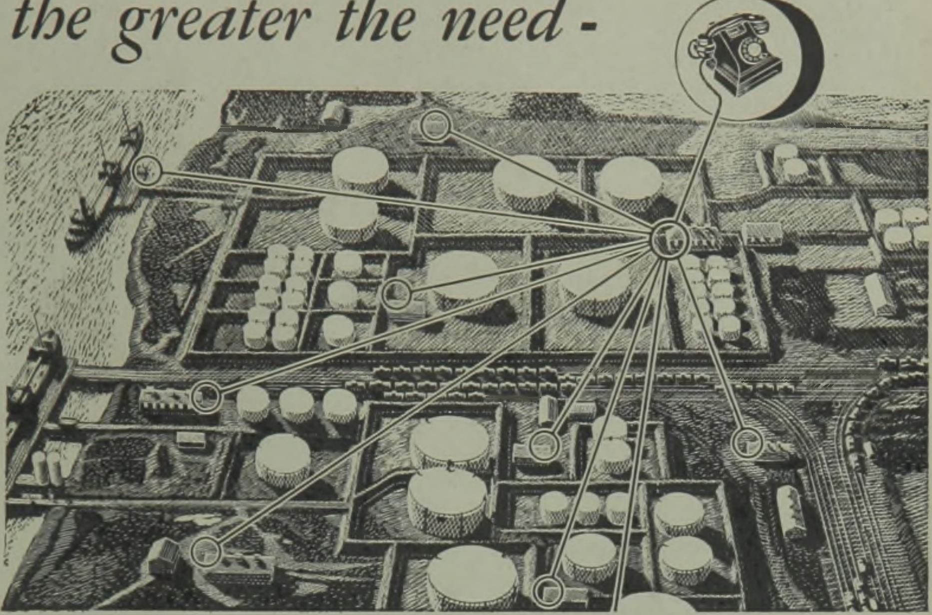


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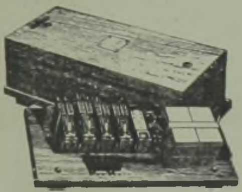

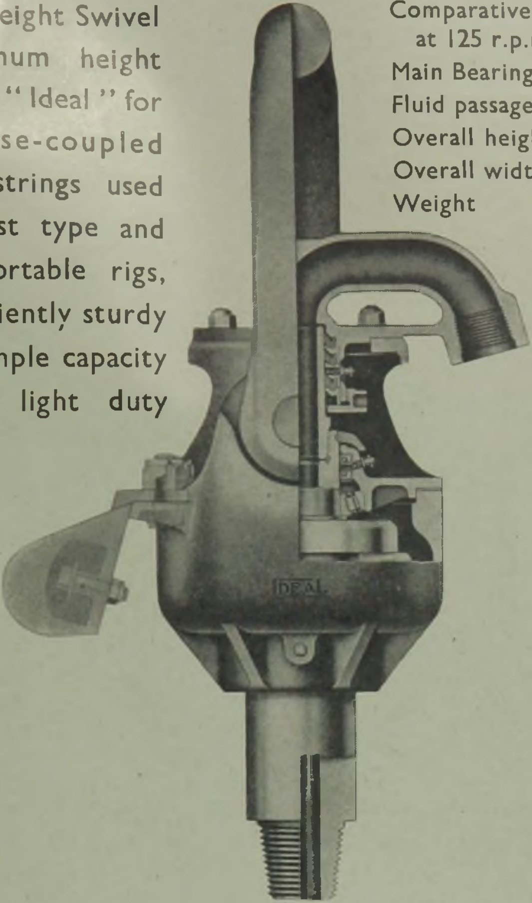
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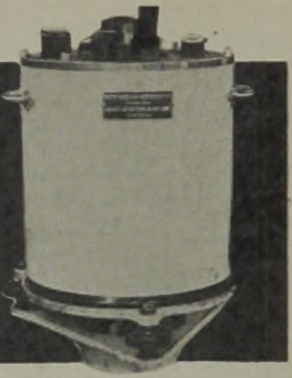

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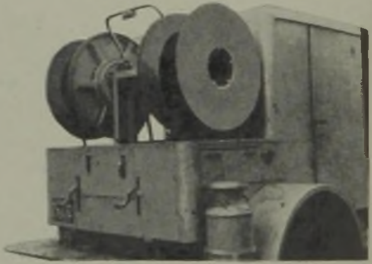

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