ABSTRACTS.

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The numbers refer to the Abstract Number.

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Geology and Development.

384.* Heart Mountain and South Fork Thrusts, Park County, Wyoming. W. G. Pierce. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2021–2045.—Between Yellowstone National Park and the Big Horn Basin, the South Fork nappe with up to 3800 ft. of beds, mainly shales, of Sundance (Jurassic) to Cody (Cretaceous) age, including a recumbent anticline, has moved towards the south-east, being diverted from an easterly direction by the Rattlesnake anticline. When viewed over a stretch of several miles, the sole of thrusting is seen to undulate, and in the zone of fracture, sometimes only 2 ft. thick, quartz pebbles and boulders, before breaking, seem to have acted as " ball-bearings " upon which horizontal displacement was facilitated. Movement was completed before deposition of the last of the Wasatch sandstones which are terrestrial and contain a Lower Eocene fauna, including *Coryphodon*, *Eohippus*, *Heptodon*, *Homogalax*, and *Lambdotherium*.

The subsequent Heart Mountain thrusting, which took place near the close of the Lower Eocene, brought a fairly horizontal sheet of Ordovician to Mississippian rocks, up to 1300 ft. thick, a distance of 34 miles eastward. In Sunlight Basin the sole was subterranean, but elsewhere the thrust-sheet moved across an erosion surface, probably of low relief, upon such earlier structures as the large anticlines of the Rattlesnake and Pat O'Hara Mountains and the smaller Shoshone anticline. Pebbles in underlying conglomerates were shattered by the thrusting, and near Dead Indian Creek a 150-ft. limestone conglomerate, eroded from the advancing mass, was deposited in front of it, and finally over-ridden. The roots of the nappe are concealed, probably under the volcanics of the Absaroka Mountains. The " early basic breccia," Middle Eocene (?), was erupted from fissures and vents of irregular shape, commonly aligned along north-west–south-east zones of crustal weakness. Movement of the breccia is regarded as having tilted some limestone blocks near the vents. A. L.

385.* Post-Appalachian Faulting in Western Kentucky. R. Rhoades and A. J. Mistler. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2046–2056.—The Devonian to Upper Carboniferous rocks in the Ohio, Tennessee, and Cumberland River regions of Western Kentucky are complexly faulted, especially near the Ohio River, where the major fractures continue for many miles and fault-blocks show displacements sometimes exceeding 1000 ft. The main blocks are crossed by a mosaic of smaller, usually vertical faults. A formerly continuous, unconsolidated cover of Upper Cretaceous—Tuscaloosa clayey gravels unconformably overlain by Ripley fine sand with argillaceous intercalations—and of Tertiary gravels furnish little clear evidence of fault-planes, although maps prepared under Jillson, who insisted that some of the faults were still active, show the Oakland fault cutting the Tuscaloosa. Roberts located Mesozoic and later faults by juxtaposition of Mississippian and Cretaceous and by high local dips in the Tuscaloosa. Slumping obscures most sections unless in recent cuts, but, from the latter, new evidence is drawn concerning intra-Tuscaloosa faults, down-throws of Ripley against Tuscaloosa, and probable throws of Tuscaloosa and Ripley against Mississippian residual chert and clay. Since the pre-Cretaceous surface was of slight relief, concealed faults may also be deduced from zones of sudden thickening in the Tuscaloosa, probably indicating movement connected with the intermittent development of the Mississippi embayment. Clay and pebble dykes up to 9½ ft. wide provide proof of earthquake vibrations though not necessarily due to movement of adjacent faults. These sedimentary dykes traverse the Pliocene (?) terrace gravels, but not those of Pleistocene age, have numerous off-shoots, and may be inclined at as much as 45°. A. L.

386.* Non-Marine Origin of Petroleum in North Shensi, and the Cretaceous of Szechuan, China. C. H. Pan. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2058–2068.—The margins of the basin of North Shensi show Cambro-Ordovician limestones and a Permo-Carboniferous coal series. The filling of the central part is non-marine : Shihchienfên purplish-red sandstone, about 600 m. (Permian) ; Yenchang grey cross-bedded sandstone with plants, lamellibranchs, and fish-scales, about 1270 m. (Upper Triassic) ; Wayaopu coal-bearing beds, 850 m. (Rhaetic and Lias) ; Anting red sandstone and argillaceous limestone with *Pholidophorus*, 80 m. (Upper Jurassic); Paoan red sandstone and shale, about 2000 m. (Cretaceous); reddish clay and loess (Upper Pliocene-Pleistocene). There are widely scattered, but minor, oil seeps from eight horizons, five in the Yenchang and three in the Wayaopu. As there is no intense folding or faulting the oil probably comes from lacustrine shales near the oil sands. It could not have migrated, without dissipation, from the deep Palæozoic marine beds under the thick sandstones and shales of the Shihchienfên series. Favourable structures seem rare. The oldest well at Yenchang has yielded 0·3 brl./day for 20 years. The greatest initial yield from a well was 34 brl./day, but this soon decreased to 1 brl.

In Szechuan province new industries are growing up and it is still hoped to find commercial oil on a small scale. The succession is: Feihsienkuan purple shale and thin limestones with *Pseudomonotis*, about 200 m. (Lower Triassic); Chialingchiang limestone and dolomite, containing foraminifera and lamellibranchs, about 600 m. (Middle to early Upper Triassic); Hsiangchi greyish coarse sandstone, dark shale, thin coals, about 500 m. (Lower Jurassic); Tzuliuching grey and red shale and sandstone, followed upwards by Chiating red beds with some black shale and thin limestones yielding the freshwater shells *Cyrena* and *Unio*, over 2000 m. (Cretaceous). Two seepages are known near anticlinal axes in red Tzuliuching, and thirty wells of about 70 m. have been drilled, two of which yielded 67 brl. before exhaustion. The source is probably in Tzuliuching limestone. There are also reports of oil-sands in the Chialingchiang and the Hsiangchi formations of the Fushun–Loshan area, where the oil presumably originates from the marine Triassic.

North Shensi and Szechuan both produce salt, and the connate water of the former field is generally saline, so that concentration to a salinity of 3000 p.p.m. may have allowed anærobic bacteria to transform organic remains into petroleum. In fresh waters only coal and oil-shale may be produced, since ordinary bacterial decay does not remove a sufficient amount of the tissues of plants or appreciably act on fats. A secondary consideration is that organic matter in lacustrine sediments may often exceed that of marine deposits. A. L.

387.* Graywackes and the Petrology of the Bradford Oilfield, Pennsylvania. P. D. Krynine. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2071–2074.—It is pointed out that the Third Bradford Sand (Upper Devonian) was deposited as a series of coalescing small deltas along a subsiding shoreline where rainfall may have been heavy, not as a delta like that of the Mississippi or like Fettke's two-lobed delta. A contrast is drawn between the greywackes of this deposit and the quartzose sandbars studied by P. A. Dickey in the Titusville quadrangle. It is emphasized that the clastic fragments in greywackes typically include rounded or angular pieces of other rocks such as shale, slate, sandstone, chert, quartzite, mica, iron ores, as in the Bradford greywacke, as well as basic and other igneous shards, in an argillaceous binding. Numerous references are given, including one, historically important, to C. F. Neumann's *Lehrbuch der Geognosie* (1850). A. L.

388.* Mississippian Formations [with Reef-Knolls] of Sacramento Mountains, New Mexico. L. R. Laudon and A. L. Bowster. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2107–2160, with Bibliography.—The Sacramento range runs south from the igneous peak of Sierra Blanca, in South Central New Mexico, and for the most part along it Mississippian limestones dip eastwards away from a western fault-scarp. They rest unconformably on the Percha shales (Devonian), but are in no place in contact with the basal Percha silts, or with the underlying Niagaran (Silurian) limestone. The unconformity is marked by an oxidized zone with phosphatic concretions and some fish-teeth. The Mississippian is overlain, with sharp unconformity, by Pennsylvanian, and in hollows of the surface of contact there are chert conglomerates.

In the Lower Carboniferous the species comprised in Kinderhook and Osage faunas respectively are almost entirely different, though ancestors of specialized Osage forms occur in the earlier formation. The Osage yields diversified crinoids, including highly adapted types like *Eutrochocrinus chrystyi* and *Uperocrinus pyriformis*, and ponderous branchiopods like *Spirifer rowleyi* and *S. grimesi.* From the Appalachians to the western United States, following an erosional break, beds of Osage age overlap widely upon older beds, so that the Kinderhook has a definite upper limit.

The Caballero formation of the Sacramento Mountains belongs to the Kinderhook, and consists of nodular, grey, shaly limestone, about 50 ft. thick at the type section in Deadman Canyon. Re-worked Caballero sediments appear in the base of the Alamogordo, which, together with the succeeding Arcente and Dona Ana members, constitutes the Lake Valley formation of Osage age. Characteristically the Arcente is of soft grey siltstone and shale, while the Dona Ana is hard crinoidal limestone with chert and small bioherms. The Alamogordo is more varied. In the type section it begins with *Taonurus* silts, about 25 ft., and these are followed by black cherty limestone, 17 ft., which expands laterally into mainly bioherm (reef-knoll) accumulations with maximum thickness, as in the San Andreas Canyon, of about 200 ft. The bioherm hummocks have fairly flat bases, from about 1 ft. in diameter to 1 mile across, and towards their outer margins, where fossils increase in number, definite bedding can often be recognized, with dips of as much as 40° on the west sides, which seem to have faced prevailing currents or waves. Away from the exposed side the bioherm material fingers into fine-bedded grey crinoid limestone, which thins and passes underneath a green crinoidal sand. Limestone conglomerates also occur close to the bioherms, but in at present unpredictable relations, and frequently show relatively angular bits of the underlying facies enclosed in the grey or green crinoidal rock. Farther back, on the sheltered side of the reef-knolls, are bluish-grey marls, deposited in a lagoonal environment, and containing the unbroken crinoids for which South-western New Mexico is famous. This bed may be only a few feet thick. Above it, upper grey crinoidal beds, though only poorly represented to seaward of the bioherms, fill up the protected—and possibly relatively warm—basins behind them.

Thanks to the reef-knolls, the upper boundary of the Alamogordo is irregular, but there is no fragmentation or evidence of overlap at the base of the Arcente silts, 100 ft. thick in Deadman Canyon, albeit these vary from 0 ft. over the large San Andreas knoll to 155 ft. less than a mile away from it. The only sign of disconformity reported is in San Andres Canyon, of the San Andres range, west of the one under discussion, where red oxidized streaks and broken shells occur above a bioherm. There is no great difference between the faunas of the Arcente silts and the succeeding Dona Ana coarsely crystalline crinoidal limestone, 55 ft. in type section. They are equal in age to the Lower Burlington of the higher part of the Mississippi valley, while the Alamogordo is principally pre-Burlington.

The Mississippian, with the exception of the Caballero, becomes attenuated towards the south end of the Sacramento Mountains. A. L.

389.* Experiments with Lights, Shadows, and Contours, and the Resulting Shadowgraphic Contour Maps. R. F. Imbt. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2161–2169, with Bibliography.—Contours date back to Cruquius, 1728, in Holland, and hachures, replacing cruder hatchings, to Muller, 1788. Of later development were graduated tints and relief-shading, the latter seen to advantage in French military maps, in which a dual source of light is employed, and in the United States Geological Survey maps of Lake Lahontan, 1885, and Lake Bonneville, 1890. Owing to cost of lithographing, the United States shelved this technique till 1921, when photolithography at last permitted the economical reproduction of the most delicate shades. Light and shadow have subsequently been applied as if the mapped areas lay under a 4 p.m. sun in late summer.

In representation of geological structure little use has been made of shading, though it would render maps more intelligible to administrators, commissions, juries, students, and even geologists. Plates are provided of five subsurface maps, on which Robert Imbt has added, by hand, gradational shadows to bring out, at a glance, folding and throw of faults. The following rules are suggested : (1) Contours and other details must not be obscured ; (2) lighting must be from a northerly direction—the United States Geological Survey and Engineering Corps restrict themselves to a northwesterly light in their " shaded topographic " and " pictorial relief " maps—but in geological work it is desirable to have the direction of lighting at right angles to the predominating structural axis ; (3) the best elevation of the source of light is about 30° above the plane of the map ; (4) deep shading should be confined to surfaces sloping away from the source of light, and must never transgress the axis of a syncline ;

(5) the downthrow side of a fault is always shaded, but the shadow is softened if the downthrow side is towards the light; (6) the lighting effects are those to be expected from a polished surface, on which contours have been plotted; (7) to eliminate the range-finding ability of the two eyes, it is well to observe the map with only one. A. L.

390.* Deposition of Free Oil by Sediments Settling in Sea-Water. O. A. Poirier and G. A. Thiel. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2170–2180. Specimens of Decorah (Ordovician) sericitic shale, Blue Earth quartzose and argillaceous silt, freshwater calcium carbonate marl, bentonite rich in montmorillonite, diatomaceous earth of hydrous or opaline silca, oil-shale, humus soil with high organic content and low sp. gr. when dry, silt made up of quartz and calcium carbonate, calcareous and sericitic shale, silty sand mainly of quartz and sericite, and kaolin from granite gneiss, were crushed and screened to two sizes—$\frac{1}{4}$–$\frac{1}{8}$ mm. and less than $\frac{1}{8}$ mm. 1-gm. samples were then deflocculated, by means of a soil-dispersion machine, for 5, 10, or 15 mins., in mixtures of 2·5 c.c. Mid-Continent crude oil, of 32·7° Be at 60° F., emulsified in 200 c.c. artificial sea-water. High concentrations of sediment were avoided, since particles, if too numerous, increase the viscosity, and may set up vertical currents which carry oil upwards.

Humus and oil-shale, which are rich in organic particles, settled very small quantities of oil, which, on microscopic examination, was seen to assume laminar rather than globular forms, due to organic acids lowering oil-water interfacial tension (Traube's rule). In the other cases varying quantities of oil-globules were carried down by the weight of adhering mineral grains. Farenwald has shown that the film of oil adsorbed by a mineral surface is thickest on galena and thinnest on quartz. Quartz and calcite do, however, stick to oil-globules, and any electrical charges on oil or mineral particles, which might cause mutual repulsion, are neutralized by the NaCl electrolyte. Irrespective of mineral composition, fine-grained sediments, with the possible exception of bentonite, carry down most oil. Large fragments of mineral may fail to adhere to globules, because of too much weight per unit of attracting force. Again, in certain circumstances, lowered surface tension may allow the buoyancy of the oil-globule to exceed its internal coherence, so that part of it breaks away. A. L.

391.* Trace-Slip Faults. R. H. Beckwith. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2181–2193.—Trace-slip faults are those in which the movement is parallel with the trace of strata or other planar elements upon the fault-plane. Following erosion, such faults may leave no evidence in the form of offset (side-stepping), omission, or repetition of beds. Even where the fault-plane is visible and shows slickensides, the latter may indicate only the direction of the last, and not of the major movement. The study of this kind of oblique dip-faulting is important in interpreting displacements which cross anticlines in the Rocky Mountain oil region—*e.g.*, in the Laramie Basin, Wyoming. One example is of a thrust dipping west at 40° in an overfolded anticline, and apparently fading out, while what looks like a normal east–west fault crosses the adjacent syncline. Actually the two are the same fault due to one oblique movement, and the connection between the two parts is obscured by the trace-slip factor. Intersecting thrust and tear-faults, if the displacement of both is in the same oblique direction, even though of different ages, need not appreciably interrupt each other's outcrops.

Some anticlines, like those of Rock Creek and Clay Basin Dome, are marginal folds formed, at least in part, by compression of Cretaceous beds in front of rising and advancing nappes of older rocks, but others, in synclinal basins far from travelled nappes, may actually overlie thrusts initiated in underlying pre-Cambrian crystalline rocks capable of transmitting stress from a distance. Such thrusts increase in dip and die out towards the surface, and trace-slip faulting in this kind of structure, parallel either to the anticlinal axis or to beds on one or other side of it, produces the appearance of ordinary dip faulting with great variation of throw, or even of pivotal faulting with opposite throws in different directions. If the oblique nature of the displacement is not recognized it may be difficult to correlate producing zones on the flanks of the faulted anticline. Sections on transparent paper should be

prepared for each side of these faults, and the two diagrams may then be made to coincide by trial movements which can often be simplified to one oblique adjustment.
A. L.

392. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 4. Townships 24 and 25 North, Ranges 10 and 11 East. L. E. Kennedy, J. D. McClure, H. D. Jenkins, and N. W. Bass. *U.S. Dept. Inter., Geol. Surv. Bull.* 900D, 1940, 131–171.—The area dealt with in East Central Osage County, Oklahoma, is a few miles south-west of Bartlesville. About 2350 wells have been drilled, and some dating from 1905 are still producing. Only gas is obtained from the Siliceous Lime (Ordovician), the upper part of which is a crystalline dolomite with chert, and this gas is concentrated in the tops of domes. The Bartlesville sand, laid down as beach deposits in the early Pennsylvanian, occurs at depths of 1500–2100 ft., and is the chief reservoir, the distribution of oil depending on stratigraphical factors rather than on structural attitude. Contouring of the Oswego Lime, about 400 ft. above the Bartlesville, seldom shows closure of over 100 ft. New oil localities should be revealed by prospecting, and much oil should also be obtained by repressuring the Pennsylvanian sands with gas or water, as has already been done, with gas, in the Bartlesville of the Avant field.
A. L.

393. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 5. Townships 26 and 27 North, Ranges 10 and 11 East. L. E. Kennedy, W. E. Shamblin, O. Leatherock, and N. W. Bass. *U.S. Dept. Inter., Geol. Surv. Bull.* 900E, 1940, 173–208.—The area lies in North-eastern Osage County, about 3½ miles west of Bartlesville. The Siliceous Lime (Ordovician), eroded to different depths on domes, sometimes with nearly the whole thickness of 1000 ft. removed, yields only gas, though in Southern Osage County it yields oil. The most productive zones are in the sub-angular quartz sands of the Bartlesville (early Pennsylvanian) irrespective of structure, and in the weathered Mississippi cherts and the coarse quartzose Burgess sand of the Mississippian–Pennsylvanian unconformity, where the oil occurs usually low on the flanks of domes and in synclines. Closures are small, and the regional dip is westward at about 30 ft./ml. There are a few localities where drilling may encounter new oil- and gas-pools.
A. L.

394.* Ohio–Clayton Pool in Perry County Best Recent Ohio Discovery. Anon. *Oil Gas J.*, 29.1.42, **40** (38), 187.—At Clayton in South-east Ohio forty-five producers were drilled to the Clinton sand, extending the pool to 5 sq. ml. The average production of these wells is 152 brl./day, as compared with 14 brl./day for the whole State.

East of Thornville, in Perry County, another Clinton oil-pool was opened. Extensions were made to the Bush Creek gas-pool.

In Central Ohio the Newark gas-field seems to have reached its peak. Water-flooding was undertaken in the Berea sand in the Lodi field.

Numerous wildcats were drilled in the eastern part of the State, but, with one exception, the results did not seem to warrant further testing.
G. D. H.

395.* Extensive Activity in Western Canada Seen for Coming Year. T. P. Sanders. *Oil Gas J.*, 19.2.42, **40** (41), 60.—Late last summer the first commercial producer was completed on the Twin River structure in Southern Alberta. 75 brl./day were produced during a ten-day test. Near by are three well-defined structures—Del Bonita, Ross Lake, and Spring Coulee. All these structures lie on the north-west flank of the Sweetgrass arch, and are local closures on anticlinal folds or noses. Del Bonita, Ross Lake, and Spring Coulee are on the Chalk Butte nose, while Twin River is on a parallel nose to the east, with the Madison apparently nearer the surface than on any other Canadian structure. The oil at Twin River is in the Madison, beneath the Ellis.

The four structures have been examined by geophysics and core-drilling as well as by other means. The first well on the Twin River structure gave oil, but went over to water mainly on acidization. The second well came in at 6,000,000 cu. ft. of gas/day with some oil. A third well was dry. While the fourth, and successful well was being drilled, cores were examined carefully to ensure that bottom-water was not penetrated or other slips made. Acid treatment and cementation were carried out, and the well was completed as a pumper.

The reflection seismograph showed the apex of the structure at depth to be east of the apex of the surface structure, and the same condition exists at Del Bonita. Two tests have been drilled to inconclusive depths on the Del Bonita structure, one finding 1,500,000 cu. ft. of gas and 10 brl. of oil/day from the Madison at 5136 ft. The Madison is much deeper on the Ross Lake and Spring Coulee structures, which have been studied geophysically.

Three hundred miles to the north the Vermilion field is being developed. Eleven wells are producing from the Cretaceous at depths of about 1800 ft. G. D. H.

396.* Argentine Increased Oil Output during 1941. Anon. *Oil Wkly*, 9.2.42, **104** (10), 56.—During 1941 Argentine produced 22,015,138 brl. of oil, a rise of 6·8% above the 1940 figure. Comodoro Rivadavia, Mendoza, Plaza Huincul, and Salta yielded 15,718,000, 3,344,470, 1,071,318, and 1,880,015 brl. of oil, respectively. The Mendoza output rose by 33%.

Only 16,000,000,000 cu. ft. of gas were produced in 1940. G. D. H.

397.* Arkansas Discovery Opens Vast Region for Exploration. G. B. Nicholson. *Oil Wkly*, 16.2.42, **104** (11), 21.—A seemingly important discovery has been made recently at Midway, in Lafayette County, Arkansas, in a previously condemned area which is separated from other deep production by a fault, generally believed to mark the limits of Smackover lime production. Furthermore, the oil and gas discovered are free from sulphur, which is one of the objectionable points about the usual Smackover production.

A fault zone runs generally north-east near the Midway pool, continuing to Nevada and Ouachita counties before turning south-east. It may be connected with the Balcones–Mexia fault system. Wells drilled near the faults usually found low permeabilities. The Midway field, lying some distance north of the fault zone and apparently unconnected with it, appears, from reflection seismograph work, to be a dome. The Smackover formation has an upper oolitic lime zone of high porosity, a middle non-permeable zone, and a lower granular, porous zone. The discovery well encountered the Smackover at a depth of 6296 ft. The casing was perforated in the oolitic zone at 6340–6370 ft., and the well's initial flow was 80 brl./hour through a 20–64-in. choke, with a gas/oil ratio of 257. The lime has a porosity of 21% and a permeability of 500–700 millidarcys. The oil gravity is 35·5. A bottom-hole pressure of 2915 lb./in.^{2} and a temperature of 173° F. were recorded.

The structure may cover 5000 acres, and the results of core examination indicate reserves of 36,000 brl./acre for the oolitic zone. Two maps and an electric log are included. G. D. H.

398.* Texas–Louisiana Coastal Region Holds Many National Records. R. Reaves. *Oil Wkly*, 16.3.42, **105** (2), 33.—Excepting Texas itself, the Texas–Louisiana Gulf Coast has few rivals from the standpoint of reserves, yield to date, and current production. The reserves have risen steadily during the past few years to 3,864,587,000 brl., nearly one-fifth of the total current U.S.A. reserve. 181,937,594 brl. of oil were produced in 1941, as compared with 162,563,323 brl. in 1940. The 1941 output was third to Texas and California, and in that year the South Louisiana production exceeded that of the Texas sector of the coastal region for the first time. At the beginning of 1942 the daily output was 558,483 brl./day, a figure exceeded only by Texas and California.

Thirty-five new fields were discovered in 1941 as compared with thirty in 1940. Fifty-nine new producing horizons were found on known producing structures in 1941. South Louisiana leads all other areas by a wide margin in the number of deep producing fields and wells. It has thirty-two fields producing below 10,000 ft., while Texas has six fields flowing oil or distillate below that level. 800 of the world's 1133 10,000-ft. wells are in this region.

The most important recent discoveries are Bayou Sale, St. Gabriel, and Pine Prairie in Louisiana, and Oyster Bayou and Lake Creek in Texas. The largest recent extensions were at North-east Gibson and Old Ocean, while new sand bodies were opened at West Bay, Venice, Gueydan, Erath, Chocolate Bayou, Hull, Dyersdale, Lucky, and North Markham.

The Wilcox trend was one of the most active, resulting in discoveries at Lake Creek and Magnolia.

