Vol. 29. No. 233. May 1943.

PEACE-TIME VALUES FROM A WAR TECHNOLOGY.

By Dr. Gustav Egloff.*

Paper presented at the War-time Marketing Conference, American Management Association, Chicago, January 14, 1943.

Introduction.

In a world at war one gets the impression that all forces are solely for destruction. When war ends, the new technology will more quickly, efficiently, and effectively convert the war effort into the pursuits of peace. With the tremendous increase in research and development, the commercialization of processes has occurred which under normal conditions would have taken years to reach fruition. Out of the welter of the war effort, values will flow that will increase man's effective span of life with greater satisfaction for living.

Science has already prolonged and saved man's life through germ-killing chemicals, new anæsthetics, and synthetic vitamins. Through scientific and technical research our food supply has increased in quantity and quality. Synthetic textiles have provided us with more beautiful, durable, and sanitary clothing. Plastics will revolutionize the building arts, for the trend is to supplant many house-building and house-furnishing materials with plastics as soon as they can be released for civilian use. Plastics, together with new and more efficient fuels, will also play a dominant part in our transportation systems.

Let us look at the transportation situation first. The petroleum industry will play a controlling part in this. Airplanes hurtling through the air at over 500 miles an hour, carrying 1000 or more passengers, will make all parts of the world less than twenty-four hours away from Chicago. Luxurious as were the *Normandie* and *Queen Mary* for ocean travel, airships yet to come will operate with a smoothness and comfort unknown to-day. Low-cost air travel and small planes should be within the pocket-book of every American. The competitive impact of the new airplane industry on all other forms of transportation may be quite serious.

Increase in air travel will be made possible primarily by the capacity of the oil industry, increased by war-time demands to produce 100 and higher octane gasoline, and by the amazing developments in airplane design, material, and construction that have been forced by the hard hand of war necessity.

The same technique and the same processes that produce 100-octane gasoline in almost unlimited quantities for use in airplanes, will also mean greatly improved fuel for automobiles—in fact, at least 50 per cent. more miles per gallon. We may hazard a guess that the automobiles to come

* Director of Research Universal Oil Products Company, Chicago, and President American Institute of Chemists.

after the war will give new pleasure to driving, because of their improved design, speed, safety, and beauty.

In the short span of twenty-five years man has entirely revolutionized transportation through the design and construction of the automobile and airplane and petroleum products. By careful study and experiment, it is certain we can produce from petroleum better rubber than was ever obtained from trees or plants, and tyres which will give 100,000 miles or more of trouble-free service are a reasonable expectation of the future.

For years we have been led to believe that world leadership in research and development rested squarely on Germany, and that the United States was laggard. Even now statements are made from time to time to the effect that we are still behind Germany in research, development, and commercialization. This is not consonant with the facts. There was an element of truth in such a statement during World War I, when the United States was short of many necessary materials due to its reliance on Germany for pharmaceuticals, dyes, fine chemicals, potash, lenses, chemical glassware, instruments, etc. We are now completely independent of any country for these and other materials.

Prior to the previous war it was thought that if one wanted to study chemistry, physics, mathematics, or medicine, one had to go to Germany, but that day is also gone for ever. In less than twenty-five years the United States has reached world leadership in research, and has awakened to a miracle of scientific and technological development under our system of free enterprise.

Private initiative is responsible for America's world leadership in science and industry. The tremendous effort that is being put forth in the United States, the effort that will win the war, is the work of private initiative.

The impact of researches, carried on by private corporations and speeded up enormously by the war, will bring vast changes in our peace-time economy. Their research departments were the organizations on which many companies relied to bring them out of the depression. Their results are the backbone of the country's mobilization for total war.

Obviously, in the time allotted one can but show a few highlights in the accomplishments of research.

The fact that many of nature's products have been unsatisfactory has stimulated man's inventive faculty fortified by the vision prevailing in our industries. The tremendous co-operation of industry in the United States is responsible for the spending of millions of dollars to develop a basic idea for the welfare of mankind. No industry stands alone in achievement, as they are all interrelated through research.