Conroe is the largest of the Gulf Coast fields. Fields with reserves in excess of 100,000,000 brl. include Hastings, Old Ocean, Anahuac, Thompson, Friendswood, Conroe, Ville Platte, Lafitte, and Paradis. Six fields on the Texas Gulf Coast and one in South Louisiana have given over 75,000,000 brl. of oil to date. G. D. H.

399.* Texas Gulf Coast Field Development, Producing and Reserve Data by Fields. Anon. *Oil Wkly*, 16.3.42, **105** (2), 35.—The fields are arranged alphabetically according to counties, also arranged alphabetically, and the following data are given: discovery date, range of producing depths, producing formations, proved acreage, spacing, the total producing wells and the number flowing, the daily production, the production during 1941 and the total production to date, estimated reserves, the depth and formation reached in the deepest test, the gravity range of the oil and the number of rigs running. G. D. H.

400.* Louisiana Gulf Coast Field Development, Producing and Reserve Data by Fields. Anon. *Oil Wkly*, 16.3.42, **105** (2), 37.—The same types of data are given as for the Texas Gulf Coast, and the arrangement is the same as for that region. G. D. H.

401.* Wilcox Trend Play at Peak. K. H. Ferguson and S. R. Casey. *Oil Wkly*, 16.3.42, **105** (2), 41.—Prior to May 1937 Wilcox production in the Gulf Coastal area was confined to the Clay Creek and Kittrell salt domes, but the completion at that date of a well at Joe's Lake showed oil to occur commercially in Wilcox sand bodies, and that the Wilcox persisted down-dip. Along this Wilcox trend the Cockfield highs along the old Conroe trend offer excellent possibilities of new deep production. Most of these prospects have been drilled and found barren of commercial production in the Cockfield and Yegua, apparently due to insufficient closure. Wilcox production has been established on structures already producing from the Cockfield and Yegua.

A study of the geophysical data in Lavaca, Colorado, and De Witt counties reveals a series of long and more or less parallel faults, mostly strike-faults with closure on the down-dip side and of greatest amount in the Wilcox. There is a need to search for stratigraphical traps.

The reflection seismograph appears to be the most valuable geophysical instrument in the present search, with subsurface geology playing a major part in the exploration of the producing trends. There is evidence that the Wilcox is deltaic; correlation of sand from well to well is often impossible.

Investigation of the Wilcox trends calls for subsurface geological work, followed by geophysics to check any anomalies; the drilling procedure should be beyond reproach, with coring where possible and a search for new methods of detecting oil and gas, for in the Wilcox it is often difficult to distinguish an oil-sand from a water-sand by electrical logging. In this connection mud analysis, geochemical analysis, and fluorescence analysis seem to offer possibilities. G. D. H.

402.* Gulf Coast Oilfields, Salt Domes, and Prospects. Anon. *Oil Wkly*, 16.3.42, **105** (2), 59.—The following information is given, where possible, for the fields and prospects arranged alphabetically under alphabetically arranged counties or parishes: location, means of discovery, discovery well, structure, elevation, producing formations, proven acreage, cumulative production, estimated reserve, daily production, the number of producing wells and the number of rigs running on 1st January, 1942, gravity of the oil, data about the deepest test, oil outlet, principal leaseholders, and sundry remarks. G. D. H.

Geophysics.

403.* Present Status of Geophysics in Canada. Part I. A. A. Brant. *Trans. Canadian Inst. Mining and Met.*, January 1942, **45** (357), 45–65.—A general study of the chief geophysical methods is made in two parts of this paper. Historical development is sketched. The following are the chief geophysical exploration methods in common usage, tabulated in approximate chronological sequence of practical development : (1) magnetic ; (2) gravimetric ; (3) electric ; (4) seismic ; (5) radioactive ; (6) soil and gas analysis. Method (3) is subdivided into (A) self-potential, (B) resistivity (C) electromagnetic.

Methods 1, 2, 3B, 4, 5, and 6 are being used in petroleum exploration, with 2 and 4 being extensively applied and yielding highly satisfactory results ; over 20% of wells thus spotted are producers.

Methods 1, 2, 3, and 4 have been attempted in various Precambrian regions. Method 1 has consistently yielded reliable data. Applications of 3A and 3B have met with only limited practical success. Method 3C has many field limitations, while 2 and 4 have been tried only a few times. These methods are discussed in the paper under the following headings : (1) physical basis of method ; (2) instruments ; (3) field procedure ; (4) interpretation ; (5) applications and limitations with field practice. Part I of the paper deals only with methods 1 and 2. The economics governing application of geophysics is briefly discussed.

Interpretation consists of finding the approximate location, extent, and nature of the rock bodies (*a*), structural occurrences (shears, faults) (*b*), bed-rock features (*c*), and topographic and overburden conditions (*d*), that cause the observed anomalies. Only (*a*) and (*b*) are of practical importance ; consideration of (*c*) and (*d*) as a cause of anomalies is, however, obviously necessary. The process of interpretation occurs in two steps : (1) the location and breadth of the anomaly-producing bodies are found by breaking down the experimental profile curves into recognizable component parts due to bodies of known cross-sectional form ; or by combining the values across known geometrically shaped bodies to give results similar to the field-observed. (2) To the various bodies a lithological or structural characteristic is assigned consistent with its physical properties as indicated by the geophysical results.

Step 1 can usually be carried out with some finality independent of 2—*i.e.*, the breadth and length of rock regions marked by contrasting physical properties can be established.

Step 2, practically, can only be carried out through geological correlation—*i.e.*, through a knowledge of the rocks present and their physical properties. Since the physical properties of a given rock may change laterally—*e.g.*, tuffs—and since two phases of the same rock may give the same geophysical results as two different rocks, it is clear that best correlation is obtained with outcrops and drill-holes in the area under survey—*i.e.*, geophysical methods serve best in geological interpolation This is why some of the most successful geophysical results in Precambrian areas have be obtained in tracing the extension of known geological conditions—*e.g.*, Buchans and Steep Rock. Reinterpretation of data in the light of subsequent drilling evidence is strongly urged. Similarly, a certain amount of drilling by geophysical parties is recommended. It is pointed out that the inverse problem to interpretation step 1 is, knowing the rock properties and general geological set-up, to calculate the geophysical anomalies for the various methods. This means that, if the rock properties and geology in a given area are even roughly known, the order of the geophysical anomalies to be expected in the field may be calculated, the most adaptable method or methods selected, and the detail, approximate cost, and time of survey required, determined before even going into the field. The accuracy of such determinations will increase with the definiteness with which knowledge of the rock properties, geology, topography, and drift conditions allow the geophysical problem to be postulated and working conditions to be evaluated. A. H. N.

404.* Present Status of Geophysics in Canada. Part II. A. A. Brant. *Trans. Canadian Inst. Mining and Met.*, February 1942, **45** (358), 66–87.—In the second part of this paper the remaining methods listed and not given in Part I are described under the several headings discussed (see preceding abstract). The use of more than one method in an area is mentioned and briefly discussed.

Generally, the following are the limitations of geophysical methods : (1) Any geophysical method is limited by the necessity for contrast in the given physical property for the rock materials present. If contrast in the physical property is lacking, the method is useless—*e.g.*, lack of sufficient radioactive contrast as regards many Precambrian regions. (2) All geophysical methods are limited by the fact that the value measured at the surface is the resultant of conditions at and around the observation point. Hence, an interpreted geophysical picture can never be more than an idealized, simplified picture of a geological complexity. (3) All geophysical methods are limited by decrease in resolving power with the depth of the body of contrasting physical property. Hence, the deeper the body the greater volume it must have to create a given anomaly, and, by the same token, the greater is the effect of surface anomalous bodies compared to comparable bodies at depth. The result is, first, that the correction for the surface anomalies is important for most methods, and, second, that the presence of large irregular surface anomalies may, for practical purposes, eliminate the applicability of certain methods—*e.g.*, the torsion balance and high-frequency electromagnetic methods in the Precambrian; and seriously limit the applicability of others—*e.g.*, low-frequency electromagnetic, self-potential, and equi-potential methods. (4) As regards practical application, geophysical methods may be limited economically—*i.e.*, by their inability to yield geological information at the cost for which comparable information may be derived by other means. This limitation is important, for into it come factors of reliability, mobility, necessary personnel, etc. Gravimetric, seismic, and perhaps soil analysis methods are thus eliminated as regards general Precambrian applicability. (5) A further limitation is interpretation by which the physical picture is changed into a geological one. Factors limiting interpretation are the number of points of geological correlation, the extent to which theory approximates the field conditions, factor (3) above, and the personal equation of the geophysicist.

Finally, the following conclusions are reached : (1) In the light of the above limitations, 1, 2, 3, and 4, the magnetic and resistivity or ratiometric methods are the only ones which have general applicability in the Precambrian. For special problems which can be fairly accurately postulated, the other methods may prove applicable and extremely valuable from time to time. In view of 3, 4, and 5, magnetic methods should be, in general, more applicable and reliable. The magnetic method is, hence, the most generally applicable method for work in the Precambrian. (2) The most efficient use to which geophysics can be put in the Precambrian is determined by the above limitations, chiefly 4. For the problem considered, geophysics must present the most economical source of the necessary information. Hence, one of the chief applications of geophysics in the Precambrian should be the elimination of the barren sections of drift-covered areas; a second should be the tracing of known conditions into and under drift-covered areas. (3) The future of geophysics in Canada in the next years is bound up in the economic limitation 4. No great flurry of geophysical activity can, hence, be expected. The necessity for patient and scientific and more complete exploration of drift-covered areas should lead to gradually greater use of geophysics in closer co-operation with more detailed geological surveying. Magnetic methods will continue to be chiefly applied, with the electrical resistivity or ratiometer methods gaining in reliability due to better theoretical approximations of experimental conditions. A. H. N.

Drilling.

405.* Drilling Records Permit Increase in Drilling-Rig Efficiency. H. F. Simons. *Oil Gas J.*, 22.1.42, **40** (37), 29–30.—The record of a well made during drilling is for the most part designed for the producing department rather than for the use of the drilling-rig owner or the crew. It does form a basis for a record which will show the various factors which are included in the cost of the drilling operation. The drilling report includes the footage made/tour, formations penetrated and their depths, deviation of the hole, down-time for rig repair, time consumed in making trips, running straight-hole tests, circulating for samples and coring. It also includes a record of the casing run in the hole.

In addition to the company record, the crew also has a drilling report to the contractor which shows essentially the same information as the company report, except that it is more complete. Rotary speed, pump speed and pressure, amount of weight run on the bit, time of making trips, and the type of bit run in the hole, unusual conditions encountered while drilling, condition of the mud, materials used for treating mud, materials used for treating boiler-feed water, repairs made on the rig and the replacement parts used, and the number of joints and the makeup of the drill stem in the hole. If any unusual work is performed, this also is set down.

Some companies also require a drilling-time record for certain intervals in the hole. These are desired because they give an indication of possible producing zones and offer a check on the electric log. Where mud maintenance is a problem, a special record is provided, as the complexity of the treatment prevents it from being kept on the drilling report. History of the drill-pipe and tool-joints is generally kept by the tool-pusher or in the main office.

The significance of such records is discussed. A. H. N.

406.* **Drilling Sharply Reduced under New Restrictions.** Anon. *Oil Wkly*, 9.2.42, **104** (10), 49.—On 1st February, 1942, 2659 wells were being drilled in the U.S.A.. as compared with 3453 on 1st January, 1942. The fall in numbers was very marked in Texas, where the change was from 1085 to 802, and in Illinois it was from 298 to 129.

Tables give by States the total rigs in operation on 1st January and 1st February, 1942, and on 1st February, 1941, and the status of the rigs on 1st February, 1942; the total monthly completions for January and December 1941, and for January 1942, in addition to the types of completions in January 1942 and the footage drilled. G. D. H.

407.* **Gasoline-Driven Pipe Threader Skid-Mounted for Use on Barges in Marine Drilling Operations.** G. B. Nicholson. *Oil Wkly*, 23.3.42, **105** (3), 25.—One large operating company has constructed a serviceable, unitized pipe-threading machine motivated by a gasoline engine for use in remote marine areas, mounting the apparatus on skids and placing it on a small barge which is easily transported to the place where the line is to be laid, or moved to various fields in the marine-producing zone. The device offers particular advantage in erecting tank batteries and separators on piling-supported platforms over open water, where pipes of varying length are frequently used and must be threaded for making connections. The barge is mobile, and may be placed in a site where the machine is accessible to workers on the line. The complete threading machinery being unitized and skid-mounted, its movement about the deck to the most convenient place is facilitated; and when moving the barge to another location, its position on deck is also changed to occupy the least space and allow loading of additional equipment.

The threader is set on heavy skids about 8 ft. long and 4 ft. wide, made of welded I-beams. At one end of the skid is placed a stationary vice, fastened to a steel rack which is welded to the skid, its purpose being to clamp the end of the pipe while threading. Length of pipe threaded is immaterial to the performance of the machine, as two horses are provided to support pipe at a uniform and level height during threading. The horses consist of two legs constructed of 2-in. pipe welded to bases made of 14-in. joints of 2-in. pipe, with grooved saddles in which the threaded pipe rests. The legs are about 2 ft. tall, welded to the centre of the bases at a 90° angle, and brought together at the tops by means of the V-shaped saddles made of steel angles 6 in. long, to which the legs are welded. A. H. N.

408.* **Side-tracking "Sink-Holes" in Western Kansas Fields.** J. A. Kornfeld. *Petrol Eng*, February 1942, **13** (5), 27.—Three "dry-holes" in the Burnett pool of Ellis County, Kansas, were recently converted into commercial producing oil-wells by the application of side-tracking and the use of whipstocks accurately oriented towards the producing area.

Hundreds of wells have been drilled in Western Kansas in or flanking producing fields in the Arbuckle dolomite offsetting wells, and, as a result of drilling into a "sink-hole" or solution cavity, have been completed as dry holes. Dry holes have been drilled in the heart of the Burnett and Silica fields, only to be offset on all sides by later development that proved the presence of a solution cavity, covering approximately less than 10 acres. These are the reasons for side-tracking dry holes in the hope of striking near-by oil. Further applications of the oriented whipstock for side-tracking dry holes in a producing field may find wider adoption where the well does not adjoin offset leases. Fortunately, no important cavernous formations are found in the side-tracking operations in the Burnett field. Wells structurally low in a field are sometimes drilled to lower horizons for salt-water disposal purposes, but in many cases an unsuccessful offset can be converted into a profitable producer by side-tracking. A. H. N.

409.* Record System Plays Important Rôle in Conserving Well Equipment. C. C. Pryor. *Petrol. Engr*, February 1942, **13** (5), 34.—One of the major oil companies producing more than 1400 wells along the Sabine River in Gregg County, East Texas, began a system of records for each well and lease produced by the company. The system has been in effect for the last 3½ years, and the results from its use have proved extremely gratifying to the company. As a result of the system of records set up, the lifting cost/barrel for this company is less than that of any other company in the field. Details of the system and examples of good records resulting in savings are given. A. H. N.

410.* World's First Indoor Oilfield. Anon. *Petrol. World*, February 1942, **39** (2), 27.—A short description is given of a project to form an odourless, sound-proof, fire-proof oilfield, operating completely out of sight under the roof of a modern concrete building in the city of Los Angeles. Directional drilling is envisaged. Two test-wells are planned for the first drilling programme. The general conditions having to do with this test drilling are: (*a*) test-drilling period; (*b*) emergency production period; (*c*) normal operating period.

During period (*a*) it is planned to drill two test-wells. The general conditions concerning this test drilling are: (1) The drilling location will be countersunk to a point possibly 5–10 ft. below the surface of the surrounding ground. (2) The drilling equipment and derricks will be enclosed on the sides with Transite asbestos sheets or similar material and painted or stained so as not to be unsightly in appearance. (3) Tools, pipe, and other equipment will be stored behind solid wood or similar fencing. (4) The inside of the temporary housing will be sound-proofed, if necessary, with some modest-priced material. (5) The power used will be electric. A. H. N.

411.* Less Steel—More Oil, is Problem of U.S. Drilling Contractors. Anon. *World Petrol*, March 1942, **13** (3), 62–65.—The question of maintaining drilling crews during slack periods is discussed. The problems of the U.S. drilling contractor are studied. He must drill necessary wells with less equipment than he has used before; and he must be prepared to pursue wildcatting activity in all promising areas. He must also co-operate with his fellow-contractor and the company for whom he works. To do this does not mean that he must entirely discard the competitive aspects of the business. The desire of the Petroleum Co-ordinator's office to drill 30,000 wells in 1942, and the office of the Production Management's plan to conserve steel and vital materials necessitate a new method of attack for the drilling contractor. The original O.P.C. schedule called for a full year's drilling programme in 1942, with 30% less materials. The recent 40-acre spacing rule has done much to complicate present and future drilling operations.

The total cost of drilling an oil-well is divided into three principal classifications. They are: labour, equipment, and expense. The proportions of each vary in the several districts and under changing conditions. A good average breakdown of costs shows labour to be about 33%, equipment 45%, and expense 22%. The average drilling cost in the United States is about $21,000/well. The average depth of all wells drilled in the United States annually varies from 2900 to 3100 ft. This represents an average cost of about $7·00/ft. for drilling and equipping a well for production. The cost of drilling a wildcat well is always much higher than the average for subsequent wells drilled after discovery. A. H. N.

412.* Portability as a Factor in Emergency Drilling. Anon. *World Petrol*, March 1942, **13** (3), 70.—Restrictions on normal production drilling may render certain equipment idle. This idle equipment and the fact that capacity of the steel and allied industries will be occupied on other work indicate that the normal improvement in drilling equipment will be retarded, but also emphasize the necessity for a solution of the problem of using this equipment and trained personnel, and suggest that new techniques may be developed in order to adapt existing equipment to broader use, both in production and drilling operations.

Some assistance in this solution may come from rearrangement of the machinery to make it readily adaptable to either drilling or work-over work. The suggestion has been made that since most work-over work requires less power and auxiliary drilling equipment, the designing of skids and substructures, so that the units of equipment needed can be added or taken off as the work requirements demand, would increase the usefulness of the available equipment. Increasing the portability of the available equipment has been receiving some study, and, as a result, progress has been made in increasing the efficiency of drilling equipment, and additional progress along this line doubtless will broaden the field of application and make it possible to use equipment that would otherwise be idle because of its being at present suitable only for specialized work. Increasing the drilling range of available medium to light equipment may assist in its utilization on work for which it is now not considered suitable. Even if some sacrifice in drilling time is required in drilling at greater depths, the greater range in drilling depths may be found desirable during the shortage of equipment. A. H. N.

413.* Drilling Economies Aid National Defence. N. A. D'Arcy, Jr. *World Petrol*, March 1942, **13** (3), 76–79.—In light of the national emergency the development of drilling with casing in place of drill-pipe is worthy of close investigation, as it completely eliminates duplication of tubular goods in drilling. Late in 1940 a major oil company substituted 4½-in. casing for drill-pipe, and during 1941 proved to their satisfaction that it was economical to use 4½-in., 12·6-lb. casing to drill 7⅝-in. hole, 5½-in., 17-lb. casing to drill 8½-in. hole, and have conducted experiments with 7-in., 26-lb. casing when drilling 10⅝-in. hole. The casing is standard Grade J, with ends upset sufficiently to provide a thickness metal under the threads equal to the normal wall thickness of the pipe. The threads are a standard cut by Pittsburgh, which is coarser than the regular pipe-thread, but a comparatively fine thread without the conventional tool-joint shoulders. Drilling with casing is a development based on the drilling costs of one major operator. The cost of the casing used runs approximately 15 c./ft. higher than standard casing, and if the normal cost of drill-pipe exceeds 15 c./ft. of hole drilled, drill-casing should be given close consideration for economy and present availability. Other economies of the system, besides the monetary ones, such as transportation, completion, and circulation, etc., are studied.

Steam and compressed-air rotary casing-tongs are described. In the same light of war-time economies, portable drilling rigs are studied. Several types are briefly described.

Bulk-cementing eliminates much of the waste prevalent when using sacked cement. Broken sacks, damaged by water and incomplete emptying, are eliminated, and even the saving in paper sacks is worthy of consideration in these trying times. Bulk-cementing is one development that won the immediate favour of the drilling crews, by elimination of man-handling cement sacks, and of petroleum engineers because of the uniformity of cement slurry produced. All major California fields are now prepared to deliver bulk cement at a saving of time and material to the operator. The new bulk-cement wagons and modern cement-pumping units are synchronized with fool-proof controls to provide a uniform cement slurry for any ratio of water to cement. It is interesting to note that the speed with which these units can deliver cement to the well is generally governed by the available water supply, not by the capacity of the unit. In the deeper and more critical wells in the San Joaquin Valley the operators are now installing special water-lines to provide sufficient volume of water to allow for the mixing and placing of 100 sacks of cement/minute with two bulk-mixing units. Cementing by this method is independent of weather conditions. A. H. N.

414. Patents on Drilling. J. C. Ballagh. U.S.P. 2,272,395, 10.2.42. Appl. 29.5.1939. Drill-pipe wiper made of resilient rubber composition.

J. Grant and J. J. Santiago. U.S.P. 2,272,405, 10.2.42. Appl. 20.2.39. Cutter-mounting for well-reamers and the like.

A. D. Larson. U.S.P. 2,272,529, 10.2.42. Appl. 7.3.41. Fishing-tool consisting of a barrel having at its lower end a work-receiving bore of abruptly reduced diameter, which bore is eccentric in relation to the remainder of the larger bore in the barrel.

E. Geraghty. U.S.P. 2,272,835, 10.2.42. Appl. 23.11.37. Drilling apparatus for a rotating core-drill.

A. Boynton. U.S.P. 2,273,017, 17.2.42. Appl. 30.6.39. Right and left drill-pipe connection.

J. Neufeld. U.S.P. 2,273,215, 17.2.42. Appl. 22.4.40. Well-surveying method and apparatus using radioactivity.

E. Lipson. U.S.P. 2,273,363, 17.2.42. Appl. 28.11.39. Method for electrical investigation of cased drill-holes.

D. C. Bond and C. W. Botsford. U.S.P. 2,273,925, 24.2.42. Appl. 30.11.40. Stabilized drilling mud containing starch, wheat gluten, or acid casein.

R. Fitzpatrick. U.S.P. 2,274,055, 24.2.42. Appl. 29.5.40. Cable strain clamp.

G. A. McCammon. U.S.P. 2,274,082, 24.2.42. Appl. 31.8.39. Method for construction of marine foundations for erecting a floor over a body of water for such purposes as marine drilling.

D. M. Smith and W. H. Fisher. U.S.P. 2,274,099, 24.2.42. Appl. 31.10.39. Travelling-block.

C. C. Scharpenberg. U,S.P. 2,274,168, 24.2.42. Appl. 16.7.40. Draw-works for deep-well drilling.

S. A. Scherbatskoy and J. Neufeld. U.S.P. 2,274,248, 24.2.42. Appl. 7.5.37. Well-surveying method using a heating medium and two temperature recorders placed at a horizontal and a vertical distance from the heating source.

E. J. Miller. U.S.P. 2,274,273, 24.2.42. Appl. 13.2.41. Well spider.

W. A. Loomis. U.S.P. 2,274,339, 24.2.42. Appl. 5.1.39. Means for automatic weight control in well-drilling.

A. H. N.

Production.

415.* Central Separator Provides Flexible Control. N. Williams. *Oil Gas J.*, 12.2.42, **40** (40), 29.—A system of centralized separators is described and illustrated. Manifolding is such as to permit the production flow in any of three different ways or combinations. First, the production from any or all field-flow lines can be run to the testing separator. At the same time all production from any or all flow-lines can be run to either of the two regular production separators or to both the latter separators simultaneously. Also the production can be split with the flow from any combination of lines being run to one of the separators, while that of any or all the remaining lines is run to the other separator. When testing-separator is not needed for individual well-gauging, it also can be used for regular production.

All wells on the lease are completed and tested through the central individual well-testing separator. Also, all periodical testing of completed wells, including potential taking and gas–oil ratio checks, is done in the same manner. Testing procedure is described.

The entire separater and tank-battery installation is set up on a single, solid, reinforced-concrete base, which not only provides a substantial permanent foundation, but also facilitates maintenance and adds to the general orderly appearance. All valves and controls are readily accessible, permitting ease of operation. An adequate fire-wall is maintained around the site, and other necessary safety precautions are provided.

A. H. N.

416.* Exhaustive Tests Performed on Oklahoma Pumping Well. Anon. *Oil Gas J.*, 12.2.42, **40** (40), 35.—This is a brief notice that strain-gauges, dynagraphs, electrical instruments, and two nine-element oscillographs were used recently in making records of over 200 operating conditions of the pumping apparatus on a 3500-ft. Oklahoma oil-well.

The tremendous mass of data compiled during the tests is now being completely analysed. Indications are that formulæ for peak pumping-rod loads, peak torques, and plunger strokes will be revised. It is hoped that proper drive, stroke, and speed for pumping wells can be selected for a particular well ahead of the time when the well must go on the pump.

Three types of drives—normal-slip induction motor, high-slip motor, and gas engine—were used on the well and were tested for performance. Effect of rotary and beam-type counterbalances was tested on the unit while using each prime mover. The unit was operated on four different strokes, from 24- to 54-in., and on a variety of speeds between 10 and 30 s.p.m. The effect of plunger size and tubing size was obtained by using two different sizes of plungers and two different strings of tubing. Shock tests on the sucker-rods were obtained by dropping the 3500-ft. rod-string several inches.

Whilst the results of the tests are not reported, it is believed that they may throw light on some unexplained phenomena, such as the breaking of a rod-string in the middle instead of at the top, where the load is supposedly the greatest. A. H. N.

417.* Operation of Electric Centrifugal Producing Pumps in Parallel. W. H. Stueve. *Oil Gas J.*, 12.2.42, **40** (40), 36.—The centrifugal pump actuated with an electric motor in the bottom of oil-wells has been adapted to producing such wells for the last 8 or 10 years, and the conventional unit consists of a 97-h.p. motor with dimentions of about 5½ in. in diameter and 20 ft. long, direct connected through a prosector about 5 ft. long to the centrifugal pump containing sufficient impellers to build up sufficient pressure to lift the fluid to the surface of the ground. The motor is usually located below the pump, and the whole unit, perhaps 49 ft. long, is suspended on the tubing, and the electric power-cable is strapped to the tubing. Variations in design of the unit sometimes locate the pump below the motor to permit the suction inlet to be set in the sump of the well-hole in cases where gas-bottom pressures are of extremely low values or entirely exhausted. Production results from the conventional bottom centrifugal pump are limited by various factors, such as the inside diameter of the casing, the depth from which the fluid is to be pumped, and of course the cost economies, keeping in mind the fixed horse-power of the motor used. In recent years motors of 135 h.p. are being used with correspondingly larger capacity pumps requiring that they be inserted in wells cased with 9-in. pipe. In wells with the fluid standing 4000–5000 ft. below the surface, the larger pumps equipped with 135-h.p. motors can produce 3000–4000 brls./day. This volume may still be too small to permit economic or paying production, but if the volume could be increased from 40% to 50%, sufficient oil could be produced together with the water to make the installation a paying proposition.

Units using two such pumps in parallel suspended one above the other, with the lower one pumping into a 1½-in. pipe by-passing the upper unit into a common 3-in. pipe, are described. The two pumps are independently connected by cable, which is strapped to the tubing supporting the pumps. The units can be used in a 9-in. casing. The entire combination of electric losses in the field electric supply lines, transformers, cable and motor, coupled with the mechanical losses in the pump and tubing friction, reveal an overall efficiency of the entire dual unit of 37% from electric metered energy at the section line to fluid delivered in the tank battery. The 150-kva. transformers, two of which are used at each well, are carrying a load of 180-kva. each, or a 20% overload, which is not excessive when consideration is given to their location in the open air. A. H. N.

418.* Cost of Producing Oil. E. Bloesch. *Oil Gas J.*, 12.2.42, **40** (40), 37.—The paper is a comment on a previous article (F. N. Bosco, *Oil Gas J.*, 15.1.1942) dealing with the same subject. It is pointed out that, in addition to costs of explorations previously mentioned, other major items may come in.

Wider spacing increases the operating costs per brl. of oil produced. To cite an extreme case: a central power on a 160-acre tract will pump with very little extra expense thirty-six wells drilled on it in a shallow field, than it would pump only four wells on this tract (40-acre spacing). However, the four wells, while probably larger per well than the thirty-six wells, would produce only a fraction of what the thirty-six would do. Where wells are operated individually, the difference in lifting cost is not quite so great, but field and office force will have to be almost the same, and again the saving in operating cost is in no proportion to the lower barrel production.

A standard 40-acre spacing may be harmful to certain fields, whilst it is ideal to others.

Again, comparing Colorado with Fort Collins–Wellington Field, which is studied in the previous paper, it is pointed out that Colorado area may be assumed to cover about 100 times the area of the one producing field. Thus expenses for geological surface work will be about 100 times the $2100 expended in the Fort Collins–Wellington Field, or about $200,000. While this amount can be substantially reduced by using reconnaissance methods, subsurface, sample, and palæogeographic studies should also be made. Assuming that geophysical work is undertaken only where surface geology has shown possibilities and where outcrops are insufficient, this may be half the area under consideration or fifty times that covered at Fort Collins.

It is emphasized that prevailing crude prices are inadequate to operate at a profit under conditions similar to those existing in North-eastern Colorado. A. H. N.

419.* Paraffin Removal by Heated Oil. T. P. Sanders. *Oil Gas J.*, 19.2.42, **40** (41), 33–34.—As compared with methods formerly used in the field, the new procedure offers the advantages of reduced treating time, more thorough cleaning, avoidance of the necessity of disturbing rods or tubing, and absence of the unsightly pile of discarded paraffin about the well-head.

Although the method depends on heated oil to dissolve the paraffin from within the tubing string, the hot fluid is not circulated: it is merely forced into the tubing to displace the cold oil, then pumped out with its load of dissolved paraffin when the well is put back on production. In order to make this operation possible it is necessary to install a simple pressure-release valve in the tubing through which the cold oil can be displaced into the annulus. This valve is placed about 1000 ft. below the interval of paraffin deposition, and hot oil is applied only to that portion of the tubing in which treatment is needed. This fact contributes greatly to the economy and time-saving features of the method. The method is described in some detail and the check-valve used on the tubing is illustrated.

Input-oil temperatures up to 450° F. with a pressure of 1000 lb. can be attained with the mobile Delta unit. With these temperatures and pressures it has been found that the unit is capable of removing paraffin from completely clogged lead-lines or from any other equipment in which deposition may occur.

If a well has been pumped too long without paraffin removal, the pump plunger may be seized by hard paraffin when a rod job is attempted for mechanical cleaning. This ordinarily necessitates stripping. However, the hot-oil unit is capable of obviating stripping even if the plunger is stuck so fast that it can be moved neither up nor down. Oil at maximum temperature pumped down the casing has been found successful in melting the paraffin to release the stuck plunger. A. H. N.

420.* Basic Principles of Closed-Type Flow-Valve Installations. J. E. Halferty. *Oil Gas J.*, 19.2.42, **40** (41), 40.—Open-type flow-valve installations are briefly reviewed. They form systems where gas-lift flow devices are run on the well-tubing, with no packer, standing valve, or other lower restriction between the casing and tubing, and no restriction between the casing and/or the tubing and the formation.

The most important considerations with which the engineer must concern himself in designing a correct flow-valve installation—after the selection of the type of valve—are: (1) the submergence of the top flow-valve below the maximum static fluid level, and (2) the maximum spacing between flow-valves. Formulæ are given to determine both the spacing and submergence.

A closed flow-valve installation differs from an open type in that the casing is packed off from the tubing above the producing formation, and further, the reverse flow from the tubing to the formation is prevented by a standing valve. This system is particularly adaptable to wells of low productivity indices (regardless of bottom-hole pressure), and especially to wells of low bottom-hole pressure. This type of flow-valve installation is also very desirable for unloading wells equipped with intermitter depletion systems where it is essential that the applied casing pressure be kept off the producing formation.

In a closed installation, where a packer and standing valve are run and the well-fluid cannot be forced back into the formation once it has entered the tubing, the submergence of the top flow-valve below the static fluid level must take into account the ratio of annulus area to tubing area. The determination of the submergence of the top valve in a closed installation is given by the following relationship :

$$S' = \frac{C - V}{w(R + 1)}$$

where S' = submergence of the top flow-valve in a closed installation below the maximum static fluid level (in ft.); C = casing pressure (in lb./sq. in.); V = differential reopening pressure of flow-valve (in lb./sq. in.); and w = static fluid gradient (in lb./sq. in. ft.). In open-type installation the submergence = $\frac{C - V}{w}$ and the spacing of valves = $\frac{V}{w}$.

The two systems are discussed and compared. The situations where each system is preferable to the other are also discussed. The closed installation is absolutely essential where it is important to keep the applied casing pressure off the producing formation, particularly above depletion intermitter equipment where the minimum bottom-hole operating pressure is required. The closed installation has another advantage over the open-type, in that the seal furnished by the packer is much more positive than the variable fluid seal of an open installation. Also, the dry casing annulus of a closed installation protects the casing against corrosive well-fluids.

In general, the open-type installation goes in when a well is first brought in, or when it first ceases natural flow due either to a loss of dissolved gas energy or to the influx of bottom water. In wells of slow reservoir pressure decline, or wells operating under restricted flow, a long and economical intermediate flow period can be maintained with an open-type flow-valve system.

After the well passes the open-type stage—and many wells, due to their low bottom-hole pressure and low productivity index, can never be adapted to an open-type—the closed installation is the next step in gas-lift depletion. Where the addition of the bottom-hole intermitter depletion equipment is contemplated in the near future, it is usually wise to run the skeleton subpacker assembly along with the flow-valve installation. This is particularly true where the drop or removable type of intermitter valve is contemplated, since it is only necessary to drop in the intermitter valve when the well decline requires its addition to the system. A. H. N.

421.* Cost of Increased Production Measured in Terms of Steel. L. C. Converse. *Oil Gas J.*, 19.2.42, **40** (41), 46.—Using the O.P.C. estimate of 210,000 lb. of steel/well for 1942, 40-acre spacing and 200 brls./day withdrawal for 1000 days, the cost in steel is 1050 lb. for each brl./day of sustained production, or 1·05 lb./brl. of total production for 1000 days. This compares with the minimum steel requirements for the average 1940 drilling depth of 3014 ft. when 20-acre spacing and 100 brls./day withdrawal were used. As a measuring rod and for comparison the unit for new production of 1 lb. of steel/total yield or 1000 lb. of steel/brl. of daily production may be used.

Gas or air repressuring may be anything from a regular geometrical pattern with every alternate well an input well to two or three gas-input wells to the 160 acres. In any case it is presupposed that the recovery wells are already in and equipped. Although small-diameter casing has frequently been used in the past, a string of tubing cemented into the top of the sand is all that is required for gas- or air-injection wells. While the recovery/acre is much less than with water-flooding, the increase in production/lb. of steel required is definitely much less than primary production. Results of gas repressuring at Glen Pool, for instance, where new input wells were drilled, indicate a return of 1 brl. of production/0·2 lb. of S.H. steel, or one-fifth the steel requirement for new primary production. Where old wells are converted into injection wells there may be a net gain in steel where tubing is substituted for casing in the injection wells.

Secondary-recovery production by water-flooding may be obtained all the way from 0·5 lb. of steel/brl. of crude to a net gain of 1·9 lb. of steel/brl. of gross production; examples of both of which are illustrated. It is assumed that research has proved 5000 brls./acre recoverable before any expenditure for steel is made under all conditions. The heaviest steel expenditure would be in the so-called shallow areas (500–1000 ft.), where all wells would have to be drilled.

Three-hundred-and-thirty-foot spacing 500 ft. deep or 440-ft. spacing 1000 ft. deep would each require approximately 2500 lb. of S.H. tubing and line pipe/acre or 1500 lb. of new smaller-diameter tubing and pipe as a minimum requirement for flowing condition. Under flowing conditions, only a drilling string of casing would be used, which is pulled when the tubing string is cemented in place.

Further costs in terms of steel are discussed at some length to show that in certain cases the steel being used to produce a barrel of oil may be of greater value elsewhere, at the expense of sacrificing that barrel. A. H. N.

422.* Closed Siphon System Handles Disposal Water at Tinsley. R. M. Sanford. *Oil Gas J.*, 26.2.42, **40** (42), 57.—The unit described is an entirely closed, pressure-operated system, and employs several practices previously not applicable to subsurface salt-water disposal systems. The iron content of Tinsley field brine is exceptionally high. If either the oil emulsion or the salt-water were exposed to the atmosphere, the precipitated iron oxide would clog the gathering lines and the disposal system.

Most unusual of the entire system is the disposal well. Drilled to the shallow Wilcox sands at 2880 ft., the well started flowing salt-water when tubing was run. A pressure-injection system was used to counteract the natural pressure and water-flow of disposal sand. However, since starting operation of the unit, the disposal well will, by suction, siphon water at the rate of 140 brls. hourly, or 3360 brls daily. While salt-water is being siphoned down into the well through the casing, formation water will flow out of the disposal well through the tubing. Pressure differentials in the sand section and specific-gravity differences in the salt-water are offered as explanations for this phenomenon.

The design of the system is briefly described and certain parts are illustrated. The entire plant was first designed to use a 5-in. × 10-in. pump, by means of which the water was to be forced into the injection well. When it was found that water would siphon into the well, a bypass was installed to entirely eliminate the pump. The line through the pump is still intact, however, for at some future date the siphoning action of the well may cease, and it will become necessary to resort to the pressure system of injection.

Operating through the pump, which is driven by a 500-h.p. gasoline engine, the system was first capable of disposing of 49 brls. of water/hr.; however, when the pump was by-passed, the system would siphon 96 brls./hr., or almost double the capacity. In order to increase the capacity still more, a 4-in. header with two 2-in. draw-off lines was installed on the injection well-head, and the capacity of the system was increased to 140 brls./hr. It does not yet operate at full capacity, for insufficient wells are connected to the disposal system.

The entire system has been in operation since the middle of January, and has performed so satisfactorily that several other producers in the field are preparing to install individual or jointly operated systems with neighbouring producers. A. H. N.

423.* Small-Capacity Metres Used to Gauge Well Productivity. H. F. Simons. *Oil Gas J.*, 26.2.42, **40** (42), 62.—The first method tried by engineers was to use a small portable tank and a pump driven by an internal-combustion engine. This could be hooked to the well-head, the daily production gauged, and the oil then pumped out of the gauging tank to lease storage. The pump and tank were mounted on a small trailer, which could be pulled by an ordinary passenger-car.

A new method has recently been devised which simplifies the arrangement, reduces the time spent in making the test, and gives a very satisfactory gauge on the well's productivity. A small oil-meter is used to measure the production from the well, and the entire arrangement—meter, strainer, connections, and hand tools—is carried in a small trailer which can be pulled around the field by hand if necessary.

Gas accompanying or released from the oil being measured is often a complicating factor when metering oil, but in this case it gives no trouble, as the wells are produced under varying amounts of vacuum. The gas cannot come out of the oil, as the pressure on it is increased when it is brought to atmospheric pressure. The accuracy of the meter was checked before putting it into service by producing oil into a tank and gauging it; the meter is checked occasionally to insure against an inaccurate gauge.

The meter used is a small, positive-displacement type, crude-oil meter, which consists of two pistons travelling back and forth. The pistons are alternately filled and emptied, and are connected to a counter so that the total amount of oil moving through the meter in any length of time is recorded. It is merely a piston pump operating in reverse.

Gauging of production from a well is not complete unless some provision is made for obtaining a sample to determine the percentage of water contained in the oil. The meter also includes a small sampler, which is merely a piston with a small hole in it which moves in and out of the metering chamber. The sampler is designed to deliver 8 c.c./brl. measured by the meter. Normally the sample is caught directly under the meter, but for convenience a small copper tube is run through the floor at the front of the trailer and into a graduate cylinder held in a burette clamp attached to a short post. A. H. N.

424.* Subsurface Pressure Regulation of High-Pressure Condensate Wells. J. O. Farmer. *Oil Gas J.*, 26.2.42, **40** (42), 67. *Paper presented before American Petroleum Institute.*—Discovery of deeper reservoirs under higher pressures has resulted in the need for control equipment to preserve and protect these great sources of energy; also, means of preventing freezing or the solidification of hydrates caused by throttling or restricting production are required. The development of a successful, removable subsurface pressure regulator has enabled operators to reduce dangerously high-flowing pressures at the surface to safe working limits. By transferring the principal point of pressure reduction from the surface to warmer subsurface levels, complete elimination of the freezing conditions in flow-lines can be accomplished. Development and operation of a subsurface regulator are described, and charts and tables for use in determining proper depths for pressure reductions to prevent freezing are shown. Other beneficial results, heretofore considered subordinate, such as the reduction and stabilization of gas–liquid ratios in condensate-producing wells and the retardation of water encroachment, have been observed. The possibility of establishing conditions in the tubing string favourable to the precipitation of condensate through the use of subsurface regulators is suggested. Further technical research relating to the use of subsurface regulators for controlling temperatures and pressures in the flow-string to obtain conditions most conducive to the precipitation and an increased recovery of condensate is desired.

The degree to which the regulator valve opens depends on the size of the surface choke used; the larger the choke, the greater the reduction in the downstream pressure; hence, the differential pressure across the regulator will be increased and the regulator valve will be opened wider. Conversely, selection of a smaller choke at the surface will cause the regulator valve to move to a position of less opening and restrict the flow. The operation of the regulator is therefore entirely automatic, and variable rates of flow at substantially constant delivery pressures can be maintained by merely adjusting the surface choke. The daily delivery can be varied through a range of from zero to 9,000,000 cu. ft.; the maximum rate, however, is dependent on the ability of the well to produce at the reduced flowing presture.

To eliminate the terrific abuse caused by the abrasive action of flow under differential pressures exceeding 1500 lb./sq. in., it is the general practice to limit the pressure reduction across a single regulator to a maximum of 1500 lb./sq. in., and to use two or more regulators in series where greater pressure reduction is required. In multiple installations the regulators are spaced at intervals of 500–1000 ft., and are so adjusted that the total pressure drop is divided among them to give optimum service. A. H. N.

425.* Central Electrical Generating Plant Designed for 160 Wells. H. E. David. *Oil Gas J.*, 26.2.42, **40** (42), 74.—The plant is at present used for pumping eighty-four wells, and is designed for the ultimate operation of 160 wells. Each well is producing an average of 50 brls. daily. The Griffin field, in which the plant is operating, is described. The loads on the individual wells vary from 3 to 10 h.p., depending largely on the formation from which the well is producing. Most of the wells are pumped 24 hrs./day, a very few being pumped on a part-time basis. Each well in the Continental system is equipped with an individually geared pumping unit driven by an electric motor. On the majority of the wells these motors are 440 v., 3-phase, 10-12-h.p., 60-cycle, 1200-r.p.m., induction-type, capable of running continuously with not more than 40° temperature rise. The electrical system is described in some detail.

From the past history of Griffin and other Illinois and Indiana fields, the period of peak oil production is quickly reached, holds steady for a period, and then gradually declines. With the present installation 160 wells can be handled at their present rate of production. As the volume of fluid to be handled falls, more leases and wells may be added, or the size of the plant may be reduced by removing one of the units to a new location where it can be utilized. A. H. N.

426.* Strategic Location of Wells in Flank Sands on Piercement-Type Salt Domes. Anon. *Oil Wkly*, 9.2.42, **104** (10), 17–20.—The 40-acre spacing provision is particularly disturbing to operators of the Texas–Louisiana Gulf Coast, where geological conditions themselves prevent rigid well-spacing regulations if maximum efficiency and conservation are to be obtained. In view of the fact that piercement-type salt domes of this area yield crude oils that are particularly needed in prosecution of the war, being desirable for making aviation gasoline, bunker oil, and diesel oil, it is imperative that the matter be given prompt attention by those administering the spacing provisions.

The successful and efficient development of these domes, with their multiple, tilted, and faulted oil-sands, requires exceptional care in the selection of drilling sites, a fact heretofore developed after long experience and fully recognized by State conservation authorities.

After describing the conditions in these fields, the following conclusions are recorded : The flank sands are separated by radial faults into segments which require one and often several wells/segment to withdraw the oil.

A spacing programme to fit the size and shape of the individual segment and the position of the oil-sands is required. A set pattern for location of wells will not apply, and would result in a large percentage of dry holes, with consequent loss of essential materials.

Governmental authorities should afford such exceptions to general regulations that salt domes may be developed with spacing and location of wells that will provide maximum efficiency. A. H. N.

427.* Decreased Costs and Improved Well Performance Gained Through Pumping Equipment Modernization. G. M. Wilson. *Oil Wkly*, 9.2.42, **104** (10), 24.—Probably the most familiar of all pumping equipment, and the type that is probably most sorely in need of repair or replacement, is the old standard-end pumping unit, with its single-cylinder engine, long belt, and band-wheel.

The replacement of this type of plant by slower speed and more efficient types is discussed. One company owning a large number of wells equipped with this older equipment has in the last two years reconditioned some sixty-two wells by partly re-equipping them in the manner generally outlined above. Substantially better performance and lower maintenance costs have been realized in those wells since the programme was started.

The reconditioning work, directed primarily towards the elimination of the large single-cylinder engines to make possible the addition of certain new equipment designed to adapt the well to slow-speed pumping, was begun on each well only after an exhaustive survey was made of the production rate, water cut, normal operating fluid-level, plunger loads, and general condition of the band-wheel, pitman, walking beam, and derrick.

Average gross production rates of wells that were reconditioned vary from 25 to 100 brls./day, with water cuts in some wells running as high as 75–90%. Wells were pumped from depths varying from 2300 to 6800 ft. Pumping with the old equipment made it difficult, and usually impossible, to slow the engine down to a speed where the pump would handle the fluid only as fast as it came into the hole. If a well pumped faster than this optimum rate, the plunger pounded fluid, tending to increase formation of B.S., causing rough action of the pumping strokes, and in general bringing about early trouble in the form of worn pumps, broken rods, and overhauling of surface equipment. Details are given of one well in particular.

On certain wells, other than those which were equipped with small electric motors, it was sometimes found to be more economical to install multi-cylinder gas engines in connection with a countershafting arrangement. This condition was found to be particularly true in wells which required power ranging from 10 to 20 h.p. and higher.

In such instances the belt and band-wheel were retained, and used in connection with a countershaft that was usually made up out of the former gas engine, or the crank and base of an old steam engine. In case of a certain set of conditions which required a particularly heavy shaft, a specially designed countershaft was used. A V-belt drive connected the engine to one side of the countershaft, with the flat belt taking off a pulley on the other side.

Salvage is discussed.

A. H. N.

428*. Reduction of Hole Size in Drilling as Affecting Costs, Completion, and Production Practice. Part II. I. W. Alcorn and J. U. Teague. *Oil Wkly*, 9.2.42, **104** (10), 32. *Paper Presented before American Petroleum Institute.*—After a detailed study of the problems involved in the production from small-size wells the following conclusions are recorded : (1) Small-diameter wells are substantially lower in cost than large-diameter wells, in every field on which information was submitted. (2) A small-diameter well is considered to be one completed with 5½-in. O.D. casing. This is regarded as the minimum practical size for well completion by the majority of those submitting data. However, wells are being completed with smaller sizes as an experiment. (3) There was no difference in potentials between small- and large-diameter wells when taken on chokes ¼-in. in diameter or smaller. (4) Small-diameter wells can be completed by all common completion methods as easily as large-diameter wells. (5) All types of artificial-lift equipment can be used satisfactorily in small-diameter wells. If large volumes of fluid are to be produced, especially with rod-pumps, the small-diameter wells may impose some restriction. (6) Small-diameter wells can be repaired as easily and cheaply as large-diameter wells, except when it is desired to deepen or side-track wells. For these two exceptions the small-diameter well is not satisfactory. (7) In view of the current low rates of production, the long-expected flowing life of most fields, and the attractive savings realized, the trend towards drilling and completing small-diameter wells will probably continue. (8) It should be pointed out that the scope of the paper has been limited to the presentation of the actual experience of the industry to date in drilling and completing small-diameter wells as it affects costs and operation. No attempt has been made to determine or discuss the effect the small-size hole through the producing horizon has on the productive capacity of the well, or the effect it may have on ultimate recovery. A. H. N.