The destructive nations' efforts to rule the world must be wiped out as surely as we must defeat the insect and bacterial hordes that prey upon us.

Health Engineering.

Man's struggle to survive is ever present. He has either vanquished or domesticated large animal life. Our present battle is to overcome the ravages of rats, insect life, and bacteria; it would seem that the smaller the scale of life, the more difficult is the problem of its extermination or control. Even the very nature of some of the smallest forms has presented man with some of his greatest difficulties of discovery and eradication by chemical or physical means. Great strides in this direction have been made, but the ultimate solution is still far off. Increased tempo in research and experimentation along many fronts will ultimately present the remedy, but with the vastly improved tools man is constantly providing for himself, the end is certain to be on the favourable side for mankind.

From the necessities that war has forced upon man have grown the scientific principles of health engineering so vitally necessary to man's well-being as a fighting force. Accurate knowledge of vast areas hitherto seldom visited by dwellers in temperate regions has been the motive force behind a medical exploration of tropical territories that may well be carried over in the future development of our own hemisphere.

When it became necessary to provide troops with anaphylactic measures against tropical and sub-tropical diseases, it was the problem of the medical force to provide accurate knowledge of the type of health dangers encountered, and to provide prevention and cure of malaria, cholera, typhus, hookworm, bubonic plague, sleeping sickness, dysentery, and typhoid. Mosquitoes, rats, leeches, fleas, flukes, bats, and a host of other disease-bearing or spreading agents had to be studied and their control and extermination planned. Drugs of all types had to be ready for disease combat and the checking of infection.

In the Far Eastern and African campaigns insects and infections have beset our armies. Our men went down with malaria and other diseases. Among these are dengue fever, dysentery, tropical ulcers and sores, as well as the bites of malarial mosquitoes and tropical spiders, some as large as crabs. There is a drainage of our soldier's vigour in this pestilential atmosphere wherein he fights, eats, and sleeps but a few hundred miles from the Equator. As one eye-witness expressed it about the Buna campaign :

> " . . . that every ounce seems to grow to 10 pounds when carried through a jungle through knee deep mud. That means giving soldiers jungle equipment, including the lightest kinds of carbines, tropical uniforms, waterproof shoes, more efficient and lighter packs, as well as smaller mosquito nets."

What has research done to modify this type of torture and death to which our fighting forces are subjected? The methods of attack are chemical, physical, medical, and engineering.

An indispensable tool in the study of man's health has for many years been the microscope, which was discovered over 300 years ago. Slow improvements had been made in this instrument until a few years ago, when a revolutionary principle was discovered through the use of the electron. This made possible a magnification of over 200,000 times, compared to the 3000 from the best previous microscope.

Anti-insect sprays, delousing, swamp drainage, felling of certain trees, sanitation, oil and chemical-dust spreading, and other methods are used to keep our troops in fighting condition, and will have great value industrially and agriculturally during peace.

A number of synthetic chemicals, such as the sulpha drugs, synthetic quinine, and synthetic vitamins, are finding amazing uses on the fighting fronts. Where the World War I record was four deaths out of five due to germ infection of abdominal wounds, the present record is one out of five. Quoting Howard Blakeslee (*New York Times*, January 10, 1943):

> "On the 2000-mile front, in all the war, only 1·5 per cent. of the Russian wounded have died. That is slightly higher than the remarkable recovery rate at Pearl Harbour, 96 out of each 100. The report says the Russian recovery rate is 98·5 per cent. of all wounded. The Russian rate is one-half of 1 per cent. worse than the Guadalcanal miracle of 1 per cent. of wounded dying.
>
> "The Russians claim some new medical advances of their own. When plasma is made in America, the red blood cells are thrown away. The Russians report that they have made a process to use these cells to manufacture blood. Nerve sections taken from the dead have been successfully grafted into the wounded. The peritonea of animals, the inner linings of visceral cavities, have been used as living bandages for gaping wounds. It is claimed that cure is facilitated and that the scars are not so heavy.
>
> "A compound that is not a vitamin, yet has the blood-clotting effects of Vitamin K, is in use. The Russians say they have found a method to obtain thrombin in thousands of quarts volume. Thrombin is a natural clotting substance in blood."

The latest sulpha drugs which are working wonders against infection and disease are sulphathiazole, sulphapyridine, sulphaguanidine, and succinyl sulphathiazole which have been synthesized for specific diseases. Each soldier's kit contains first-aid doses of sulphanilimide for the purpose of checking infection at the time a wound is received.

Pentothal, which is injected intravenously, is one of the very best of the newer anæsthetics, having no explosive hazards, as have ether and the hydrocarbon gases. In addition, the equipment necessary for its administration is simple. An injection in the arm is all that is required to put one asleep.

Bacteria, soil moulds, and moulds found in the intestines of animals or insects create chemicals that are highly useful in destroying infection. Penicillin, a new drug produced in soil mould, is about 100 times as effective as sulphanilimide for combating infection, and far less toxic. Gramacidin from soil bacteria, has been found to be a powerful germicide for both pneumococci and streptococci, two germs extremely dangerous to man.

One cannot pass public health without mention of the vitamins. Many diseases of a baffling nature have been due to dietary deficiencies, and have been cured on treatment with the proper vitamins. New methods of production, mainly chemical synthesis, have made vitamins available. Vitamin C (ascorbic acid) and Vitamin B_1 (thiamin chloride) are probably the most outstanding examples. In 1933 the cost of Vitamin C was $213 per ounce, and in June 1942 the price had been reduced to $1.65 per ounce. Vitamin B_1 was sold for $8000 per ounce in 1935, and is now marketed at $15.00 per ounce. Due to the huge reductions in price, these vitamins, as well as several others, can be added to fortify various foods, giving them protective factors for health never before included in their manufacture.

Food.

Food plays the dominating rôle in all nations. Rationing has hit all of us, hence our keener interest in this subject. Research has made available foods relatively new to our civilization, not alone from the standpoint of new varieties, but of chemicals used for treatment increasing their quality, size, and vitamin content.

Petroleum plays a rôle in the newer methods of increasing food supply. When oil is cracked to produce motor fuel, olefinic gases are by-products. These gases, such as ethylene, propylene, and butylenes, hasten fruit-ripening and growth. Ethylene was first used for the purpose of ripening oranges rapidly, by putting a tent over each tree or storing the unripe fruit in a room and adding small percentages of ethylene. By using this method of ripening, the fruit could be shipped without loss due to rotting. The growth of potatoes has been stimulated by ethylene and propylene. It has been reported that the speed of growth of potatoes has been increased 100 per cent. when the seedlings have been treated with ethylene. The time of growth to maturity was shortened, while at the same time the potatoes were more numerous and larger and contained higher percentages of vitamin C.

The Russians have studied the use of butylene gas, showing that it has a stimulating effect on the speed of growth of trees, such as the apple, apricot, pear, cherry, plum, peach, and walnut, bringing them to fruition much faster than without its use. Where the growth season is too short to allow the full maturing of trees, due to the inclement weather in parts of Russia, so that flower formation and fruit-setting are delayed, butylene has been used to hasten the growth period. The method of treating a tree is to enclose it in a tent for two weeks before the normal or desired leafing—*i.e.*, start of the growth cycle. Butylene is passed into the tent in concentrations of one part in 100,000 parts of air at temperatures between 69° and 100° F. for a period of 1–2 hours. Small heaters are probably used to raise and maintain the temperature of the air around the tree, so as to obtain maximum effects of the growth inducing hydrocarbon, butylene.

Acetylene, so important in the production of synthetic rubber, plastics, and other materials, is being used in Australia to increase the growth of pineapple plants. Calcium carbide derived from coal and limestone is placed in the heart of the plant, and rain or dew reacts with it to produce acetylene in sufficient quantities to increase the growth of the pineapples.