429. Efficient and Flexible Gathering System. G. M. Wilson. *Oil Wkly*, 23.2.42, **104** (12), 23.—Outstanding among the points of interest in the lease-gathering system are : (1) Three stages of separation before the oil reaches the large lease-tanks. Individual well-gauging is accomplished in weigh-meters in the second stage of separation, making unnecessary the use of small lease gauge-tanks. (2) Complete stabilization of the oil in the tanks, which results in the elimination of gas wastage, and a marked absence of turbulence of the fluid in the tanks. (3) Efficient use of two small and one large compressors to boost the gas taken off at the second and third stages of separation, up to the pressure of the initial or high-pressure stage, thus making for simplified disposal into the field gathering-line of the utility company. (4) A number of smaller but very interesting operating ideas that contribute greatly to the ease and efficiency of operation of the wells and the gathering system. The development of the lease is detailed. Each of the four items is also discussed in more detail.

To aid in the efficiency of operations a unitized header for each well is used. The flow-header consists of an 11-ft. length of 9-in. heavy casing, welded closed at each end to withstand the maximum anticipated flow-pressure. Flow-lines from both sides of the Christmas tree are hooked up to the back side of this chamber, and the lead-line going up to the trap-setting takes off from either end. Two steel legs welded to the bottom of the header are cut out of short section of I-beam material, and provide a sturdy base to minimize vibrations.

Mounted on steel supports welded to, and extending upward approximately 1 ft. above the top of the flow-header, is another smaller and somewhat shorter chamber. This chamber, made of 6⅝-in. casing, is 5 ft. long, and is divided into four equal compartments, which were made by welding steel plates between cut-out sections of the pipe. Each section is a separate receiving chamber for pressure taken off from (1) tubing or flow-string, indicating oil or gas pressure in the lead-line on the down-stream side of the flow-bean; (2) between the water and surface strings of casing, which, although under all normal conditions they should be zero, must nevertheless be constantly checked; (3) the inner casing string; and (4) tubing head, recording the tubing pressure (flowing or static) on the upstream side of the flow-bean.

Pressure enters the compartments through a ½-in. collar welded into the back side of each chamber. Half-inch collars, nipples, and tees on the top provide an outlet for pressure gauges, as well as for a recording meter. The latter is mounted at eye-level height on an upright piece of 2-in. pipe screwed into a fitting that is welded to the front of the flow-header chamber. A ½-in. outlet and bar-stock valve below each compartment allows fluid to be drained out into a common waste-gathering ½-in. line, which then extends on over to a hole cut into the wooden cellar-floor. The entire header assembly can be dismantled in comparatively large units when wells are to be worked on.

Other equipments are similarly described. A. H. N.

430.* Unsteady Flow of Vaporizing Hydrocarbons through Unconsolidated Sand. T. Y. Ju and R. L. Huntington. *Oil Wkly*, 23.2.42, **104** (12), 32.—The paper is a report on a research project carried out to investigate the behaviour of reservoirs producing hydrocarbon vapours which are in contact with their own liquids. An artificial reservoir, composed of 93½ ft. of a 2-in. A.P.I. pipe, mounted vertically and packed with unconsolidated Wilcox sand, was used to investigate the production characteristics of butane and propane reservoirs. The curve for production rate decline of a reservoir of this type was found to be similar to that for the usual gas reservoir. The cumulative production is related to the cumulative time by an exponential function relation. The production-rate equation developed for ordinary gas reservoirs was modified, and the modified form was found to be applicable. For butane and propane reservoirs it is quite possible, therefore, from the known production data, to estimate the future cumulative production and future production rates by means of these empirical relationships.

In this, the first part of the paper, a description of the apparatus, its mode of filling and use, and of the procedure adopted is given, together with tables showing the results of five runs. The results are to be discussed further in two succeeding parts.

A. H. N.

431. Value of Planned and Controlled Operations Demonstrated by Successful Shallow Water-Flood. G. M. Wilson. *Oil Wkly*, 23.3.42, **105** (3), 17–22.—The feasibility of successfully water-flooding many shallow, semi-depleted oilfields in certain areas of West Central Texas has definitely been proved in at least one project started in the early part of 1941. A group of fourteen wells, producing from a sand at 350 ft., the total lease production of which had slumped to only 4 brls./day, and to which were later added fourteen more wells (twelve of which are re-drilled, formerly abandoned wells), on adjoining leases, have responded to water-flooding to the extent that the twenty-eight oil-wells are now producing a total of 4000 brls./month, with the rate still on the increase, after only eleven months of active flooding operations. The field is described.

Several conditions, operating as well as economic, in this field, appear to lend themselves ideally to secondary recovery by water-flooding methods.

First is the shallow depth of the oil-sand, being only 350 ft., and which has no water-sand overlying it, making it unnecessary to case the injection wells or any oil-wells that may be drilled on the property in the future.

Second are the uniformity and extremely high permeability of the oil-sand. Permeability ranges from 350–500 millidarcies. This compares with 75 for the Bartlesville sand of Oklahoma and Kansas, and from 6 to 20 for the sands of the Bradford, Pennsylvania, region. Sand porosity averages 25%. So far as is known, this sand is the highest average permeability of any so far attempted for water-flooding.

Still another factor favourable to water-flooding is the close proximity of an ample supply of fresh water, the source being a lake several miles north of the field.

The drilling of injection wells by inexpensive methods, storage tanks, pumps, and other items of the system are discussed. A constant pressure of 320 lb. is being maintained at the pumping plant. Plant injection pressure has been gradually increased from approximately 250 lb. at the beginning of the flood up to the present value. Pressure is held constant by means of a back-pressure valve tied in to the discharge line near the base of the pump. Excess water is by-passed back into the suction line of the pump. The water system, the tests undertaken, and their interpretation are described.

Several noteworthy conclusions are reached, particularly the fact that small projects, covering only a portion of a field if necessary, can be successfully flooded.

A. H. N.

432*. Wild Gas-Well is Controlled. Anon. *Oil Wkly*, 23.3.42, **105** (3), 23–24.—A photographically illustrated description is given of a method used to control a gas-well which blew wild an estimated 20–50 million cu. ft. of gas. The method consisted of lowering a control gate-valve and setting it into the well head. A. H. N.

433.* Determining Fatigue in Sucker Rods. W. A. Sawdon. *Petrol. Engr*, February 1942, **13** (5), 23–26.—The testing service described in this paper utilizes a magnetic method of measuring the fatigue in steel, and is based on the fact that no two pieces of steel can have the same hysteresis curve unless they are identical in chemical composition, heat treatment, and physical characteristics. The rod to be tested is inserted in a coil that is excited with alternating current. The flux induced bears a direct relationship to the physical characteristics of the steel, and if a second coil is brought into inductive relationship to the rod, the voltage induced in it will also bear a direct relationship to the physical characteristics. As the physical characteristics of the steel change, small changes occur in the induced voltage, and these changes can be correlated to the physical characteristics. By properly arranging the circuits and exciting the material, the development of fatigue is established by measuring the phase angle that occurs in the induced voltage.

Two recordings are made on a chart, and these show the characteristics of the steel in the sucker rods. One recording is the phase angle that identifies the fatigue, and the other is the magnitude of the change. The charts obtained are illustrated, and the method of use is described fully, together with certain typical sets of results of such tests.

It appears from the results obtained to date that replacement of rods by fatigue-test data has been effective and economical. In many cases more new rods have been bought at one time, but by the replacement of rods definitely shown to be fatigued many subsequent pulling jobs have been eliminated. The broken rods have to be replaced in any case, so by doing the job at one time a number of shut-downs and the expense of pulling and frequently fishing for rods have been avoided. In testing a pile of salvaged rods there will also be more rods junked, but as such rods would only cause trouble if run into a well, their retirement is economical. Moreover, by classification of the rods they can be put into a service within their limitations, and rods well able to handle light duty will not be over-stressed and begin to give trouble.

Considerable study has been given by one of the major companies on when it is profitable to test a string of rods in a well. Exclusive of the value of deferred production, it was concluded that it pays to test the string when the frequency of rod failures exceeds a rate of one break in 60 days.

Another company has found that in the average well the number of rods to be replaced appears to have a direct relationship to the frequency of breaks. The ratio is approximately 1·25 times the average number of breaks a year, which, for a well having one break in 60 days, would be seven or eight rods. In a well with fifty breaks a year, the number of rods to be replaced would be sixty-two, which would still be only 30% of a 6000-ft. string.

It must be remembered that little corrosion is encountered in most California fields when compared with many other oil-producing areas. Fatigue induced by corrosion is therefore not so prevalent; but even small corrosion pits are a definite source of fatigue. A. H. N.

434.* Wells in Big Lake Field Now Pumped by Power from New Generating Plant. F. H. Love. *Petrol. Engr*, February 1942, **13** (5), 53.—The plant described has an output of 2000 kw./24-hr. day. This output is distributed to the several consuming outlets by three feeder circuits. One circuit feeds a bank of four 1000-kva. transformers, of which one is a standby that steps-up the voltage from 2300 to the 13,800 volts required for field operations. A second circuit feeds three 2400-kva. transformers that reduce the voltage to 110–220. This power is used by the company camp and the town of Texon. A third circuit, for operation of the generating plant's auxiliary equipment, feeds three 50-kva. transformers.

In the field, power generated by the plant is pumping 145 wells that produce from depths of 2900–3100 ft., and four that produce from a 2400-ft. zone. Sectionalized pole-top disconnecting switches have been installed, one at the plant and several throughout the field, so that, should the load become inadequate at any time, a part of the field can be removed from service.

On the individual wells a special thermal overloading relay allows for a long starting period. After the well is pumping, the thermal overload relay is set for a lower rating, equivalent to the pumping load of the well. Should an overload occur due to rod break or some other cause, the overload relay will trip and clear the well from the line.

The motors used in the field are double-rated, variable-speed, slip-ring units. To pump the wells, motors of 15 h.p. at 575 r.p.m. are used, and for well-servicing they are 35 h.p. at 1160 r.p.m.

The plant equipment and other details are described and illustrated. A. H. N.

435.* Flexibility and Efficiency of Two-Zone Completions Proved in Condensate Field. W. R. Brown. *Petrol. Engr*, February 1942, **13** (5), 66.—In the conventional double or two-zone completed well the casing is perforated opposite the upper formation and again opposite the lower formation with a production packer separating the two formations, in order that one may produce through the casing annulus and the other through the tubing. In distillate wells, even in this high-pressure district, the gas flowing from the formation forms a liquid due to retrograde condensation, and loads up the casing annulus, finally shutting off the flow of gas, because the velocity of the gas-stream is not sufficient in the large area of the annulus to keep the liquid in the gaseous phase.

A special valve was designed to remove the load of condensate from the casing annulus. The valve, exclusive of the 1¼-in tubing, is made up in the 4-in. tubing string used in wells in the field, and is placed between the upper producing formation and the packer separating the zone producing through the tubing from the zone producing through the casing. It is designed with passages through the valve-joint around the valve mechanism to permit flow from the lower formation at all times through the annulus between the 4-in. and 1¼-in. tubing. After the tubing string is set in place on the bottom of the hole and the packer set, the 1¼-in. tubing is run with a guide to, and made-up in, the Lewis valve. As the surface end of the 1¼-in. tubing is made-up with a hollow piston-rod, it is necessary to allow for stretch and temperature expansion before the tubing is cut and the connection made. The operation of the valve is simple.

Distillate in the Stratton field, because of the temperatures and pressures, exists in the formation only in the vapour phase. A decrease in bottom-hole pressure would therefore present occasion for retrograde condensation within the sand, resulting in a large part of the distillate wetting the sand and becoming unrecoverable. Operators are thus required to maintain a close check on pressures of the well and individual sands to prevent the occurrence of condensation below a predetermined pressure. When this point is reached production from the sand is discontinued, and in case both sands are regarded as depleted at the same time, the well is then converted into a double injection or input well. Distillate remaining in the sand in gaseous phase may be recovered from some other well completed in the same sand, as dry gas being injected into the sand apparently moves in a wave front away from the well-bore with a little mixing or diffusion with the rich or distillate-bearing gas. Other producers in the same sand some distance from the input well will eventually become dry-gas producers, and may then be converted into input wells, but the condensate will have been recovered by that time. A. H. N.

436.* Petroleum Engineering. Part 2. L. C. Uren. *Petrol. Engr*, February 1942, **13** (5), 82.—Professor Uren concludes his paper on educating a petroleum engineer by giving a full description of the courses considered as minimum requirements in colleges. A. H. N.

437.* Depleted Sands Serve as Safe, Economical Oil Storage. F. R. Cozzens. *Petrol. Engr.*, February 1942, **13** (5), 162.—Natural gas has been returned to depleted sands in fields near Pittsburgh, Pennsylvania, and Louisville, Kentucky, and later successfully recovered. In various stripper-oil districts, especially in South-eastern Ohio, it has long been a practice to introduce into depleted wells fresh crude oil in quantities ranging from 50 to 1000 brls., for the purpose of cutting paraffin and sludge. In many such wells the oil was forced into the sand by air-pressure, and left dormant for a period of 90 days and longer. When these wells were reopened and pumped vigorously, the measured quantity of injected oil was taken out, plus a higher than normal drainage from the oil-sand. The increase in normal drainage was undoubtedly due to the solvent effect of the injected oil on any deposit of paraffin and sludge on the face of the sand. Calculations were based on previous sand-core tests, showing an average oil content of 200 brls./acre-foot of sand. Previous pumping records in these fields showed an oil recovery of 180 brls./acre-foot, so it could be estimated fairly accurately that the injected oil was entirely recovered. As such tests have been scattered over wide areas, and made in sands of various textures, there is ample reason to believe that larger quantities of oil can be injected and recovered at will by modern recovery methods. Certain sands cannot be used for storage, as oil thus pumped into them is irrecoverable.

For his experiments, the operator chooses a district of settled production, and a sand virtually depleted of oil (containing less than 200 brls./acre-foot). By coring, or from records of previous drilling, he charts three to ten wells in a restricted area (5000 ft. or less), where the producing sand is fairly uniform in thickness, colour, and porosity. Pumpers are then given instructions to compute carefully the output of production from each well, and to observe whether they build-up uniform " heads " of oil between pumpings, also whether wells nearest the edges of the sand-body respond with a gradual increase of production when other wells near the centre of the reservoir sands are left dormant. After such observations have been made over a period of weeks, or even months, the operator has gained fairly accurate knowledge as to his project's possibilities in safely retaining oil. If air or gas pressure is or can be used, he can inject small quantities of oil and compute the effort and expense necessary to recover it. These and numerous experiments and calculations can be made on a sand by the operator and his crew without excessive cost. A. H. N.

438.* Field Application of Core Analysis and Depth-pressure Methods to the Determination of Mean Effective Sand Permeability. N. van Wingen. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1464, 1–5.—The permeability profile of a producing horizon can be integrated graphically to give an average permeability for the horizon. The dry pore permeability of each sample can be corrected to give a true measure of the ability of the horizon to transmit oil, provided that the percentage of connate water is known.

Effective sand permeabilities can also be estimated from analytical studies of field-pressure measurements. In one method the time rate of pressure build-up after a well is shut in from steady state flow is required, and in the other the direct measurement of a steady state rate of flow and the corresponding equilibrium pressure is employed.

The methods outlined are applied to two wells, and the results obtained from core-analysis data, from the rate of pressure build-up, and from the productivity index are compared. Results obtained by the last two methods are similar, and considerably lower than those obtained by the first method. G. D. H.

439.* Oil-Well Spacing, War, and Geology. Anon. *Petrol. World*, February 1942, **39** (2), 24.—The main thesis of this paper is that a standard oil-well spacing programme for all areas might be as injurious to certain areas as it is beneficial to others. The oil-fields of California are studied in particular detail. Certain misconceptions are discussed. For instance, the much-criticized Long Beach field is actually wider spaced/acre foot of oil-sand than some of the model development examples of the east. The principal area of some 1300 acres with some 1400 wells has well in excess of 1000 ft. of oil-sand. This results in roughly one well/1000 acre ft. of sand. It is therefore comparable to developments elsewhere with 10-acre spacing and 100 ft. of sand, or 100-acre spacing with 10 ft. of sand. Recovery has been about half a million brls./acre.

Furthermore, neither the economic import nor the sociological and military aspects can be ignored. The great per-acre yield caused lease values to reach, and sometimes exceed, $5000/acre. A 40-acre spacing regulation in 1923 would have had the practical and anti-social effect of handing over this reserve of well over half a billion barrels of oil to a handful of operators, because only those few could have been able to acquire 40 acres at $5000/acre and then drill a well.

Such a ruling would have required at least $250,000/drill site for participation in the Long Beach oil reserve, and would thus have removed from many citizens their right to engage in the oil business. However, under " close " spacing a number of independent operators got their start in the oil business. And a number of those companies, because of healthy subsequent growth elsewhere, developed from that start to a position to-day of being capable each of supplying the entire west coast military needs for petroleum.

Thus, it is emphasized that California should find its own well-spacing programme, regardless of what is found to be of optimum value elsewhere. A. H. N.

440.* Economics of the Modern Pumping Unit. J. R. Thomas. *Petrol. World*, February 1942, **39** (2), 29.—The paper discusses the economics of the modern pumping unit in comparison with the older system, with special reference to maintenance and cost of operation.

The advantages of modern units over the old standard and with single-cylinder engine are listed as : (1) Smoother motion, thus less wear and tear on subsurface and surface equipment. (2) Lower fuel and lubrication costs. (3) Lower maintenance in : (*a*) prime mover ; (*b*) gear-box as against reverse clutch. (Reverse clutch should be stressed, as it is probably the most expensive single piece of equipment to maintain in the standard end.) (4) Reduction in belt trouble. (5) Reduction of labour in starting engines. (6) Less down-time as a result of above reductions. (7) Larger realizable salvage. Each of these items is discussed after a brief discussion of the economics of a change-over. Other advantages of the newer-type equipment are mentioned, but are not considered in detail. In the floor unit especially the haphazard lubrication of bearings on the saddle, pitman, and crankshaft is eliminated. It is impossible to keep the areas around the sampson post and crank clean with this type of lubrication, where the pumper throws the oil at a bearing and hopes that some of it gets in the right place. This practice creates a definite fire hazard and does not improve the operator's safety rating. A good deal of oil is wasted. Another factor worth mentioning is that one pumper can properly tend twice as many wells equipped with modern units, due to the less frequent need for lubrication, adjustment of lubricators, etc.

Typical savings are cited. A. H. N.

441.* Band-Wheel Drives Pay Out Quickly. G. E. Henderson. *Petrol. World*, February 1942, **39** (2), 31. *Paper Presented before American Petroleum Institute.*—The discussion is confined to band-wheel drives, wherein existing standard ends, less the power equipment and long belts, are usually utilized. The name " band-wheel drive " as used here is really a misnomer, as all wells equipped with band-wheels for pumping are band-wheel drives. However, during the last ten years, through general usage, the term " band-wheel drive " has been supplied to units that use small motor with necessary reduction to use the band-wheel shaft to pump wells at slow speeds.

Actual cases are cited and analysed in detail to illustrate the savings, among other advantages, of the system. Both the economical and engineering aspects are studied.

When band-wheel drives are properly installed and engineered, the life of the equipment has already been shown to be in excess of 10 years, as maintenance on equipment as old as this is still negligible. This is particularly interesting as applied to the life of chain. There are many records in the San Joaquin Valley of unprotected chains having run for 10 years without replacement.

A decision as to whether or not the existing equipment should be replaced on a producing well is purely a matter of economics. This depends on the volume of production, condition of rig, and lifting costs. The band-wheel drives are not a cure-all for all producing wells. However, there are still a large number of wells in California where the instalment of special equipment such as the band-wheel drive would pay for itself in 6–19 months.

The application of the band-wheel drive fits into national defence, inasmuch as it utilizes the maximum amount of the existing equipment, and thus conserves material for war-time uses. A. H. N.

442.* War-time Problems of the Petroleum Producing Industry. L. C. Uren. *World Petrol.*, March 1942, **13** (3), 48–53).—American authorities have formulated objectives for the petroleum producing industry: "(1) Produce at least 1,500,000,000 brls. of crude petroleum if that quantity can be supplied without impairing the ability to sustain the necessary production during the emergency. (2) Drill a sufficient number of wells, efficiently spaced, to furnish that amount of oil next year and to prove up sufficient reserves to furnish at least that amount during the following year. (3) Operate all wells so as to conserve reservoir pressure to the end that the greatest practicable ultimate recovery will be attained at the lowest possible cost, with minimum expenditures required to provide artificial energy to effect production. (4) Conduct an exploration campaign that will result in the discovery of new supplies adequate to maintain a comfortable ratio between reserves and current annual consumption. (5) Maintain surface stocks of crude oil at adequate levels with respect to refinery requirements for the various grades and qualities of products, as well as stocks of the products sufficient to protect against any unusual demand that may arise."

The realization of these objectives forms the substance of the paper. It is noted that it is fallacious to assume that the U.S. oil industry can produce what will be required by merely opening flow-valves, as each reservoir has an optimum rate of flow. The daily rate of production that could be had from present-known fields of the United States without exceeding the economic optimum rate of production has not been determined. Some authorities believe that it does nor greatly exceed the present daily production rate. The writer has lately sought opinions on this matter from men in the industry qualified to express such an opinion, and the resulting estimates have in most instances been between 4,000,000 and 5,000,000 brls./day. The current rate of production (January 1942) is about 4,100,000 brls./day. Col. E. O. Thompson has stated that in his opinion fields now producing in the United States cannot support a production of 5,000,000 brls./day over a long period of time without loss in ultimate recovery. In other words, it would appear to be the considered opinion of competent authorities that production much in excess of the present daily rate cannot be maintained economically from present reserves, and any additional supplies that may be needed should be provided by discoveries of new reserves. Apparently substantial increases in production are possible only in Texas and California, and even in these States only moderate increases are possible if the increased rates are based on consideration of conservation and maximum ultimate recovery of petroleum resources.

Increased production implies intense exploration and drilling programmes. Estimates by competent authorities indicate that at least 30,000 new wells should be drilled in the United States during 1942. Probably more than this will be needed if we are to maintain reserves and provide sufficient flush production to meet prospective crude demand. The average well drilled in the United States during recent years has been about 3000 ft. deep. Assuming that this average depth may conservatively be applied, it would appear that the total footage drilled during 1942 should be at least 90,000,000 ft. The average cost/ft. of drilling has not been determined recently, but possible averages are about $7 or $8, including casing and fixed charges. The total expenditure of the industry for new drilling may therefore aggregate nearly $750,000,000 for the year 1942.

The long paper discusses further the problem of spacing, rehabilitation of idle stripper-wells, power requirements, and the need of maintaining a large number of skilled man-power. A. H. N.

443.* Transferring Well Allowables to Conserve Steel. H. M. Staggs. *World Petrol.*, March 1942, **13** (3), 71.—The effects of the present hostilities on production of oil are briefly discussed. Conservation of oil production may be defined as the production of the greatest possible amount of oil with the smallest possible amount of energy. This is of the greatest importance for several reasons, chief of which are ultimate oil recoveries and more oil produced by natural flow. The most satisfactory means of accomplishing such conservation would be by Unit Operation, where the entire pool is operated under one management. This would make possible long-range planning for the best interests of all concerned. Some progress has been made along these lines in recent years. However, complete Unit Operation is not fully accomplished except in a few instances; therefore, more progress is much to be desired. In the absence of Unit Operation, some accomplishments that would aid in conservation would be to create units within a field for operating purposes whereby the allowable of such units could be produced by any well or combination of wells in the unit to conserve reservoir energy. Thus gas energy could be conserved by producing lowest gas-oil ratio well or wells in each unit. The transfer of allowables from high-volume water producers to other wells on a lease, as is suggested in some fields, will assist in the conservation of both reservoir energy and artificial-lift equipment. Where wells are closely spaced, some system of allowable transfer to offset wells on the same lease would free large quantities of artificial-lift equipment for use elsewhere. Where possible, wells should be reworked and natural flow re-established in preference to the installation of artificial-lift equipment. A. H. N.

444.* Sustaining Productive Capacity during the War. J. H. Abernathy. *World Petrol.*, March 1942, **13** (3), 72–75).—Means available for increasing productivity of producing wells falls into two classes: (1) Producing from a new pay-zone. (2) Increasing production from the present pay. Within these broad classes, however, divisions are numerous. In the first class, the well may be drilled down to tap known or suspected deeper horizons, or, conversely, the well-casing may be opened opposite zones which were penetrated in the original drilling. Methods for two-zone production which have been recently developed will, no doubt, find an increasing use. In drilling deeper, some of the problems encountered are: protection of the zone from which production had previously been taken, in order to avoid contamination and other damage to the formation; proper casing, cementing, and mudding practices to minimize use of materials and to avoid damage to equipment already in the well; and working out fishing jobs and completion and production problems occasioned by the small holes that must necessarily be cut in most deepening work.