In California, fruit orchards are fertilized by ammonia added to the irrigation water, which has markedly improved productivity. It may be of interest to point out that this ammonia is produced from the nitrogen in the air and the hydrogen from cracking of petroleum.

The autumn crocus contains a yellow powder called colchicine, which is extracted from the plant. This powder, when applied to seeds, leaves, or buds of a plant, increases growth of fruits and vegetables to double their normal size. Colchicine also gives rise to new varieties of fruits and vegetables never known before. The colchicine acts at a very critical point in the germination of the seeds. When cell division is ready to take place, the cell does not divide, as is usual in nature, and the specie-bearing chromosomes remain in the seed in double the number, giving rise to new species of fruits and vegetables.

The shipping of food supplies to the United States fighting men abroad is in a critical situation due to lack of transportation. To overcome this obstacle a number of processes have been developed to dehydrate foods in order to cut down their bulk and weight.

" Quick freezing " of fruits, vegetables, and meat has added materially to food supply, particularly in decentralized communities, and steel and tin in the form of cans are thus conserved. This development has great economic value for peace and war.

The impact of these researches on the food economy of the world will develop enormously, in that one may work out new hormones and chemical stimulators which will give rise to new plant life.

Developments already achieved present an almost incredible picture of our food supplies of the future. Obviously these developments will make it possible to raise more food of higher nutritive quality on less acreage, with far less labour compared with present methods.

Textiles and Clothing.

For years the silkworm was the sole producer of the raw material used in weaving fine silk fabrics symbolic of richness and luxury. Marco Polo in the fourteenth century introduced these fabrics into Europe. The products from the silkworm held leadership for centuries as a symbol of wealth. The silkworm's job is well-nigh finished, although silk will probably find a number of special uses. The research chemists have developed synthetic silks far superior to the best that the silkworm can do. Rayon is one of the earliest of the silk substitutes, and was produced primarily from wood and cotton linters.

The most striking development in the textile and plastics industries in the past few years is the commercial production of Nylon. One of the main uses of Nylon was for hosiery that has at least ten times the wear quality of the best silk from the worm. It is now used largely in parachutes and for ammunition bags, in which it replaces natural silk.

Structural Materials.

After World War I a great impetus was given to the building arts. Structural steels, alloys, aluminium, concrete, synthetic stones, plywoods, insulators, plastics, and a host of other materials were made generally available. A new era in design, building, housing, and transportation, will be the aftermath of the present war with the many new materials now produced being diverted from the war to peace. A tremendous business potential is ahead of all of us, which will strain us to the limit to fulfil the demands of building, furnishings, automobiles, and trains, etc.

Glass.

For thousands of years almost no progress was made in the glass industries of the world. The only researches of moment were through the addition of minerals to give beautiful colours to the windows of the world's cathedrals.

Researches in the glass industry of the U.S.A. since World War I have made amazing strides in the materials that can be produced from sand. The U.S.A. in World War I was cut off from the chemical glassware and lenses of Germany, which held leadership at that time. We are now entirely independent of any foreign country, for we have developed new products from sand that are leaving their impact on other industries in a competitive way that will be intensified in the peace period to come. Mass production of hard glass for laboratory use has found its way into everyday life in its use for baking and other heat-resisting utensils. In addition to this development, the present war is bringing out the utility of glass in jobs which were previously taken care of by steel, silk, and cork. Glass fibre boards for heat insulation in fighting planes have saved 5½ million pounds of aluminium and other scarce light-weight metals which can be used in building 250 Flying Fortresses. For electrical insulation, glass filaments are spun which make a flameproof wire coating for use in heavy bombers. Glass foam has found use in displacing cork in life-preservers and lifeboats. Unlike air-filled rubber floats, a puncture is not vitally destructive, since when a bullet passes through, only the cells in the immediate vicinity are destroyed. One of the outstanding uses of spun glass in the present war is as a replacement for silk and gut in surgical sutures. Spun glass is also widely used as a fireproof textile. Some of the newer optical glasses use no sand at all, but depend on the rare-earth elements such as tantalum, tungsten, and lanthanum. The glass made from these materials is highly satisfactory for use in aerial photography lenses, since it gives more sharply defined images at higher altitudes than was ever previously possible.