The second class of increasing production is briefly sketched, as it can represent an almost unlimited number of alternatives. Water encroachment may be retarded, gas repressuring employed, etc. Yet another group of wells exists in which decreasing production is largely the result of mechanical failures. The screen may be corroded or plugged with sand, shale, or gypsum. The screen may have collapsed by moving sand or cut out by erosion resulting in a sanded-up condition. In areas where corrosive water or electrolytic conditions are encountered, holes or breaks may occur in the well-casing itself. Similar difficulties may appear owing to casing wear if the well is baled or swabbed for extended periods of time, especially if the hole is crooked. Some of these mechanical difficulties are almost indistinguishable at the surface from other types of well troubles, and great care must be exercised in determining the repair procedure, otherwise irreparable damage may be done to the well. A. H. N.

445. Patents on Production. J. E. Frances. U.S.P. 2,272,194, 10.2.42. Appl. 23.9.39. Pipe-joint.

C. M. Williams. U.S.P. 2,272,388, 10.2.42. Appl. 25.1.40. Controlled pumping choke for oil-wells.

D. D. Perry. U.S.P. 2,272,579, 10.2.42. Appl. 3.10.40. Well-pumping mechanism for driving the walking beam.

H. T. Kennedy. U.S.P. 2,272,672, 10.2.42. Appl. 23.3.36. Water-flooding of oilfields and using a reagent to produce plugging in the formation.

H. T. Kennedy. U.S.P. 2,272,673, 10.2.42. Appl. 24.3.36. Gas repressuring of oilfields and using a plugging reagent in the formation.

K. F. Budd. U.S.P. 2,272,963, 10.2.42. Appl. 19.10.39. Swab comprising a mandrel and complementary swab sections.

M. De Groote and B. Keiser. U.S.P. 2,273,181, 17.2.42. Appl. 7.7.41. Process for breaking petroleum emulsions by means of a chemical.

R. C. Farley and J. W. Gillespie. U.S.P. 2,273,349, 17.2.42. Appl. 18.8.38. Pumping apparatus which can be lowered into a well and removed therefrom on a flexible line.

F. E. Wellman. U.S.P. 2,273,915, 24.2.42. Appl. 18.3.38. Process of desalting petroleum crude by means of contacting with water and settling.

B. D. Hays. U.S.P. 2,274,062, 24.2.42. Appl. 23.8.38. Differential pressure unit for flowing-wells having a casing.

R. P. Miller. U.S.P. 2,274,084, 24.2.42. Appl. 13.5.40. Valve for pumps of the automatic fluid-pressure type.

D. Ragland and J. U. Teague. U.S.P. 2,274,093, 24.2.42. Appl. 19.10.38. Apparatus for completing submarine wells.

C. H. Sweet. U.S.P. 2,274,107, 24.2.42. Appl. 10.2.40. Paraffin cutter for use in the oil-production tube of a flowing well.

C. Irons and S. M. Stoesser. U.S.P. 2,274,297, 24.2.42. Appl. 16.12.38. Method of treating earth and rock formations by means of a solidifying resin-forming liquid.

O. Hammer. U.S.P. 2,274,407, 24.2.42. Appl. 9.8.39. Means for producing from spaced oil-sands one of which requires pumping.

J. H. Howard and J. H. McEvoy. U.S.P. 2,274,477, 24.2.42. Appl. 24.8.39. Tubing hanger for washing and completing wells.

J. F. Inderdohnen and A. Noble. U.S.P. 2,274,479, 24.2.42. Appl. 22.7.39. Device for measuring pressures of flowing fluids irrespective of temperature.

J. M. Hartgering and C. M. Perkin. U.S.P. 2,274,601, 24.2.42. Appl. 1.7.39. Oil-well pumping unit using a walking beam with springs attaching the beam to opposite sides of the samson post. A. H. N.

Gas.

446.* Liquefied Petroleum Gas in 1941. Anon. *Chem. Met. Eng.*, February 1942, **49** (2), 125.—Estimated domestic use of liquefied petroleum gas in 1941 amounts to 221,880,000 gal., an increase of 65·5% over 1940, when 134,018,000 gal. were so consumed. On the basis of the most reliable information available, the number of new domestic users of liquefied petroleum gas increased by approximately 520,000 during the year. It is now estimated that there are a total of 1,645,000 users of liquefied petroleum gas in the domestic and small commercial classification.

One trend in refining technology relating to the manufacture of aviation gasoline which will have a pronounced effect on the available supply of butanes to the liquefied petroleum gas industry is the process of isomerization of normal butane into *iso*butane, with the *iso*butane then being converted into aviation gasoline by either the thermal or catalytic alkylation process. The demand for tremendous quantities of aviation gasoline has greatly stimulated the installation of new large-capacity isomerization and alkylation plants, and plans for further expansion along these lines throughout the petroleum industry are well under way. A. H. N.

Cracking.

447.* Revised Cracking Technique Increases Octane Rating of Michigan Distillates. Anon. *Refiner*, February 1942, **21** (2), 43–44.—Early difficulties in cracking Michigan crude oil have been eliminated in recent plant designs. A typical plant and its operation, as well as results obtained therefrom, are described. A. H. N.

448. Patents on Cracking. Standard Oil Development Co. E.P. 543,215, 16.2.42. Appl. 28.12.39. Method of processing oils containing constituents unvaporizable under temperature conditions suitable for catalytic cracking treatment. The oils are processed to form lower-boiling hydrocarbons in the motor-fuel range by subjecting them to mild thermal cracking at temperatures of the order of 850° F. Products of this thermal cracking are separated into vapours of products boiling substantially below 800° F. and a heavy residue. The vapours are passed into contact with an active solid catalyst at a temperature suitable for the production of a high ratio of motor fuel to normally gaseous products.

L. C. Huff. U.S.P. 2,271,298, 27.1.42. Appl. 28.8.37. Conversion process which includes cracking hydrocarbon oil heavier than gasoline, fractionating the resultant vapours and returning fractions thus condensed to further cracking, whereby the vapours are separated into light gasoline fractions of satisfactory anti-knock value and a higher-boiling condensate. The light gasoline fractions are condensed and recovered, and the condensate subjected to reforming to increase the anti-knock value of the heavy gasoline fractions.

C. H. Angell. U.S.P. 2,271,610, 3.2.42. Appl. 31.8.38. Subjection of hydrocarbon oil to cracking conditions of temperature and pressure. Afterwards the resultant heated conversion products are removed from the conversion zone and a relatively heavy reflux condensate, a lighter condensate, a final distillate and gases separated therefrom. At least a portion of the gases are scrubbed with a portion of the lighter reflux condensate and the resultant enriched condensate stripped of the absorbed gaseous components.

W. L. Benedict. U.S.P. 2,271,617, 3.2.42. Appl. 25.5.39. A hydrocarbon oil-conversion process which comprises contacting the charging oil, with an active cracking catalyst to form a substantial quantity of gasoline and heavier products more refractory to catalytic cracking than the charging oil. The gasoline is separated from the heavier products, and at least a portion of the latter subjected in admixture with hydrogen, to the simultaneous action of a cracking catalyst, and a hydrogenating catalyst. In this way a substantial yield of gasoline is obtained from the heavier products.

H. S. Bloch and E. C. Lee. U.S.P. 2,271,618, 3.2.42. Appl. 30.9.38. Production of gasoline from hydrocarbon oils heavier than gasoline by contacting the oil at cracking temperature with a calcined mixture of the hydrogels of silica and vanadia. The mixture is substantially free of alkali metal ions.

E. R. Kanhofer. U.S.P. 2,271,645, 3.2.42. Appl. 22.1.40. Conversion of hydrocarbon oil by introducing into a fractionating zone and fractionating same, together with cracked products to form a gasoline-containing overhead product, a residual fraction containing unvaporized charging oil, and a condensate fraction boiling intermediate between the two. A powdered cracking catalyst is mixed with the intermediate condensate and the resultant product subjected to catalytic cracking conditions. Conversion products and admixed catalyst are introduced into the fractionating zone, thereby mixing the catalyst with the residual fraction. Afterwards residual fraction and catalyst are removed from the fractionating zone and subjected to independently controlled cracking operations. Products of this cracking process are separated into vapours and residue and the former passed to the fractionating zone. H. B. M.

Hydrogenation.

449. Patents on Hydrogenation. R. Leprestre. U.S.P. 2,271,017, 27.1.42. Appl. 10.5.38. Method of increasing the hydrocarbon content of hydrocarbon products by preparing an aqueous colloidal mixture of the base material. The mixture and a hydrogen carrier are injected simultaneously, at a pressure of 12,000–14,000 lb. per square inch, into a chamber within which a temperature of approximately 1000° F. is maintained. The base material and carrier are brought into direct impingement at a common point in the chamber, and the mixture circulated in contact with a catalyst. Thereafter the gaseous products from the catalytic reaction are cooled and condensed.

W. Herbert. U.S.P. 2,271,259, 27.1.42. Appl. 25.5.38. Catalytic conversion of gaseous mixtures, containing carbon monoxide and hydrogen, into hydrocarbons with catalysts adapted to form benzine oil and paraffin under atmospheric pressure.

H. B. Kipper. U.S.P. 2,274,204, 24.2.42. Appl. 4.5.40. Process for the dehydrogenation of hydrocarbons of a class consisting of the hydrocarbon gases above methane and delivered as waste gases from petroleum-oil cracking. The process includes subjection of the hydrocarbons to treatment with a mixture of oxygen and an inert gas. The oxygen is present in sufficient amount only to react substantially with all the liberated hydrogen. H. B. M.

Polymerization and Alkylation.

450. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 543,046, 9.2.42. Appl. 12.1.40. Production of normally liquid saturated hydrocarbons boiling within the gasoline range by reacting a mixture of hydrocarbons comprising both *iso*- and normal paraffins with a mono-olefin or a di-olefin, in the presence of an alkylation catalyst.

Standard Oil Development Co. E.P. 543,085, 10.2.42. Appl. 30.4.40. Improved process for the conversion of normal paraffins into *iso*paraffins with a metal halide Friedel–Crafts catalyst. Halide or boron is used as a catalyst activator.

A. R. Goldsby. U.S.P. 2,271,860, 3.2.42. Appl. 17.2.38. Manufacture of higher-boiling *iso*paraffins from low-boiling *iso*paraffins and olefins by subjecting a hydrocarbon fraction containing low-boiling *iso*paraffins, olefins, and normal paraffins to alkylating conditions. Normal paraffins are afterwards separated from the reaction products and isomerized to *iso*paraffins, which are then charged to the alkylation operation to increase the ratio of *iso*paraffins to olefins in the reaction mixture and to produce further quantities of higher-boiling *iso*paraffins.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,041, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting *iso*butene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of the hydrocarbons in liquid phase.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,042, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting normal butene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of hydrocarbons in liquid phase.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,043, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting propene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of the hydrocarbons in liquid phase. H. B. M.

Synthetic Products.

451.* Mobilizing Petroleum Hydrocarbons. G. F. Fitzgerald. *Chem. Met. Eng.*, March 1942, **49** (3), 83–87.—The effects of the war on various synthetical processes using hydrocarbons as raw materials are discussed, particularly the situation of butadiene and fighting-grade aviation gasoline. Statistical data are given. The rubber situation is discussed, and it is noted that about a year and a half is the maximum time allowable to improve the situation.

Acetylene production from petroleum is under development by research workers at the University of Texas. They report that it has been made experimentally from propane, but has not yet reached the commercial stage. Existing facilities for the synthesis of butadiene from petroleum gases are being rapidly augmented. Typical of the new facilities is a 5000-ton/year unit which went into production late in 1941. Several more plants are under construction, but details must be considered as military secrets at this time.

Isomerization, polymerization, and catalytic cracking are briefly discussed. It is concluded that all industry is being mobilized in the States. Demand for synthetic rubber has put an unexpected burden on the petroleum industry. The production of 100-octane gasoline must be rapidly increased. Sufficient *iso*butane, butadiene, high-octane blending agents, and other strategic petroleum derivatives must be provided to carry on the war production programme. Existing capacities for these materials must be expanded 300, 400, and in some cases even 500% to meet the demand of the armed forces. A. H. N.

Refining and Refinery Plant.

452.* Decoking Petroleum Residues. J. S. Swearingen, M. R. Morrow, and B. Jones. *Refiner*, February 1942. **21** (2), 31–35.—An historical review of the process is given. Shell-still methods were followed by the continuous tube-still heater methods. The charge is heated by continuous charging of the reaction chamber through a tube-still heater, the oil being allowed to stand in the reaction chamber and go to coke and distillate due to its own sensible heat. Obviously, there should be more than one chamber in parallel, to allow time for cleaning out the coke. The charge may also be heated by contact with a hot stream in the cracking unit where the two enter the reaction chamber together. Variations of these methods with even the inclusion of re-circulation of a portion of the residuum are possible, and necessary to suit particular conditions.

These methods of heating are particularly feasible in view of the fact that the residuum is available in a continuous stream at about 850° F. The development of these methods was apparently delayed until cracking-plant control was perfected, and made sufficiently automatic that additional continuous apparatus also requiring control could be attached without unduly complicating and hampering the whole operation.

The methods of coke removal have also been improved, with three methods predominating—namely, cable pulling, drilling, and the hydraulic method. The cable-pulling method consists of filling the coke-chamber with layers of steel cable in spirals. When the chamber has been filled with coke, the removal of the cable by means of a winch located on the end of the drum ploughs up the coke so that it practically falls out. The disadvantages are the labour requirement, the presence of wire in the choke, and the time required (8–15 hrs. or longer).

The drilling method is, as the name implies, the removal of the coke by a series of drilling operations. The hydraulic method involves the use of high-pressure (1200 lb./sq. in.) jets of water, which literally wash the coke out of the drum.

A study of the effects of coking conditions and of the type of residuum on the yields of products and on the properties of the liquid products is apparently not recorded anywhere in the literature, and so constitutes an important part of the present work, wherein the effect of temperature and period of detention and the type of charging stock were varied. In the light of these data a method and a large laboratory apparatus for carrying out the reaction under optimum conditions is described and the results are given. A. H. N.

453.* Sub-Cooling Absorption Oil in Two Phases. Anon. *Refiner*, February 1942, **21** (2), 38.—The principal application of chilling is in the base of the absorbers, while the secondary application is after the absorption oil has passed through the atmospheric sections in the cooling tower. Since the greatest rise in temperature in the absorbers is at the first contact between the gas and the oil, these absorbers are equipped with two tube bundles each, located immediately above the connection through which the compressed gas enters the columns. The oil which is chilled in the second phase enters the top of the absorbers above the bubble trays at a temperature sufficiently low to absorb and retain propane and heavier fractions extracted in the absorption process. Details of the plant are briefly described.

The fall in temperature of the oil and gas in the base of the absorbers is controlled by gate valves in the vapour lines from the hair-pin chillers, which are set to place the necessary back pressure on the butane to accelerate or reduce the rate of vaporization of the butane. The line carrying the butane vapours from the absorber chillers is insulated to prevent loss of refrigeration before reaching the butane vapour-to-absorption-oil cooler.

The vapour-to-absorption-oil cooler is made in the plant shops from a 40-ft. section of 24-in. pipe, with 212 ½-in. tubes inside, and connected for oil-flow through the tubes and butane in the shell. Since most of the butane is expanded to vapour in the two pairs of hair-pin bundles in the absorbers, the material entering the vapour-to-oil exchanger is a mixture of vapours and liquid, which is reduced in pressure with a pilot-operated controller at the entrance to the exchanger. The piping is arranged so that the refrigerant enters the exchanger at the base and passes to the suction line of the compressor at opposite end through a top connection. With the reduced pressure in the shell of the exchanger and the direction of flow, a combination of flooded—at one end—and vapour chilling is obtained, sufficient to reduce the temperature of the oil from summer conditions of 92° F. in, and 80° F. out.

With an oil temperature at the inlet of the absorbers above the top bubble-tray running around 80° F. during summer, desired fractions are prevented from passing to the residue line in the stripped gas, and by controlling the temperature of the oil and gas in the base of the columns, fractions are retained in the oil as it leaves the columns to obtain the necessary composition of the raw gasoline for manufacturing any grade of natural gasoline and liquefied petroleum gases. A. H. N.

454.* Welding Grooves in Refinery Practice. W. L. Archer. *Refiner*, February 1942, **21** (2), 48.—A detailed study of the importance of grooves in welding refinery equipment is made. Dimensions and practical hints are given in full. A. H. N.

455. Patents on Refining and Refinery Plant. E. I. Du Pont de Nemours. E.P. 543,292, 18.2.42. Appl. 15.5.40. Process for inhibiting deterioration in colour of viscous petroleum oils. Organic compounds of the type of Schiff's bases are incorporated with the oils.

C. M. Ambler. U.S.P. 2,271,882, 3.2.42. Appl. 9.8.39. Purification of used hydrocarbon oils by mixing with the oil an aqueous alkaline reagent. Afterwards the mixture is subjected to an evaporating operation to remove a substantially large part of the water and concentrate the reagent. Finally alkaline reagent and impurities are separated from the oil by subsidence.

W. L. Benedict and J. E. Ahlberg. U.S.P. 2,273,012, 17.2.42. Appl. 30.1.39. Method of removing impurities from hydrocarbon oil by treating it under refining conditions with hydrochloric acid and a calcined mixture of a silica hydrogel and a heavy metal hydrogel.

W. O. Heilman. U.S.P. 2,273,104, 17.2.42. Appl. 24.2.41. Method of removing mercaptan compounds from oils boiling above 250° F. The feed-oil is segregated into a relatively low-boiling fraction and a relatively high-boiling fraction. The low-boiling fraction is treated in a primary contacting zone with an alkali metal hydroxide solution to remove mercaptan compounds. The treated oil is then separated from the solution and the respective streams of oil and solution are removed from the contact zone. The relatively high-boiling fraction is treated in a secondary contacting zone with the separated alkali metal hydroxide solution to remove mercaptan compounds. Finally the high-boiling fraction is separated and combined with the low-boiling fraction to make the final product.

F. W. Schumacher. U.S.P. 2,273,147, 17.2.42. Appl. 21.9.38. Method of decolorizing petroleum oils in a distillation tower. Constituents of the oil are withdrawn from a point below the feed inlet to the tower and a clay slurry formed with the fraction withdrawn. Afterwards the clay slurry is reintroduced into the tower at a point below that at which the constituents were previously withdrawn.

W. A. Schulze. U.S.P. 2,273,224, 17.2.42. Appl. 3.1.39. Method of improving the quality of straight-run and cracked gasoline stocks containing organic sulphur impurities. The mixed vapours of the straight-run and cracked gasoline stocks are passed over a catalyst of absorbent clay at a temperature between 500° and 1000° F., a pressure between atmospheric and 100 lb., and a flow-rate of 1–100 liquid volumes per hour per volume of catalyst. Temperature control is maintained by the addition of an inert gas at a temperature above that of the gasoline stock vapours to supply a portion of the endothermic heat of reaction.

J. Happel, Jr., and D. Warren. U.S.P. 2,273,263, 17.2.42. Appl. 13.11.39. Method of sweetening oil fractions containing sour sulphur compounds by contacting with an oil-soluble lead naphthenate and with added reagent sulphur in the absence of water and at normal atmospheric temperature. Afterwards lead sulphide formed by the reaction is removed from the oil.

A. Szayna. U.S.P. 2,273,299, 17.2.42. Appl. 8.10.38. Method of desulphurizing hydrocarbon oils by passing through a porous contact mass having an extended surface comprising free metal of the class consisting of nickel, cobalt, and iron, and having sulphur distributed throughout the surface. After the mass has taken up a substantial amount of additional sulphur from the oil, at least part of it is segregated and the additional sulphur removed by oxidation. The oxidation process is terminated while there still remains sufficient sulphur in the mass substantially to poison its catalytic activity.

J. W. Poole, U.S.P. 2,273,661, 17.2.42. Appl. 27.1.38. Method of refining a mineral oil containing lubricating oil by selective action of solvents substantially liquid at usual atmospheric conditions of temperature. Under such conditions none of the solvents will approach by itself maximum selective efficiency. A blend of crotonaldehyde and another solvent which is sparingly solvent in the oil is used.

R. P. Dunmire. U.S.P. 2,273,846, 24.2.42. Appl. 25.8.41. Method of removing impurities from used mineral oils and mineral waxes. The used material is mechanically mixed with a solid adsorbent material in a sealed container to adsorb high-boiling-point impurities. The mixture is then heated under vacuum at a temperature between 50° and 150° F. to drive off water and low-boiling-point impurities. Finally the adsorbent material with its impurities is separated from the mineral substance under treatment.

F. E. Wellman. U.S.P. 2,273,915, 24.2.42. Appl. 18.3.38. Process for desalting crude oil or fractions thereof by contacting with water in a continuous system having a settling chamber. A brine concentration is built up by contacting and re-contacting of incoming crude oil with water precipitated from the crude oil in the settling chamber, and maintained by the introduction of water into the system and release of excess brine from the system. H. B. M.

Analysis and Testing.

456.* Practical Corrosion Tester for Chemical Engineers. M. H. Heeren. *Chem. Met. Eng.*, February 1942, **49** (2), 126–127.—Principal factors in corrosion are briefly reviewed :—1. Temperature : (*a*) Corrosion reactions are accelerated with increased temperature, as are chemical reactions in general. (*b*) An increase in temperature can result in increased ionization and rates of diffusion. (*c*) Local differences in temperature may set up electrolytic cells acting as concentration cells. 2. Moisture : (*a*) Serious damage by corrosion to metal parts commonly takes place only if the metal surface is moist. 3. Galvanic action : (*a*) When two dissimilar metals are coupled and placed into an electrolyte, corrosion takes place. (*b*) When metal is placed into a solution in which the solute is stratified in different concentrations, corrosion of the metal takes place.

The method uses an endless chain from which specimens are suspended, the chain moving continually, and thus either dipping the specimens in trays full of the corroding liquids or exposing them to air draught, radiant heat, or a spray. The apparatus is flexible, and whilst there are many cases for which this apparatus is inadequate, its variability answers a large portion of the ordinary laboratory demands, and its agreement with actual field results is most gratifying. While the unit was designed primarily to determine the collective effects of corrosive conditions on metals, it has also been used advantageously in weathering tests on non-metals, such as paint, plastics, etc. In the case of paints, the radiant-heat chamber should be equipped with a source of ultraviolet light.

The selection of specimens for test naturally is governed by the types of materials to be employed in the construction of a plant or piece of equipment. In much of the current work at the Research Foundation, steel, cast iron, brass, copper, and aluminium are used. The specimen strips, approximately ½ in. × 3 in. used both individually and coupled dissimilarly, are suspended from the chain by means of glass hooks.

Preparation of the specimens consisted of careful cleaning by means of emery paper, followed by washing in alcohol and ether and weighing. The duration of a test is generally 336 hr. (2 weeks) continuous operation. On completion of the test the specimens are rinsed in distilled water, alcohol and ether, and re-weighed. A specific case is studied in some detail. A. H. N.

457.* Development of a Capillary Viscometer. A. H. Nissan. *J. Inst. Petrol.*, March 1942, **28** (219), 41–56.—Detailed description of a capillary viscometer adapted to measure viscosities between 10 and 750 poises is given. The errors in the measurements of temperature, pressure, rate of flow, and in the constancy of head across the viscometer are analysed. The total maximum error is shown to be of the order of 2%. A. H. N.

Motor Fuels.

458. Patents on Motor Fuels. J. K. Roberts. U.S.P. 2,271,095, 27.1.42. Appl. 29.12.37. Conversion of higher-boiling hydrocarbon oil into lower-boiling hydrocarbons by heating a crude-oil residual stock to cracking temperature and passing the heated products to a coking zone maintained at a coking temperature. In this way vapours are separated from coke residue. These are then fractionated to separate heavy gas-oil from light gas-oil, and the former afterwards passed through a viscosity breaking zone, wherein it is maintained under superatmospheric pressure and relatively high temperature conditions. Thus is produced a relatively high yield of intermediate constituents suitable for further cracking to produce gasoline constituents.

R. F. Ruthruff and C. F. Feuchter. U.S.P. 2,271,096, 27.1.42. Appl. 29.12.37. Treatment of crude residual charging stock in a similar manner to that described in U.S.P. 2,271,095.

R. F. Ruthruff and J. K. Roberts. U.S.P. 2,271,097, 27.1.42. Appl. 29.12.37. Treatment of a relatively heavy hydrocarbon oil in a similar manner to that described in U.S.P. 2,271,095.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,317, 27.1.42. Appl. 6.1.41. Conversion of hydrocarbon distillate heavier than gasoline into substantial yields of gasoline. The distillate is subjected under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions by treating with a solution of a salt of magnesium, and the purified materials mixed in the wet condition. Finally, they are dried to remove a major portion of the total water content.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,318, 27.1.42. Appl. 6.1.41. Conversion of distillates heavier than gasoline into substantial yields of gasoline by subjecting the distillate under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions, by treating with a solution of a salt of manganese, and the purified materials mixed in the wet condition. Finally, they are dried to remove a major portion of the total water content.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,319, 27.1.42. Appl. 6.1.41. Conversion of distillates heavier than gasoline into substantial yields of gasoline by subjecting the distillate under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions by treating with a solution of a salt of cerium, and the purified materials mixed in a wet condition. Finally, they are dried to remove a major portion of the total water content.

S. Shappirio. U.S.P. 2,272,134, 3.2.42. Appl. 13.3.42. Preparation of a liquid hydrocarbon motor fuel containing a minor proportion of a metallo-organo diazo compound.

A. Szayna. U.S.P. 2,273,298, 17.2.42. Appl. 23.9.38. Production of motor fuel which is substantially free from sulphur by heating a hydrocarbon oil to cracking temperature, and passing the heated oil, in vapour phase and in admixture with 1–5% by weight of hydrogen, through a body of contact material comprising a metal of the group consisting of iron, nickel, cobalt, and copper. The contact material is in a special state of activity, so that its hydrogenating and desulphurizing power is less than maximum throughout the body. In this way absorption of sulphur from the hydrocarbon oil is effected. Thereafter flow of the oil-vapour through the body is discontinued and the body regenerated. H. B. M.

Chemistry and Physics.

459. Structure of Vinyl Co-polymers. F. T. Wall, *J. Amer. chem. Soc.*, 1941, **63**, 1862–1866.—Vinyl chloride and vinyl acetate are taken as a typical pair of substances capable of undergoing co-polymerization. A theoretical treatment on the composition of co-polymers is given. There is also a consideration of the intramolecular distribution of monomer units within the polymer chains. E. H. W.

460. Alkyl-Substituted Hexa-arylethanes. XL. Symmetry and Steric Effects as Factors in Dissociation. C. S. Marvel, J. F. Kaplan, and C. S. Himel. *J. Amer. chem. Soc.*, 1941, **63**, 1892–1896.—Continuing previous work, these authors have prepared various di-, tetra-, and hexa-alkyl substituted hexa-arylethanes and calculated their per cent. dissociation by magnetic susceptibility measurements.

From the results obtained the following conclusions were reached. *ortho*-Alkyl substitution greatly increases the degree of dissociation. The symmetry of the ethane seems to be the next important factor after the steric or *ortho* effect. Also *meta*-alkyl groups promote dissociation more than *para*-alkyl groups. E. H. W.

461. Photolysis of Ketene and the Structure of Methylene. M. Burton, T. W. Davis, A. Gordon, and A. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 1956–1960.—The photolysis of ketene has been studied over a restricted range of temperature in the presence of varying concentrations of nitric oxide and ethylene. Evidence for the structure of methylene as a stable molecule or as a free radical is discussed. E. H. W.

462. Resonance-Energies of Unsaturated and Aromatic Molecules. G. W. Wheland. *J. Amer. chem. Soc.*, 1941, **63**, 2025–2027. Following the paper by Mulliken and Rieke (*ibid.*, 1941, **63**, 1770) a modification is suggested here on the calculation of resonance energies of molecules and free radical resonance energies of radicals. The results obtained with a number of unsaturated and aromatic hydrocarbons, and also a series of free radicals, are compared with experimental thermal data and earlier valence bond and molecular orbital calculations. E. H. W.

463. Structure of Alicyclic Compounds. J. G. Astron, S. C. Schumann, H. L. Fink, and P. M. Doty. *J. Amer. chem. Soc.*, 1941, **63**, 2029–2030.—These authors have compared the entropies of *cyclo*pentane obtained from thermal data down to 11·1° K. with those obtained from molecular and spectroscopic data based on three ring models. The experimental data they obtained are shown to agree more nearly with a non-planar model with one atom out of the plane, the other models being a planar model and a non-planar model with two atoms out of the plane.

Similar comparisons made with methyl*cyclo*pentane led to the same conclusion. *cyclo*Hexane gave a symmetry number of $\sigma = 6$, as expected. Their results also agreed with those of Beach (*J. Chem. Phys.*, 1941, **9**, 54), from the electron diffraction by tetrahydrofuran, which led also to a non-planar configuration. E. H. W.

464. Dehydration of Tertiary Carbinols Containing the Neopentyl Group. F. C. Whitmore and E. Rohrmann. *J. Amer. chem. Soc.*, 1941, **63**, 2033–2035.—This paper describes the dehydration with anhydrous copper sulphate of diethylneopentyl carbinol, giving 90% of 2 : 2-dimethyl-4-ethyl-4-hexene (dehydration from ethyl group), and less than 10% of 2 : 2-dimethyl-4-ethyl-3-hexene (dehydration from neopentyl group). Similarly, methyl *n*-butylneopentyl carbinol gave over 80% of 2 : 2-dimethyl-4-methyl-4-octene (dehydration from *n*-butyl group), and about 10% of 4 : 4-dimethyl-2-*n*-butyl-1-pentene (dehydration from methyl group), and only a trace of 2 : 2-dimethyl-4-methyl-3-octene (dehydration from neopentyl group). This work confirms the difficulty with which the neopentyl group will enter into a dehydration reaction. E. H. W.

465. Polymerization of Olefins. V. The Isomers in Tri*iso*butylene. F. C. Whitmore, C. D. Wilson, J. U. Capinjola, C. O. Tongberg, G. H. Fleming, R. V. McGrew, and J. N. Cosby. *J. Amer. chem. Soc.*, 1941, **63**, 2035–2041.—The structures and ratio of the various isomers of tri*iso*butylene are of importance to the work being done on polymerization, hence the fractionation and separation of these isomers was attempted.

Partial separation into lower- and higher-boiling fractions, in the ratio 9 : 1, was accomplished by repeated fractionations. The lower-boiling fractions of N^{20}D 1·4300 were shown to be 2 : 2 : 4 : 6 : 6-pentamethyl-3-heptene (I) and 2-neopentyl-4 : 4-dimethyl-1-pentane,—*unsym.*-dineopentylethylene (II) in the ratio of 2 : 3. The slightly higher-boiling fraction of N^{20}D 1·4310–5 could not be completely separated, but was apparently mainly the higher-boiling geometric isomer of I.

The higher-boiling isomers were shown to consist of 2 : 4 : 4 : 6 : 6-pentamethyl-1-heptene and 2 : 4 : 4 : 6 : 6-pentamethyl-2-heptene in about equal quantities. No evidence was found for the presence of 2 : 4 : 4-trimethyl-3-*t*-butyl-2-pentene, as reported by other workers. E. H. W.

466. Reaction of Olefins with Solid Cuprous Halides. E. R. Gilliland, H. L. Bliss, and C. E. Kip. *J. Amer. chem. Soc.*, 1941, **63**, 2088–2090.—The reactions of ethylene, propylene, and *iso*butylene with solid cuprous halides was described previously (*ibid.*, 1930, **61**, 1960). The paper now presented continues that work, and shows that butadiene, acetylene, and isoprene react with solid cuprous halides in a similar manner. The former two give compounds containing 1 mole of olefin with 2 moles of cuprous halide. The reaction with isoprene, however, is not so definite.

No reaction of amylene or *cyclo*pentadiene with solid cuprous chloride could be detected. E. H. W.

467. Synthesis of 5-Methoxy-10-methyl-1:2-benzanthracene and Related Compounds. M. S. Newman and P. H. Wise. *J. Amer. chem. Soc.*, 1941, **63**, 2109–2111.—Continuing a study of the carcenogenic action of 10-methyl-1 : 2-benzanthracene produced by the introduction of functional groups at various positions, these authors have prepared 5-methoxy-10-methyl-1 : 2-benzanthracene (VI) and 5 : 9-dimethoxy-10-methyl-1 : 2-benzanthracene (VII). Tests on VII were still being conducted, while VI had shown no carcenogeneric activity on mice in 10 months, after subcutaneous injection. E. H. W.

468. Refractive Index of Paraffins in Terms of the Number and Frequency of the Dispersion Electrons. S. S. Kurtz, Jr., and M. R. Lipkin. *J. Amer. chem. Soc.*, 1941, **63**, 2158–2163.—Previous work on hydrocarbons has shown a direct relation between the number of dispersion electrons (calculated by the Sellmeier–Drude equation) and the number of formula bonds. In this paper it was assumed that all valence electrons have the same effect in refracting light; calculation shows this to be only approximately true. Using the above equation, the number and frequency of the dispersion electrons were calculated. It was also shown that the frequency is linear with the density. Using these figures, an equation was developed for the calculation of the refractive indices of paraffins at any wave-length of light and at any temperature and pressure, providing the corresponding density is known. The effect of temperature and pressure on these calculations is discussed. A comparison of the refractive indices calculated by this method and by the Lorenz–Lorentz equation using the Eisenlohr constants is given. The authors emphasize the need for further research along indicated lines. E. H. W.

469. Polymerization of Olefins. VI. The Dimers Obtained from Tetramethylethylene. *Preliminary Paper.*—F. C. Whitmore and P. L. Meunier. *J. Amer. chem. Soc.*, 1941, **63**, 2197–2199.—Tetramethylethylene has been polymerized with 80% sulphuric acid at 0° C. The results of Brunner and Farmer (*J. chem. Soc.*, 1937, 1039) were confirmed and extended. The chief products of the dimer were: 2 : 2 : 3 : 5 : 6-pentamethyl-3-heptene (about 50%), 2 : 2 : 4 : 6 : 6-pentamethyl-3-heptene (about 25%), 2 : 3 : 4 : 6 : 6-pentamethyl-2-heptene (about 10%), and 0·2% 1 : 1-dineopentylethylene. All the observed results corresponded to rearrangements before and after the union of the parts of the dimers. Existing theories of polymerization do not explain the formation of the dimers, but these results are in agreement with a combination of polymerization and rearrangement theories held by the authors. E. H. W.

470. Polymerization of Olefins. VII. Isolation and Oxidation of 1 : 1-Dineopentylethylene. F. C. Whitmore and J. O. Surmatis. *J. Amer. chem. Soc.*, 1941, **63** 2200–2201.—1 : 1-Dineopentylethylene was readily obtained in 15–20% yields from the oxidation of crude tri*iso*butylene. Oxidation of the product was difficult, thus confirming previous work, but with chromic acid mixture at 50–60° C. about 25% dineopentyl acetic acid and about 50% of unchanged olefin were obtained. E. H. W.

471. *cis*- and *trans*- Forms of 2 : 5-Dimethyl-3-hexene, 2 : 5-Diol Correction. I. Zalkind. *J. Amer. chem. Soc.*, 1941, **63**, 2282.—Notice is called to an investigation of Bourgel's crystals by I. Zalkind and S. Bukhovets (*J. Gen. Chem. USSR.*, 1937, **7**, 2417; *Chem. Abs.*, 1938, **32**, 2086). It is pointed out that crystals of Bourgel are not ethylenic, but are an acetylenic derivative—namely, 2 : 5-dimethyl-3-hexine, 2 : 5-diol. Hence the *trans*-form of 2 : 5-dimethyl-3-hexane-2 : 5-diol could not have been obtained from the above crystals by J. R. Johnson and O. H. Johnson (vide "Rearrangement of Unsaturated 1 : 4-Glycols, II," *J. Amer. chem. Soc.*, 1940, **62**, 2615). E. H. W.

472. *cis*- and *trans*- Forms of 2 : 5-Dimethylhexene-2 : 5-Diol Correction. J. R. Johnson. *J. Amer. chem. Soc.*, 1941, **63**, 2282.—Recent work by this author confirms the work of Zalkind and Bukhovets, and in consequence a correction is necessary for the experimental data given on page 2619 in the paper by Johnson and Johnson (see preceding abstract for references). The correction is as follows (referring to page 2619): "The dichloride obtained by the action of hydrochloric acid should be designated as 2 : 5-dichloro, 2 : 5-dimethyl-3-hexine, and the product of dehydration as 2 : 5-dimethyl hexadiene, 1 : 5-ine-3. The conclusions relating to the relative reactivity of the alleged *cis*- and *trans*- forms should be stricken from the literature." E. H. W.

473. Nitrogen Compounds in Petroleum Distillates. XXIII. Isolation of 2 : 3-Dimethylbenzo-(*h*) Quinoline (I) and 2 : 4-Dimethylbenzo-(*h*) Quinoline (II) from California Petroleum. L. M. Schenck and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**, 2331–2333.—The benzo(*h*)quinoline homologues I and II were isolated for the first time from natural sources by accumulative extraction of California gas-oil bases in the range 355–365° C. with hydrochloric acid and chloroform. The structure of these was deduced and confirmation was provided by synthesis. R. D. S.

474. Heat Capacity of Gaseous Paraffin Hydrocarbons, Including Experimental Values for *n*-Pentane and 2 : 2-Dimethylbutane. K. S. Pitzer. *J. Amer. chem. Soc.*, 1941, **63**, 2413–2418).—A new flow-type calorimeter capable of measuring both the heat capacity of the gas and the heat of vaporization was devised for this research. Flow of vapour was obtained by electrical evaporation of the liquid at a constant rate, and the condensed vapour was returned to the vaporizing chamber as liquid at its boiling point, so that a continuous cycle was established The results obtained on this instrument were found to agree with the heat capacity of carbon tetrachloride vapour as calculated statistically. For *n*-pentane and 2 : 2-dimethylbutane, results are reported of the measurements of heats of vaporization and heat capacities from boiling point to about 450° K. The statistical calculations in this paper show that the barriers to internal rotation in *n*-butane and *n*-pentane are probably about 3600 cal. per mole, instead of 30,000 and 16,000, respectively, which have been previously proposed. A general empirical equation has been evolved for all gaseous paraffins above ethane, both normal and branched; where *n* is the number of carbon atoms and *t* is in degrees Centrigrade: $C_p{}^0 = 5{\cdot}65n - 0{\cdot}62 + t(0{\cdot}0111n + 0{\cdot}0158)$.
R. D. S.

475. Thermodynamics of Branched-Chain Paraffins. The Heat Capacity, Heats of Fusion and Vaporization and Entropy of 2 : 3 : 4-Trimethylpentane. K. S. Pitzer and D. W. Scott. *J. Amer. chem. Soc.*, 1941, **63**, 2419–2422.—This paper reports the results of measurements of the thermodynamical constants of 2 : 3 : 4-trimethylpentane. A simple semi-empirical formula is suggested for calculating the entropies of the heavier branched-chain paraffins as follows:

$$S = Sn + R \ln 2 + R \ln (I/\sigma_e\sigma_i) - 3{\cdot}5B$$

where I, σ_e, and σ_i are respectively the number of isomers included (2 for a racemic mixture), the symmetry number for external rotation in the carbon skeleton; and B is the number of chain branchings. The factor $R \ln 2$ arises because the normal paraffins all have the external symmetry number two. Sn is the entropy of the normal paraffin isomer at the temperature desired, and may in the case of the gaseous normal paraffins above butane, be represented by the sample equation $Sn = 9{\cdot}13n + 37{\cdot}62$ cal. per degree mole, where n is the number of carbon atoms. It is claimed that the combination of the formula for entropies with the sample formula for heat capacities, reported in the preceding abstract, should constitute a convenient method for thermodynamic calculations. R. D. S.

476. Dehydrogenation of Normal Heptane and *cyclo*Hexane on Cerium, Vanadium, and Thorium Oxide Catalysts. R. A. Briggs and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 2500–2503.—In the authors' examinations of the dehydrocyclization of normal heptane on chromium oxide catalysts, data have been collected on the aromatizing properties of the oxides of vanadium, thorium, and cerium, and on the influence of temperature, of mode of preparation, of depositions on supports, and of reaction feed rate. It was found that the order of aromatization activity was vanadium oxide, ceria, thoria. While none of these catalysts was as efficient as chromium oxide, vanadium oxide was comparable with chromium oxide. Thoria was found to be a poor aromatization catalyst, but possessed dehydrogenating activity. R. D. S.

477. Preparation of Some *p*-Dialkylbenzenes. C. E. Welsh and G. F. Hennion. *J. Amer. chem. Soc.*, 1941, **63**, 2603–2604.—The authors report the preparation of *p*-di alkylbenzenes from mono-alkylbenzenes and normal primary alcohols in the presence of boron fluoride and phosphorus pentoxide. Alcohols between C_4 and C_{12} give the best reactions. This method produces higher yields than direct dialkylation of benzene.
R. D. S.

478. Viscosity Function. III. Complete Viscosity Range. E. P. Irany. *J. Amer. chem. Soc.*, 1941, **63**, 2611–2617.—In the first paper of this series (*ibid.*, 1938, **60**, 2106–2115; *J. Instn Petrol. Tech.*, 1938, **24**. Abstr. No. 1425) there was deduced the "ϕ scale," which provides linear representation of the relationship between viscosity and volume (dilution) and applies to all ideal (*i.e.*, non-associated or non-dissociated) mixtures. It was further deduced that the viscosity–temperature relationship could also be represented by the ϕ scale, and that therefore the laws governing viscosity relative to volume and viscosity relative to temperature are identical. In addition, it was shown that viscosity relative to pressure could be represented linearly by a separate function, the π scale. The present paper reports the extension of the scales in the regions of extremely high and extremely low viscosities. It is pointed out that the process of the extension does not merely call for the further application of the same graphical technique as before, but that it must be shown first that the fundamental law exists and can be expressed throughout the whole range of the liquid state. However, when the extremes of the liquid state are approached, the criteria of ideality (calorimetric, gravimetric, or cryoscopic evidence) become less sensitive, and standards of ideality must be based on evidence supplied by the existing scale. For example, a system comprising mixtures of liquid of widely dissimilar viscosities may be represented in part on the existing ϕ scale, and if that portion of the system within the range of the scale is linear, the system is, by hypothesis, ideal; so that those portions of system outside the existing scale provide new fixed points for the extension of the ϕ scale. In a similar way the temperature scale can be extended. Investigation of the low-viscosity range on pure hydrocarbons reveals the gradual divergence of the pure temperature scale from the mixture scale, and it has been found necessary to abandon the postulation of the identity of the temperature and dilution laws. The ϕ scale is now reserved for the mixture function, and the temperature function is designated by θ. Factors are given which allow the construction of any section of the two scales. General equations of the exponential type normally used for the representation of the viscosity–temperature function would seem to be of only limited validity, since they diverge from the θ scale in approaching the critical region. The π scale, or viscosity-pressure function, is extended by a method similar to that used on the ϕ scale. The acceptance of extended fixed points is made if all isotherms are linear and converge to a common point of intersection, the abscissa of which represents the internal pressure of the liquid. These investigations reveal that, unlike the lower aliphatic hydrocarbons, many mineral lubricating oils are non-ideal and deviate from the ϕ scale, due, possibly, to the accumulation of large molecules of structure groups. Most American paraffinic oils are non-ideal, as are poly*iso*butenes, but naphthenic oils have ideal functions, although the latter do not appear to give conclusive linearity on the π scale. The π scale for paraffinic oils is tentatively accepted as correct, and approaches a purely logarithmic function in the higher viscosity levels. The internal pressure of paraffinic oils seems to be higher than that of the naphthenic type. The three viscosity functions, ϕ, θ, and π, provide the most extensive empirical evidence to test the validity of mathematical formulations of the viscosity functions. R. D. S.

479. Common Basis of Intramolecular Rearrangements. VIII. Formation of *cyclo*Propanes from Monohalides and Sodium. II: Formation of 1 : 1 : 2-Trimethyl-*cyclo*propane from 1-Chloro-2 : 2-dimethylbutane. F. C. Whitmore and T. P. Carney. *J. Amer. chem. Soc.*, 1941, **63**, 2633–2635.—The authors report the formation of neohexane (2 : 2-dimethylbutane), 29%; 1 : 1 : 2-trimethyl*cyclo*propane 13%, and *tert.*-butylethylene, 8% from the reaction between sodium and 1-chloro-2 : 2-dimethylbutane. The mechanism is probably bimolecular. No 1-methyl-1-ethyl*cyclo*propane was detected, and only a small amount of the coupled products 3 : 3 : 6 : 6-tetramethyloctane could be detected, which provides further evidence that the rearrangements accompanying the dehydration of *tert.*-amyl carbinol to give 2-methyl- and 3-methyl-2-pentenes do not occur by a free radical mechanism. R. D. S.

480. Reduction of Multiple Carbon–Carbon Bonds. III. Further Studies on the Preparation of Olefins from Acetylenes. K. N. Campbell and L. T. Eby. *J. Amer. chem. Soc.*, 1941, **63**, 2683–2685. In this paper are recorded the reduction of dialkylacetylenes, (1) to the *cis*- forms of 2-hexane and 2-octene by catalytic hydrogenation and (2) to the *trans*- forms by sodium-liquid ammonia. Method (2) was applied to monoalkylacetylenes for the successful production of 1-alkenes. The advantage of the sodium-liquid ammonia method is that reduction stops at the olefin stage without contamination by saturated hydrocarbons. Similarly both dimethylethynylcarbinol and dimethylhexynylcarbinol were smoothly reduced to the corresponding olefinic carbinols without cleavage into ketones. The effect of the position of the double bond on the physical constants of straight-chain hexenes and octenes is discussed.

R. D. S.

481. Heats of Combustion and of Formation of the Nine Isomeric Heptanes. G. F. Davies and E. C. Gilbert. *J. Amer. chem. Soc.*, 1941, **63**, 2730–2732.—The thermochemical data at 25° C. in the liquid state are tabulated. R. D. S.

482. Changes in the Pressure of Monomolecular Films of Stearic Acid due to Added Drops of Benzene. E. R. Washburn, L. F. Transue, and T. J. Thompson. *J. Amer. chem. Soc.*, 1941, **63**, 2742–2745.—The authors have measured the times of evaporation of small uniform drops of benzene added to monomolecular films of stearic acid in different states of compression on water, and have determined the changes in film pressure which occur during the life of the drops. If the film is under a lower pressure than the spreading pressure, each drop penetrates the film and increases the film pressure. The larger the amount of benzene added, the larger becomes the increase in film pressure, until the latter equals the spreading pressure of the benzene, but no further increase in the amount of benzene will cause the film pressure to exceed the spreading pressure. Below a certain volume, drops of benzene evaporate before the film pressure equals the spreading pressure. If the film pressure is greater than the spreading pressure, the former decreases immediately benzene is added. The authors suggest explanations with reference to changes in shape and condition of the drops and also to solution of the film in the drops and its subsequent re-deposition.

R. D. S.

483. Oxygen Effect in the Reaction of Bromine with Neopentane *tert.*-Butylbenzene and Trimethylacetic Acid. M. S. Kharasch and M. Z. Fineman. *J. Amer. chem. Soc.*, 1941, **63**, 2776–2779.—Dilute solutions of bromine do not react with neopentane at room temperature even in the presence of oxygen, peroxides, or light, but at higher temperatures the reaction is stimulated by these agents; thus, at 50° C. organic peroxides accelerate the bromination to the same extent as oxygen at 80° C. Trimethylacetic acid is brominated slowly in the dark at 150° C., producing hydrogen bromide, carbon dioxide, mixed brominated hydrocarbons, and 9% of trimethylacetoxytrimethylacetic acid. Bromination of *tert.*-butylbenzene occurs in similar conditions to neopentane, and the reaction affects the nucleus and not the side-chain. This work confirms that primary hydrogen atoms are more difficult of bromination than secondary hydrogen atoms. R. D. S.