Plastics.

The plastics industry was founded years ago by Hyatt, an American. He was the first to work with cellulose nitrates and camphor as a plastic mass in an effort to find a substitute for the ivory in billiard balls. In general, however, the founding of the modern plastics industry occurred in 1907, when Dr. Leo H. Baekeland produced in his laboratory in Yonkers, New York, the first phenol-formaldehyde products, commercially known as Bakelite. This American research was the stimulating force that has brought the plastics industry to the important position it now holds in our war effort. World leadership in the plastics field is without question in the United States. One can be clothed from head to toe by plastics that are now available. One may live in a plastic house and be transported in vehicles largely made of these materials. There is no end to the variety of plastics that are potentially available and in the making.

These remarkable plastics have at least 100,000 uses. Perhaps one of the most important at the moment is for the production of hoods for pilots and gun-turrets on airplanes, where prolonged high visibility is so essential. One of the most important plastics is Plexiglass, made of methylmethacrylate. The flexibility of this material lends itself to forming any shape desired by moulding. In addition to clarity of vision, which these plastic windows give for a long time, they are practically shatter-proof.

It is to be expected that in the automobile to come plastics will play a great part in its structure. One may expect practically 100 per cent.

visibility in the new type car based on plastics. For these uses it will be highly competitive with other types of structural materials.

Much has been accomplished in the United States in brightening life, housing, and transportation by the use of plastics of every colour. One may say that the period in which we are living is the renaissance of colour. This reawakening to colour values was apparent before the Global Blackout. Many plastic products form excellent media in which the commercial artist and designers have expressed their art in home and business interiors. Current U.S. magazines are full of beautiful illustrations of radios, electric irons, telephones, airplanes, milady's boudoir, many of which are made of plastics.

The colour effect of these plastics plays a definite rôle in the well-being of humanity and in our capacity for work. This industry of colour effect from glasses and plastics has not been fully exploited. However, a number of manufacturing plants have worked out colour schemes that raise the tempo of production and ease fatigue at the same time. Eye-strain particularly is in general an overlooked factor in well-being and productivity. Walls of dull grey, brilliant white and black machines in many cases contribute to accidents. The fatigue factor also holds for office work, and study should be given to the relation of colour to accuracy and output of those engaged primarily in mental activity.

In general, the architect, in planning buildings, has limited himself as regards colour to a comparatively narrow range—grey portland cement, red sandstone, and grey, red, and yellow bricks, etc. Newer building plastics are available in colours as beautiful and far more practical than precious stones whose colours they imitate. The architect could well use plastics in slabs that would give us colourful buildings at low cost.

One may expect that the new plastics will play a competitive rôle with building and window-glasses. Both the plastic and glass industries will also be highly competitive with the paint and varnish industries.

Synthetic Rubber.

We were caught with our natural rubber supplies shut off by the devastating attacks of the Japanese, who now control over 95 per cent. of the world's rubber supplies. In normal times the United States requires about 600,000 tons for its peace-time pursuits. Fortunately science and research in the United States were not caught napping in the knowledge and technique for the production of synthetic rubber. For a matter of twenty years or so, long before the fall of the Far East, processes were available to produce synthetic rubber. The production schedule is for 1,100,000 tons of synthetic rubber for the war effort. The synthetic rubbers, Neoprene, Thiokol, and Ameripol, were in commercial production prior to the fall of the East Indies. The methods of producing other rubbers, such as Buna-S and the butyl-type rubbers, were also available. The U.S.A. has all the raw material necessary to produce any quantity. It is now a question of materials and their fabrication to equipment in order to construct the plants already passed by the Government.

Neoprene rubber is based on acetylene—the same acetylene that induces plant growth and is the basis of a whole host of other products.