484. Oxidation Studies. II. Oxidation of Di*iso*butylene in the Presence of Potassium Hydroxide at Elevated Temperature and Pressure. R. W. Bost and L. B. Lockhard, Jr. *J. Amer. chem. Soc.*, 1941, **63**, 2790–2792.—Di*iso*butylene was oxidized by molecular oxygen in a bomb at 100° C. and 100 lb. per sq. in. pressure; the reaction was essentially complete after 8 hours. Acetone, 4 : 4-dimethylpentanone-2, carbon dioxide, formic acid, and pivalic acid were formed, together with unidentified oxygen-containing compounds boiling higher than any of the predicted products. R. D. S.

485. Action of Elementary Fluorine upon Organic Compounds. XI. Vapour-Phase Fluorination of Benzene. N. Fukuhara and L. A. Bigelow. *J. Amer. chem. Soc.*, 1941, **63**, 2792–2795.—Benzene was fluorinated in the apparatus recently described. The products isolated were CF_4, C_2F_6, C_3F_8, C_3F_{10}, C_5F_{10}, C_6F_{12}, C_6HF_{11}, and $C_{12}F_{22}$. The last four were believed to be decafluoro*cyclo*pentane, dodecafluoro*cyclo*hexane, undecafluoro*cyclo*hexane, and diundecafluoro*cyclo*hexyl, respectively. No aromatic fluorine compounds were isolated. The reaction is probably of the free radical type, and the initial attack of the halogen is presumably by direct addition to the ring.

R. D. S.

486. Influence and Behaviour of Thiophene in Aromatization Catalysts. R. W. Hummer and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 2801–2805.—The authors report the investigation of the effect of sulphur on two typical aromatization catalysts, chromium oxide and molybdenum oxide. These substances are active in removing sulphur compounds from gasoline and benzene. Thiophene was chosen since it is among the most difficult of such compounds to remove either catalytically or by liquid-phase treatments. It was found that the catalysts are highly efficient for the removal of thiophene at 470° C. Chromium oxide removes the thiophene in the form of hydrogen sulphide, but only traces of hydrogen sulphide appear with molybdenum oxide, from which most of the recovered sulphur comes out in the regenerative oxidation. Whereas thiophene poisons the aromatizing efficiency of chromium oxide to the extent of 60% decrease in yields, the activity of molybdenum oxide is enhanced : an increase in yield of 21–64% was produced by the presence of sulphur compounds in the molybdenum catalyst. R. D. S.

487. Raman Spectra of *cyclo*Pentane and Some of its Monoalkyl Derivatives. E. J. Rosenbaum and H. F. Jacobsen. *J. Amer. chem. Soc.*, 1941, **63**, 2841–2842.—Raman spectra are described for *cyclo*pentane and the following *cyclo*pentane derivatives : methyl, ethyl, *n*-propyl, *iso*propyl, *n*-butyl, *s*-butyl, *tert.*-butyl, *tert.*-amyl, and 3-*cyclo*pentylpentane. R. D. S.

488. Synthesis and Characterization of Some Tertiary Naphthenic Acids. B. Shive, W. W. Crouch, and H. L. Lochte. *J. Amer. chem. Soc.*, 1941, **63**, 2979–2984.—The chemical behaviour of the $C_{10}H_{18}O_2$ acid isolated from California and also, apparently, Iranian petroleum, limit the possible structures of this acid to the four which were accordingly synthesized. (1) *dl*-1 : 2 : 2-trimethyl*cyclo*hexanecarboxylic acid was prepared by the reduction of *dl*-camphorenic acid by hydrogenation in glacial acetic acid in the presence of Adams platinum catalyst ; (2) 1-*iso*propyl*cyclo*hexanecarboxylic acid was synthesised from *cyclo*hexanone via 2-carboethoxy-2-*iso*propyl*cyclo*hexanone and subsequent reduction of the carbonyl group by the Clemmensen method ; (3) 1-*iso*propyl-2-methyl*cyclo*pentanecarboxylic acid was synthesized via 2-carboethoxy-2-*iso*propyl*cyclo*pentanone from 2-carboethoxy*cyclo*pentane ; (4) *aa*-2-trimethyl*cyclo*pentane acetic acid was synthesized from 2-carboethoxy*cyclo*pentanone through 2-methyl*cyclo*pentanone. None of these acids was identical with the $C_{10}H_{18}O_2$ acid, but this work did result in the development of general methods for the syntheses of 1-alkyl*cyclo*alkanecarboxylic acid, and 1 : 2-dialkyl*cyclo*alkanecarboxylic acids by methods (2) and (3), respectively. R. D. S.

489.* Molecular Explanation of Retrograde Condensation. R. F. Nielsen. *Refiner*, February 1942, **21** (2), 40–42.—The phenomenon has been predicted from Van der Waals' theory for binary mixtures, and has been described and named in 1893. It is explained in this paper on the basis of attractive forces between the molecules. The case of ethane-heptane is studied in detail to illustrate the system.

The constants of Van der Waals' equation are studied and their significance as volume and attractive-force terms is detailed. The phenomenon of retrograde condensation is then explained qualitatively in terms of these attractive forces. A. H. N.

490. Patents on Chemistry and Physics. Standard Oil Co. E.P. 543,375, 23.2.42. Appl. 30.8.40. Continuous process for the endothermic catalytic conversion of hydrocarbons and the exothermic regeneration of the catalyst.

M.V. de Groote and B. Keiser. U.S.P. 2,273,181, 17.2.42. Appl. 7.7.41. Method of breaking petroleum emulsions of the water-in-oil type by subjecting to the action of a demulsifier comprising a compound of the following formula :—

$$D\vdots N\begin{matrix}\diagup \text{Halogen} \\ \diagdown CH_2\text{–}CH_2\text{–}NH\cdot OC\cdot R.\end{matrix}$$

The acyl radicle R·CO is derived from a monocarboxy detergent-forming acid having at least 8 and not more than 32 carbon atoms. D⁝N represents a radicle derived from a heterocyclic compound of the pyridine series. H. B. M.

Lubricants and Lubrication

491.* Changes Occurring in Oils and Engines from Use. F. A. Suess, H. C. Baldwin, W. A. Jones, and B. H. Lincoln. *Refiner*, February 1942, **21** (2), 51–62. *Paper presented before Society of Automobile Engineers.*—Some of the factors affecting the nature and degree of changes in engines or in the oil are physical and chemical, design and condition of the engine, conditions of service, such as speed, load, duration, ventilation, temperature, extraneous material from fuel, cooling system, combustion zone air, or other sources. Each of these factors and various combinations may affect different lubricating oil-engine systems differently.

Accordingly, the study and rating of oils and engines must include a study of many combinations of the more severe of all these factors. Reliable information cannot be obtained by one piece of laboratory equipment, or a single type of engine, or a single set of service conditions. To rate accurately lubricating oils or engines, a large number of tests on several pieces of equipment operated under a number of different sets of operating conditions is required. Each distinct test will produce a large number of types and degrees of change in both the oil and the test equipment, which must be isolated, evaluated, and recorded for comparison. Such a test programme faithfully carried out will produce a volume of data so large that conclusions and predictions are impossible without tabulating, correlating, and digesting all the data.

In outline, data are presented to show the changes which occurred in the lubricating oils and the engines during use in a comprehensive study which culminated in road tests. Prior to these road tests, a very extensive study was made of twelve commercial oils marketed as premium-grade oils by the predominant oil companies and fourteen experimental or development oils. If these twenty-six oils, three of the commercial oils and two of the experimental oils were found to display outstanding merit. These oils were therefore selected for extensive road tests, and the paper includes a discussion of the service changes in these oils and engines as follows : (1) Lubricants and equipment used. (2) Chemical laboratory and mechanical laboratory investigations. (3) Road tests. Each section is given in great detail. The mass of data accumulated and an analysis of the over-all picture of results certainly indicate that there is still considerable room for debate as to the optimum degree of peptizing or detergency desired in an oil. The minimum change in oil characterisitcs in service is most imperative, together with enough peptizing to prevent excessive deposition of materials of either intrinsic or extrinsic origin. The evidence certainly indicates the desirability of preventing the formation of products of oil change rather than permitting their formation and causing them to be dissolved in the oil, since such oil-soluble products result in accelerated rates of oil change due to their catalytic effect. A. H. N.

492. Patents on Lubricants and Lubrication. A. A. Schilling. U.S.P. 2,271,044, 27.1.42. Appl. 13.12.39. Preparation of a lubricant having metal surface corrosion-inhibiting properties. The mixture includes a mineral oil, a blend of 2 : 6-dimethylphenol and 2 : 4 : 6-trimethylphenol, and a mixture of mono- and di-lorol phosphates.

E. M. Dons ahd O. G. Mauro. U.S.P. 2,271,683, 3.2.42. Appl. 25.3.40. Admixture of a lubricating-oil stock with a solvent comprising 2-pentanone, 4-hydroxy-, 4-methyl, and diethyl glycol, and dissolving the naphthenic components of the stock oil in the solvent. The resultant solution is separated from the more paraffinic components of the lubricating-oil stock, and the solvent separated from the solution.

L. A. Hamilton and E. W. Fuller. U.S.P. 2,273,862, 24.2.42. Appl. 22.11.39. Preparation of a lubricating-oil composition consisting of a viscous mineral-oil fraction and a small proportion of an N-phenylphenylenediamine to prevent deterioration under oxidizing conditions.

J. S. Yule. U.S.P. 2,274,025, 24.2.42. Appl. 28.12.40. Manufacture of a lubricant consisting of a mineral lubricating oil and 0·1–5% of sulphurized and phosphorized fatty material.

L. H. Mulit. U.S.P. 2,274,302, 24.2.42. Appl. 22.1.40 Preparation of a lubricating composition consisting of a hydrocarbon oil, a small amount of a metal alcoholate to stabilize the oil against deterioration at high temperatures, and a salt of a substituted acid of phosphorus containing an organic substituent. The salt is added in sufficient quantity to minimize corrosive tendencies of the oil solution of metal alcoholate.

T. P. Remy. U.S.P. 2,274,305, 24.2.42. Appl. 6.5.38. Preparation of a lubricant consisting of a petroleum lubricating oil and a small amount of chlorinated *iso*prene containing more than 50% chlorine.

T. P. Remy. U.S.P. 2.274,617, 24.2.42. Appl. 27.4.38. Preparation of a lubricant consisting of a petroleum lubricant and about 3% of a sterol to increase oil-film strength and prevent sludging. H. B. M.

Special Products.

493. Patents on Special Products. Standard Oil Development Co. E.P. 542,925, 3.2.42. Appl. 23.4.40.—Improvements in processes relating to the subjection of materials consisting essentially of hydrocarbons boiling in the gasoline range to heat treatment at a temperature above 500° F., and in the presence of catalysts to produce a dehydrogenated or otherwise chemically reconstructed product.

Standard Oil Development Co. E.P. 542,995, 5.2.42. Appl. 27.6.40. An improved method of converting normal paraffins into *iso*paraffins by subjecting the normal hydrocarbon to the action of a Friedel-Crafts metal halide catalyst modified with an alkali metal halide while at a temperature below 400° F. It is claimed that the process may be used to increase the anti-detonation value of normal naphthas. Normal butane and normal pentane may be converted into the *iso*-compounds, which are more reactive for alkylation with olefins.

Holford Processes, Ltd. E.P. 542,996, 5.2.42. Appl. Appl. 29.6.40. Process for the simultaneous production or purification of oil, together with the production of a hard, carbonaceous residue. An oil, or a blend of oils, is mixed with peat or similar solid carbonaceous substance containing volatile matter, and the whole subjected to distillation.

A. J. Van Peski. U.S.P. 2.271,043, 27.1.42. Appl. 5.9.39. Process for the isomerization of a saturated aliphatic hydrocarbon containing between three and six carbon atoms with an aluminium halide catalyst. The isomerization is effected under 0·08–33 atmospheres pressure of hydrogen, the partial pressure of the hydrogen being sufficient substantially to repress undesirable side reactions, but insufficient substantially to repress the isomerization reaction.

P. K. Frolich. U.S.P. 2,271,636, 3.2.42. Appl. 6.6.33. Preparation of high-molecular-weight polymerization products having the properties of plastic solids rather than of viscous lubricating oils, soluble in hydrocarbon oils, and capable of improving the viscosity–temperature characteristics of lubricating oils when blended therewith.

W. H. James and E. W. Fuller. U.S.P. 2,271,940, 3.2.42. Appl. 2.3.40. Production of a high-boiling petroleum product stabilized against formation of acidic and sludge products of oxidation by the addition thereto of a small amount of the oil-soluble condensation reaction product formed by reacting a tri-nitrated member of the group consisting of benzene, toluene, cresol, resorcinal, anisole, with a member of the group consisting of naphthylamine and substituted naphthylamines.

V. N. Ipatieff and A. V. Grosse. U.S.P. 2,273,320, 17.2.42. Appl. 23.3.39. Production of a higher-molecular-weight mono-olefin hydrocarbon from a lower-molecular-weight olefin hydrocarbon and a *cyclo*paraffin. An olefin is reacted with a *cyclo*-paraffin of less than five carbon atoms in the ring in the presence of a condensation catalyst under conditions of pressure and temperature effective for the condensation reactions. H. B. M.

Coal and Shale.

494.* Liquid Pitch Fuel. E. B. Davies. *J. Inst. Fuel*, 1941, **15**, 80, 15.—Contrary to former expectations, recent developments in the technique of using pitch as fuel have been along the lines of using the material in liquid rather than pulverized form.

Physical data on normal medium soft pitch, relevant to its use in molten form, are given as follows: Softening pt. (K. and S.), 70° C.; cal. val., 16,250 B.Th.U./lb.; sp. ht. 0·4; latent ht. fusion, negligible. Typical curves showing viscosity *vs.* temp. and sp. gr. *vs.* temp. are given.

Whilst transport of molten pitch in insulated wagons is feasible, it is safer to arrange the consuming plant to operate mainly on liquid deliveries, but to include also melting facilities for make-up and emergencies.

The following equipment is described and discussed in some detail: steam coil, hot oil, and electrically heated melters; storage and feed systems for liquid pitch; valves and cocks; pumps; burners.

The paper is illustrated with numerous graphs and diagrams. C. G. G.

Economics and Statistics

495. Survey of Fuel Consumption at Refineries in 1940. G. R. Hopkins. *U.S. Bur. Mines. Report of Investigations*, No. 3607, January 1942.—The almost invariable rule that the average amount of heat required to refine a barrel of crude oil declines as crude runs to stills increase was broken in the United States in 1940. In fact, the average heat requirement per barrel of crude oil rose from 55,000 B.t.u. in 1939 to 579,000 B.t.u. in 1940, although crude runs increased from 1,237,840,000 brls. to 1,294,162,000 in that period. According to this report, no very definite reason can be given for this apparent loss in fuel efficiency. The principle of heat exchange was used as extensively in 1940 as in the previous year; also the yield of complex products, known to require more fuel in production, actually declined in 1940.

There were, however, several developments in 1940 which tended to increase fuel requirements, notably the greater output of aviation gasoline and the tendency for refiners to expand operations in thermal reforming, gas reversion, or other light-end processing, as a means of maintaining gasoline quality.

Consumption of fuel oil in refineries remained about the same in 1940 as in 1939, a total of 32,085,000 brls. being recorded for the year under review. This represented 25·7% of total heat units consumed in refineries in 1940.

Acid sludge became more economically attractive during the year, and total heat units supplied increased from 2·6% in 1939 to 2·7% in 1940. In spite of advancing prices, refiners increased their consumption of coal by 32% during 1940, and this fuel was responsible for 3·4% of total heat units.

Total consumption of natural gas rose to 128,007,000,000 cu. ft. in 1940, or 31% above the 1939 level, and increased use of this fuel at refineries was quite the most outstanding change recorded in character of fuel employed.

The remainder of total heat units were supplied by still gas (50·7%), petroleum coke (less than 1%), steam, and purchased electricity. H. B. M.

BOOK REVIEW.

Stratigraphic Type Oil-Fields [U.S.A.]. Edited by A. I. Levorsen. 902 pp. Bibliography including Canada, Trinidad, and Venezuela. American Association of Petroleum Geologists, Tulsa, Oklahoma. $5.50.

This important book reflects the increasing amount of work being done by petroleum geologists on stratigraphy, on conditions of sedimentation, and on questions relating to the porosities and microscopic composition of rocks as determining oil occurrence. A stratigraphical reservoir is one closed by varying permeability either of the oil-rock or of adjacent strata; and the term may be extended to include those fields where closure by tilting, folding, or faulting is subsidiary to the lithological factor. The volume deals with thirty-seven such examples, and many other stratigraphical fields are succinctly referred to in the annotated bibliography. This new symposium forms an invaluable supplement to that in two volumes on *Structure of Typical American Oil-Fields*, published by the A.A.P.G. in 1929, in which the emphasis lay on the tectonic side. Salt Creek, Wyoming, is an example where the oil-trap is bounded on all sides by structural anomaly, whereas in shoestring pools—ten of these which originated as sandspits are described in the work under review—oil accumulation is almost entirely a function of sand distribution, with local structure playing a minimal part in localizing the oil. Other stratigraphical pools are found where porosity wedges against coast-lines or areas of uplift are overlapped by impervious strata, as in several East Texan fields; or where there is lateral change of permeability due to solution cavities, as in limestone reservoirs of New Mexico and West Texas, or due to dolomitization as in the Trenton (Ordovician) limestone of Ohio and Indiana; or where there are changes due to original deposition, as in the flood-plain and delta deposits of Montana and Alberta. Differential cementation and clogging by viscous bitumens are also important. Most of the "synclinal" fields of the Appalachian province are probably the result of depositional and porosity variations, although, as in the Berea sand (basal Mississippian) of the Gay-Spencer-Richardson trend of West Virginia, structure may also be of significance. Pools where porous igneous rocks—for example, the serpentines or serpentine sediments of Central Texas—form the reservoir are likewise to be treated as stratigraphical.

California.—In the Edison field, sands deposited off an original promontory were sealed in by transgressing shales. Miocene warping produced a north-west pitch. Oil is yielded from the Walker sand and ash (?Eocene–Miocene), the Jewett silt, and the Olcese sand (Lower Miocene). Upper Duff oil, in the base of the fan alluvials of the Kern River formation (Pliocene–Pleistocene), is bounded on the south by change of porosity and in the north-east against a fault which moved in Kern River time. In the Kern Front field, three oil-sands, imbricately arranged, occur in the Chanac formation (?Upper Miocene), which is alluvial, but has more soil content than the Kern River. The structure is a south-west dipping monocline without closure. Faults have a sealing of gouge derived from weathered minerals, but their throws are less than the thickness of the oil zones. The Chanac has less than 10% sand in the north-west, but coarsens down dip. Most of the oil is located where there is 10–30% of sand.

Colorado.—The Greasewood field is on a very gentle anticline dipping about 7 ft./ml. on the south-west and up to 20 ft./ml. on the north-east. Oil is found in the Greasewood sand (Upper Cretaceous), the top member of the Dakota group. The sand has poor porosity, maximum 9%, and in places is rendered quartzitic by deposition of secondary quartz. It thins and thickens by lensing. Westward divergence of the top and bottom of the Upper Cretaceous points to subsidence during deposition. Dip in the Greasewood is greater than in surface beds. It wedges out down dip, while to the north-east the Niles fault acts as a barrier. Accumulation is thus due to mixed structural and stratigraphical factors. Bottom temperatures are high, and the oil is gas-propelled so that successive wells reduce production from those already in operation.

Kansas.—A sand-stringer, high in the Cherokee shale (Lower Pennsylvanian), 13 mls. long by 1000–2000 ft. wide, and 0–50 ft. thick, is the source of oil in the Bush City field. It is convex on the underside and flattened on top, with some irregularities possibly due to late stream action. It fills a channel carved in shale, and the wider parts are shallower than the others. The lower measures of fine, micaceous, slightly sub-rounded sand, forms the pay-zone. Warping of shales over the sand is attributed to differential compaction, and flattening out of the channel sides may also be due to this. Seven anticlinal flexures are crossed by the sand-body, on the crests of which initial production has invariably been highest in oil and gas, while in the synclines there is little gas. As the sand is dry, it is suggested that water was replaced by oil first on the anticlines and later, when less oil was available, in the synclines.

In the Chanute oil-pool, now revived by water-flooding, a deposit of fine, well-sorted, sometimes cross-bedded sand, in the Cherokee, forms a shoestring several times longer than wide. It has a flat base, and is convex upwards, but slopes more steeply on the east side. The outline is a smooth curve on the east, but the western margin is irregular. These features suggest that the sand collected, like the Bartlesville and Burbank shoestrings, as an off-shore bar. A coal-seam under part of the sand shows how the waves of the Pennsylvanian sea drove the sand landward over a fresh-water swamp. Significantly enough, the sand-body is more permeable to water longitudinally, the better-consolidated layers lying at right angles to the direction of fetch of the storm-waves that built the bar. For further details of interpretation the attention of the authors may be directed to recent work on comparable present-day sand accumulations by European authors, including W. V. Lewis (*Proc. Geol. Assoc.*, xlix, 1938, 107–127), A. Lamont (*Scot. Geogr. Mag.*, lv, 1939, 317–331), M. A. Arber (*Nature*, cxlvi, 1940, 27–28), R. A. Bagnold (*Journ. Inst. C.E.*, xv, 1940, 27–52), and I. N. Lobanov (*Nature, Acad. Sci. U.S.S.R.*, i, 1940, 77–79). For flooding, water from the Neosho river is mixed with water from the oil-wells, and is treated with lime and alum; chlorine and copper sulphate are added to kill algæ which would otherwise clog the filters of the water-treatment plant and pore-spaces of the oil-sand. Clear water is pumped into the input wells.

The Hugoton gas-field yields from drusy dolomite in the Sumner group and from dolomite passing down into bryozoan and fusulinid limestone of the Chase group, both in the "Big Blue" lower division of the Permian. The dolomitization is secondary, and weathering is evident from the presence of soft, white, porous cherts. That gas is specially rich in a zone of almost pure dolomite indicates the importance of shrinkage during dolomitization in creating porosity. Apart from slight interruption by westward-pitching noses of broad anticlines, the beds dip to the east. To west, porosity is lost, since micaceous silts and red shales of terrigenous character, from a Permian land-mass of the southern Rocky Mountains, replace the marine limestones. Initial pressures at about 436 lb./sq. in. are sub-normal, and suggest communication with the Amarillo gas-field, where initial pressures approximate to 430 lb. The water-table seems to show some adjustment, since the conclusion of eastward tilting of the beds.

The Nikkel pool, on the Voshell anticlinal trend, is remarkable, since a folded and faulted outlier of Hunton dolomite and glauconitic limestone (Siluro-Devonian) has been sealed between Maquoketa shale (Ordovician) with graptolites below and strongly unconformable Kinderhook shale (Lower Carboniferous) above. At the Wherry Pool, production is described from levels in the Sooy conglomerate, which varies in thickness, and consists of chert pebbles deposited in shallow marine waters at the time of the Mississippian–Pennsylvanian unconformity. The regional dip is steadily south-east off the margin of the Central Kansas uplift. In Zenith pool, Misiner sand (basal Mississippian) is in contact with Maquoketa vuggy magnesian-limestone and shale with conodonts, underlain by Viola limestone and cherty dolomite (Ordovician), the last forming the chief reservoir. A nose structure extends south over the pool, but there is no closure to north or west, so that oil concentration must be accounted for by lateral changes of permeability, by truncation of the oil formations in the north, and by a Kinderhook seal.

Kentucky.—The Big Sinking field lies on the south-eastward dipping side of the Cincinnati arch, and the yield is from Lockport cherty limestone (Silurian), now a sucrose dolomite, from which calcite fossils were dissolved probably in the late

Devonian, leaving cavities lined with dolomite crystals. The Lockport thins westward, and is replaced at outcrop by Hamilton limestone (Middle Devonian). Seals are the underlying Clinton red and green shales (Silurian) and Devonian and Carboniferous black shales. Local closures may be due to the irregular topography of the weathered Lockport surface, but the general configuration seems to depend upon a buried and eroded, or even completely planed down, structural "high."

Louisiana.—In East Baton Rouge parish, seven Miocene sands on a domal structure are producers or potential producers. Concentration in three cases is controlled by pinch-out, or by pinch-out and entrance of a shale-wedge, as well as by structure. For the Miocene of the Gulf Coast erratic contemporaneous deposition from several sources has been assumed. Electrical logs are a great help in plotting lateral changes.

Michigan.—In the gas-fields of southern Michigan shoestring developments of the Stray sand (Mississippian) are interpreted as sandspits resting unconformably on shoals of Upper Marshall sandstone. The latter is a very clean Carboniferous sand which, to the authors, suggests deposition during a dry epoch. The fields of Austin and Six Lakes, lying on the same north-west trend, are described in detail, and the shore parallel to which they have formed is attributed ultimately to anticlinal folding. One is inclined to enquire whether the pre-Stray ridges may have been preferentially preserved under the sand-bars. Again, in the Austin field, is it possible that the larger and smaller accumulations flanked the sides of a river-mouth, with drift of sand alongshore from the north-west? The thickest and highest accumulations are least muddy, most porous, and give the biggest yields, so that the features of the bars can be shown by means of isopore and production maps. Cross-sections suggest longest fetch of waves from the south-west, but there are difficulties about the palæogeographical distribution of land. The authors are to be congratulated on their detailed maps, made from bore records in country covered by glacial drift, but a large-scale outline of all the twenty-three spits might throw additional light on direction of beach-drift and relative ages of bars.

Montana and Alberta.—The Border-Red Coulee oilfield derives its yield from the Cosmos quartz and chert sands, at the base of the continental Lower Cretaceous. They lie unconformably on the Ellis formation (Jurassic), from the shale and limestone of which all the oil may be derived. There are lenticular and other stratigraphical traps. Migration has taken place through joints, and a buried hill of Madison limestone (Lower Mississippian) has localized the production.

Montana.—Oil and gas in Cut Bank field, in monoclinal beds on the west side of the Sweet Grass arch, are obtained from similar black chert-sands of the Kootenai (Lower Cretaceous), which were derived from erosion of a Jurassic upland in the position of the Selkirk and Purcell ranges, 160–300 mls. west and north-west of the field. The trap is due to irregular sedimentation in a flood-plain and delta environment, and may represent spit or beach deposits on the margin of a large body of fresh(?) water. Cementation prevents edge-water from encroaching. Tilting is indicated by variation of water-level from 1300 ft. above sea-level in the north-east to 600 ft. above sea-level, down dip, in the west.

Ohio.—In eastern Ohio lensing sands are important in formations from the Clinton (Silurian) to the Cow Run (Pennsylvanian), but about 65% of production, including that from the Berea sand at the base of the Mississippian, has some structural factor. Following flooding operations, the Berea is soon likely to take precedence of the Clinton.

Oklahoma.—The Davenport field, Lincoln County, produces from the Cleveland and Prue sands (Pennsylvanian). In a gently westward dipping monocline the Prue sand pinches out in all directions. The Dora pool, Seminole County, is also in an irregular lenticle, slightly convex upwards, probably formed as a beach deposit of Pennsylvanian age. The general dip is to south-east. In the East Tuskegee pool, Creek County, production is from the Misiner fine marine sand with some chert conglomerate and dolomite (basal Mississippian), probably laid down near shore, and from the Wilcox (Ordovician). Wilcox production is restricted to structural apices, but the laterally inconstant Misiner yields from the flanks of "highs." The Olympic pool, Hughes and Okfuskee Counties, with flat bottom and convex top, running 6½ mls. from north to south and ½–1¼ mls. wide, is in the Senora formation, well down in the Pennsylvanian. It pinches out steeply on the east side, more gradually to the west. An original eastward slope of the sea-floor can be demonstrated, and the history is almost certainly of a spit that grew southwards, with almost equal exposure throughout its length to maximum constructive waves fetching from a little south of east. In the southern lobe over 70 ft. of sand has accumulated. A north–south channel in the northern part may be tidal or due to break-through by a river.

The Red Fork shoestring (Pennsylvanian), in North-Eastern Oklahoma, is of the same age as the Burbank, and represents two sandspits growing from opposite sides of an estuary. That beach-drift was predominantly from the present north seems likely in view of the larger number of wells in the spit on that side. Most interesting is the "Basin Red Fork," a silt bank, at the river-mouth. Outflow probably went on for some time after the turn of the tide because of water ponded in the spit-protected lagoons, and the reviewer would point to the analogy of the former "Dogger" bank opposite the Slaney estuary, in Ireland. The Red Fork sediments are fine in comparison with the material of modern beaches. This is taken as illustrating quiet marine conditions. The relative scarcity of coarse sediment cannot be due to poor rainfall, since there are coal-seams of equal age, so that a planated topography must be invoked, upon which the Cherokee sea gradually stepped westward.

Pennsylvania.—An Upper Devonian sandspit, 4 mls. long and 800–2000 ft. wide, is formed by the Sliverville sand of sub-angular medium to coarse grains, in the Music Mountain oil-pool, McKean County. The spit thickens towards the south, but its level rises north-eastwards as it lies obliquely on the side of the Bradford anticline which plunges to the south-west. Connate water has not been reported; gas expansion expels the oil.

The Venango sands of the Catskill (Upper Devonian) and basal Pocono (Mississippian) are discontinuous sands which may be grouped in three successive types: (1) small sands at right angles to the ancient shore-line, possibly filling distributary channels, with fine material landward becoming coarse towards the sea; (2) sheet-sands which pinch out along smooth edges of a stratigraphical nature on their north-west sides parallel with the shore, and which are generally fine-grained and red towards the land; (3) long, narrow, north-easterly trending, pebbly bars, with some discoidal pebbles. Cementation is good with growth of secondary quartz, but in the coarsest beds absence of cementation may be due to early entry of oil.

Texas.—The Bryson field is interesting because oil occurs in a north-dipping monocline that formerly dipped south, and since several members of the Bryson sand-zone, in the Strawn (Pennsylvanian), lose permeability at the same linear position up dip. In Brown County the Cross Cut sand, Canyon (Pennsylvanian), has sand-lenses which are thickest on the higher parts of the pre-Cross Cut topography where they would be least affected by stream erosion. The area of accumulation is on or near the Bend flexure. Oil usually occupies the tops of the lenses, either above the thickest parts, or where anticlinal noses cross the flexure.

The Davis sand-bar, Hardin field, Liberty County, is of medium, clean, angular to sub-angular quartz grains, with few heavy minerals. On its inshore side, or near the mouth of a stream, it contains leaves of *Sapindus* cf. *georgiana* Berry. The length of the spit is over 2 mls., average width 125 ft., height 45 ft. Its deposition may have been begun at 5 or 6 mls. from the land, but it was deserted by the retreating Middle Yegua sea (Upper Eocene) and at the same time the landward lagoon was filled by fine sand. Its steeper side faces the land. Preservation was effected by ample precipitation of calcareous matrix. The pool appears to be sealed in all round.

The East Texas field lies on a westward-dipping homocline at a position where the Eagle Ford and Woodbine sands are bevelled up dip by transgression of the Austin Chalk. The finer strata are mainly non-marine, and comprise red, green, and black shales, poor in lime and laterally inconstant. The sands are variable, with many disconformities, stream channels, much cross-bedding and irregular lamination. Water which allowed siliceous cementation was only replaced by oil where the sands were poor in fine material. Silty sand with up to 17·5% porosity may thus be without oil. Some of the fine mud seems to be an altered ash. Water is now encroaching from the west where bottom-hole pressures are highest.

The Hitchcock field, in Galveston County, yields from Middle Miocene sand which on three sides dips off a flat dome, but on the east lenses out. The gas-cap is small, and the gas/oil ratio large. Miocene beds above the producing sand have been erratically deposited : numerous faults were erroneously postulated in the first interpretation of the electrical logs.

In the Hull-Silk field, Archer County, an east-south-east–west-north-west anticline has a closure of 90 ft. on the Caddo lime, Bend (basal Pennsylvanian), but, higher up, closure is less marked in four oil-sands of the Strawn (Pennsylvanian), in which lack of porosity limits the occurrence of oil. In the 4300-ft. sand rather more than half the production is from positions below the closure. Effective closure was formerly greater, but has been reduced by eastward tilting.

The Lopez field, about 16 mls. north of Bruni, produces from the Lopez or West Cole sand at the top of the Mirando (Eocene). The structure is a terraced to faintly synclinal monocline, with sand thinning out up dip and occupying a long embayment in the strand line. There is no surface indication of the field apart from its lying on the same trend as the West Cole and French fields and a slight flattening of dip. The Noodle Creek field, north-west of Abilene, is also on a terrace, with a number of areas of closure. Absence of porosity in the Noodle Creek limestone, Cisco (Pennsylvanian), on the east side, has retarded movement of fluid. Minor accumulations far down on structural flanks are evidence of channels of permeability leading from the major pool.

In a downthrown block on the south-east limb of the Cole–Bruni anticline, oil is yielded from the O'Hern sand (Eocene) at or near the contact of the Jackson and the Cockfield–Yegua formations. It is a shore-line sand-wedge, forming an inland-pointing tongue which grades into impervious shaly beds towards land and thickens seaward and south-eastward to a maximum of 30 ft. An area where the sand is of minimal thickness occurs along the centre of the tongue, and gives sub-normal production. Non-marine appearances and brackish Foraminifera hint that this area may be the end of a river-course blocked towards the sea by wave-sorted material (pp. 726–727). The channel was possibly filled in by muddy and wet silty sludge before the completion of O'Hern deposition, since the contours of the upper surface show a later hollow, perhaps of another channel, south of the principal minimum, and again this ends with a pit and a blocked mouth (p. 734). In a marginal zone all wells have had to be pumped from the start. Gas-wells are widely distributed in structural position, but are all in the pumping zone. The gas may come out of oil held captive by capillarity and adhesion to sand. Pore-space becomes less towards the fringes of the deposit.

In the Sand Belt field which runs roughly north–south, several miles east of the Capitan reef front, structure in surficial beds of Tertiary and Recent age is poor, but beneath the Trias, at least in the north, there is an anticlinal. Production is mostly from below the top of the Yates (Permian), and depends on the varying porosity of beds of sand and dolomitic sand.

The Seymour pool, Baylor County, yields from a reservoir of grey, soft, crystalline limestone with fossils, deposited as a reef in the Canyon series (Pennsylvanian). Structure at ground level in red and yellow Permian shales betrays no evidence of the reef. The latter was built, after crustal warping of Middle Canyon date, on a westward tilted floor of Palo Pinto limestone with chert bands. The upper surface of the reef has a more gentle slope to the west than to the east.

In the Walnut Bend pool, Cooke County, anticlinal structure is responsible for oil in the Simpson dolomite (Ordovician), and in the 4900-ft. and 5100-ft. sands of the Lower Red Strawn (Pennsylvanian), but in the 4100-ft., 4600-ft., and 4700-ft. zones, as shown by cross-sections based on electrical logs, stratigraphical traps are determined by gradation of sandstone into shale. Skiagraphic structural maps explain clearly the simple, steep-sided, north-west–south-east elongate dome of the Simpson, as contrasted with the overlying Pennsylvanian structure in which a number of radiating folds pitch off a much gentler dome. In successively higher beds amounts of dip are diminished.

West Virginia.—The Berea sand, at the base of the Mississippian, running from west-south-west to east-north-east in parts of Jackson, Roane, and Calhoun Counties, is bounded above by black shales which are pyritized at the contact, as a result, it is suggested, of a reaction connected with oil formation, and is sealed underneath by light grey, silty shale of variable thickness at the top of the Devonian. The sinuous form of both sides of this body of fine, quartz sand militates somewhat against its being a sand-bar. Nevertheless, the upper surface shows longitudinal ridges with a steep slope to the seaward side. After suggesting that, in an area of low relief, the coastal outline may have been affected by earth-movements which initiated the first slight anticlines that were later so strongly folded, Heck ascribes to this factor the changing course of his off-shore bar. The L-shaped bend of the sand, where intensively developed in the Richardson field, is not readily explicable on a simple sand-bar hypothesis, or even if we presume that we are dealing with a shore sand, unless there was a small island of Devonian shale south of Richardson. This would be helpful, since sand drifting from the north-east might have extended towards it in a short tombolo, and at the same time it would have served to protect the anomalous north-west–south-east accumulation of sand from being dissipated by waves from east and east-south-east. The oblique incidence of these no doubt promoted the general beach-drift from the north-east. Farther south the possibility of a sand-bar passing into a storm-beach may be borne in mind. The well-known absence of water in the Berea sand may be due, as Thom says, to absorption of water by neighbouring clays, when unloading following partial erosion of superincumbent beds permitted increase in the size of spaces between the clay particles.

The Shinnston pool, Harrison County, is segregated in a sand of Upper Devonian age, depleted of water, and lying in a westerly dipping homocline. The oil would have descended westward into the Shinnston syncline but for the tightness of the western sand.

Wyoming.—The Osage field, Weston County, lies on a terraced homocline that dips west from the Black Hills uplift. Much of the oil is in Newcastle muddy sandstone, which in places contains lignite and which is of mixed marine, brackish, and continental origin. The Newcastle is enclosed as lenticles in the predominantly marine shales of the Graneros formation which constitutes the basal division of the Upper Cretaceous. Tilting and flexuring were of Laramide date.

Space fails in which to pay tribute to the work of the editor and of the individual authors who have made the production of this splendid volume possible. The material presented and the manner in which it has been presented will be an education and inspiration for all students of petroleum production for many years to come.

Archie Lamont.

INSTITUTE NOTES.

MAY, 1942.

MEMBERS SERVING WITH H.M. FORCES.

The Institute has received notification of the following changes or additions to lists already published :—

Balfour, N. R., to be Captain, R.A.O.C.
Barrett, G. M., Capt., R.A.
Brunner, D. G., 2nd-Lieut., R.A.O.C.
Bushnell, G. H. S., Lieut., R.E.
Cole, F. A. J., Capt., Indian Army.
Haker, J., Ft.-Lieut., R.A.F., V.R.
Manderstam, L. H., Capt.
Moore, J. L., R.A., now Lieut.
Neilson, I. McI., R.E.
Paul, D. S., R.A.S.C., now Lieut.-Col.
Perks, J. G., 2nd-Lieut., R.A.O.C.
Perrott, T. P., Capt., R.E.
Simpson, A. M., R.A.F.
Whitehead, R. C., Royal Fusiliers.
Willmott, I. A., P.-O., R.A.F., V.R.

NEW MEMBERS.

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

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

As Fellow.

THACKER, Gilbert Doe ... ... England.

Transferred to Fellow.

STALLARD, Richard Joseph ... ... England.

As Members.

CLARK, Henry William ... ... England.
FEATHERSTONE, Arthur James ... ... ,,
HEALEY, Harry ... ... ,,
HOLLINGSWORTH, Clifford ... ... ,,
POSTLETHWAITE, Cyril ... ... ,,
WILSON, Alexander ... ... ,,
WITARD, Stuart Lancaster ... ... ,,

Transferred to Member.

SNOW, Percy Henry ... ... England.

As Associate Members.

CHATTERLEY, Leslie George ... ... England.
PATERSON, Edward Victor ... ... ,,
SMITH, William Henry ... ... ,,
WHYTE, Thomas Robert Norman ... ... ,,

Transferred to Associate Members.

GREEN, Sydney James	England.
KEELING, Philip Stanley	Burma.
YOUNG, Raymond Owen	Trinidad.

JOURNALS FOR OVERSEAS MEMBERS.

Numerous requests are being received by the Secretary for copies of back issues of the *Journal* which have failed to reach their destination overseas. The Council has agreed that copies of the *Journal* to replace those lost in transit shall be issued to overseas members free of charge. But it is requested that members will not apply for such *Journals* until at least six months after the date they would have normally have been received. Preferably, a list of missing numbers should be retained until after the war, when they will be supplied in bulk. The Institute has at present ample stocks of the *Journal* covering the past three years, sufficient to meet all likely demands.

JOURNAL, AUGUST AND SEPTEMBER 1941.

The *Journal* was not published in August nor September 1941.

The issue following July 1941 (No. 213) was that of October 1941 (No. 214).

The *Annual Reviews of Petroleum Technology*, Vol. 6, was issued to all members and subscribers entitled to receive the monthly *Journal* in lieu of the issues of August and September 1941. It was despatched in the same wrapper as the October 1941 *Journal.*

CHANGE OF THE INSTITUTE'S ADDRESS.

As from Monday, 15th June, 1942, the offices of the Institute will be transferred from the University of Birmingham to the Imperial College of Science and Technology, London, S.W.7.

All communications should be addressed to :

The Secretary,
The Institute of Petroleum,
c/o The Imperial College of Science and Technology,
Prince Consort Road,
LONDON, S.W.7.

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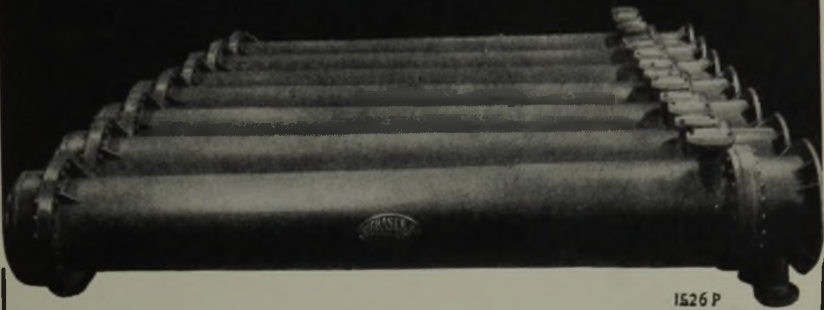
APPOINTMENT OF SECRETARIAL ASSISTANT.

The Council invites applications from members of the Institute and others for an appointment as Secretarial Assistant on the Institute's staff in London. Secretarial and accounting experience essential. Applications, stating salary required, should be forwarded to the Secretary not later than 30th June, 1942.

Kindly mention this Journal when communicating with Advertisers.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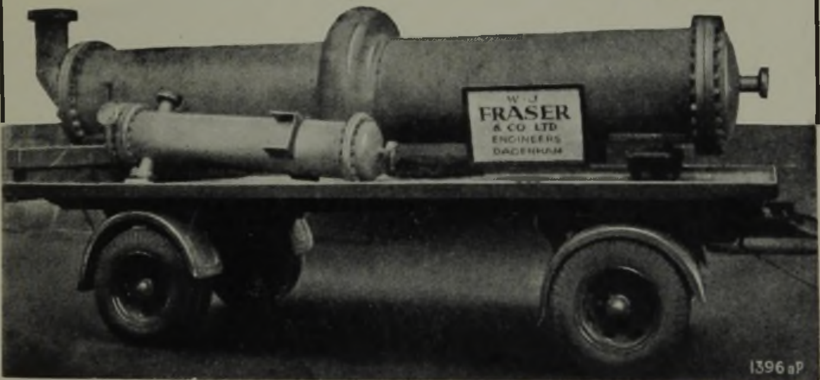
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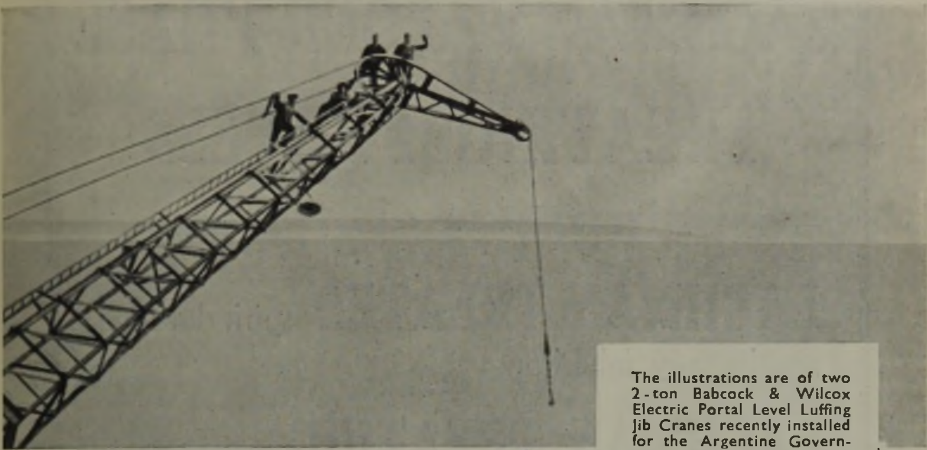

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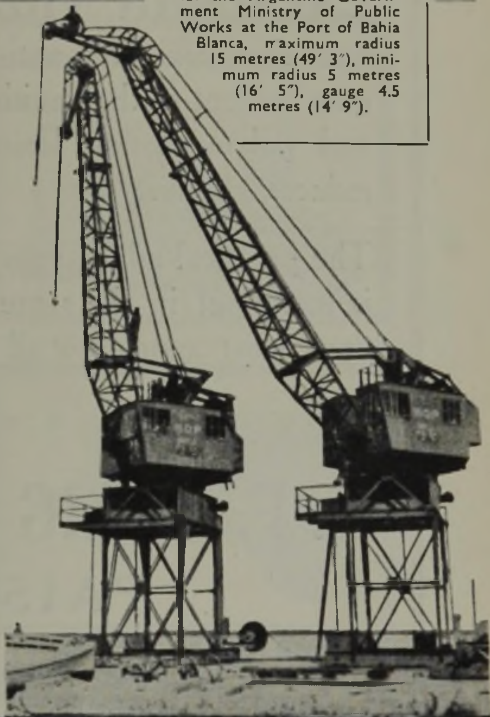

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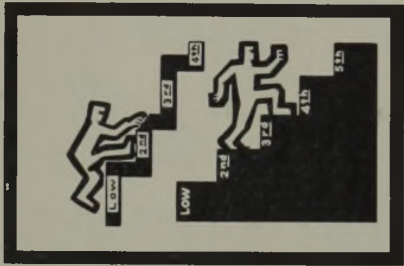

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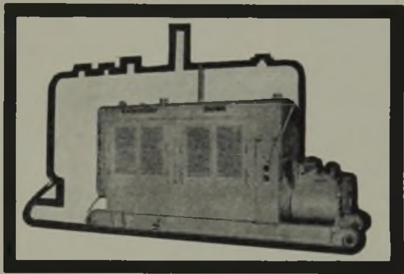

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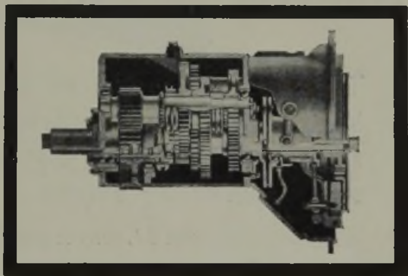

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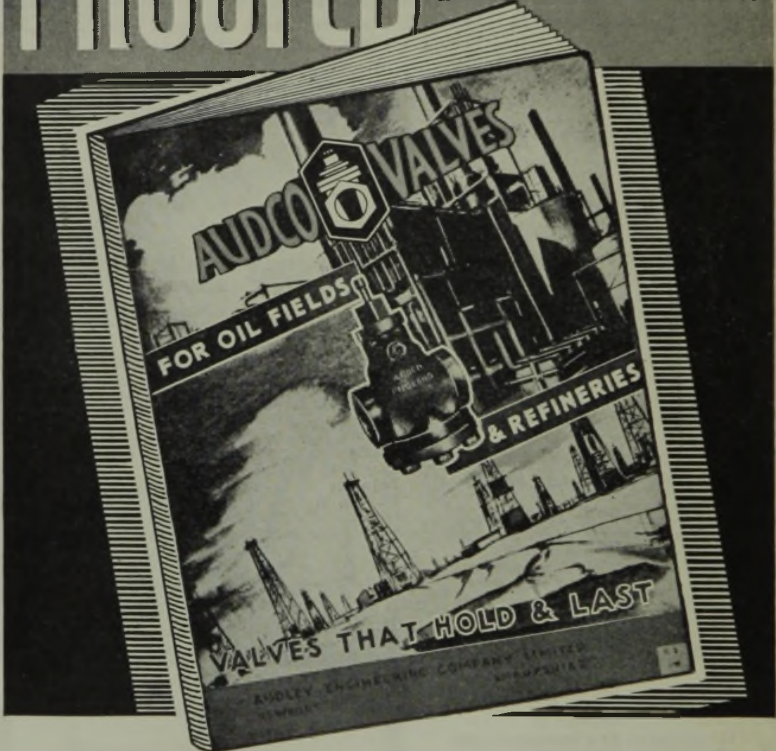

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