Acetylene is one of the most important of all the hydrocarbons, and has been produced through the years almost entirely from coal and limestone in electrical furnaces. One of its primary uses for years has been in acetylene welding, and now it is used in the manufacture of synthetic rubber. Researches have been going on for years in an endeavour to use our vast natural gas and petroleum resources for the production of acetylene. There are a number of commercial units now in course of construction, one of which will produce at the rate of 75 tons a day of acetylene, or 27,000 tons a year. It is believed that acetylene will be produced at a lower cost from processing our natural hydrocarbons than by the high-temperature electric-furnace method. The natural gas industry of the U.S.A. produced in 1942 about 3,000,000,000,000 cubic feet of gaseous hydrocarbons, part of which could supply the whole world with acetylene and its derivatives.

Thiokol is manufactured from ethylene derived from the cracking of oil, chlorine and sulphur, whereas the Buna-S rubber is produced from styrene from coal and petroleum, and butadiene derived from grain alcohol and petroleum.

Butyl rubber is based on the chemical reaction of *iso*butylene, butadiene, or *iso*prene.

We are being geared to produce synthetic rubbers in the following tonnages :

	Tons per year.
Buna-S	845,000
Butyl	132,000
Neoprene	69,000
Thiokol	60,000

The world's natural rubber production for 1941 was 1,675,000 long tons, of which the United States imported 820,000 tons. With the tremendous number of airplanes, tanks, motor trucks, ships, trains, gun mountings, etc., the rubber demands are ever increasing, not alone for the fighting forces on the far-flung fronts, but for the necessary war work behind the lines. A statement appeared recently that ground tanks were obsolete due to the fact that the heavy guns of the U.S.A. were able to smash them. If this be so, then airplane tanks, heavily armoured for low altitude flying, should be the answer, and this will call for increased quantities of rubber. Medium-size tanks require 500 lb. of rubber and pontoon bridges over 1000 lb. The gasoline tank alone of a Fying Fortress uses 500 lb. of bullet-sealing rubber, while large bombers require over 1200 lb. Gas masks use three-quarters of a pound, and battleships between 75,000 and 150,000 lb. Excavation trucks used by the Army with tyre diameters of 9½ feet require about 3500 lb. There are many hundred more products requiring rubber that are vital in the war effort, such as blimps and barrage balloons. The latter have not been used in the United States to any extent. However, if the war reaches our shores tremendous quantities of rubber will be needed for this purpose. Rubber boats, rafts, safety vests and suits for flyers, hospital rubber requirements, etc., are also some of the products demanded from the rubber industry.

Ironically, Press dispatches from the Far East indicate that the Japanese are cracking rubber to produce gasoline and other oils, which is an indication that they have a shortage of oil despite the fact that they have taken over the Far Eastern oil-fields of the Netherlands and the British. As a contrast, in the United States we crack petroleum to produce synthetic rubber and gasoline.

You may well ask the question: Is synthetic rubber equal to the natural? One may say, the synthetic product is at least equivalent to the natural, but at present it does not duplicate it. Nor is it essential to duplicate nature's product, for the chemist's goal is to produce rubber with far superior properties to the natural. It has already shown far superior properties from the standpoint of gasoline, oil, and chemical resistance. The synthetic product has greater wearing properties, and does not deteriorate readily in sunlight and air.

A number of trucks and motor-cars using synthetic rubber have gone over 35,000 miles, and one may reasonably expect at least 100,000 miles with the amount of research going on in the laboratories of the U.S.A. The greater general strength of a synthetic tyre means less driving hazards and far better road gripping. The latter property has been thoroughly tested on wet and muddy roads. Hill tests made with a number of trucks on a muddy road showed that the synthetic-tyred vehicle had very little side-slipping, while the natural tyred slipped all over the road. Taxi-cab drivers advise that they all feel far safer in driving in mud or on wet city streets when their cabs are tyred with synthetic rubber.

The research laboratories of the United States have discovered at least 3000 synthetic rubbers of varying properties. Some of them are exceedingly expensive to produce and others relatively low-priced. One may state that synthetic rubber for tyres will be highly competitive with the natural rubber and in mass production synthetic should be less than 15 cents a pound. Natural rubber has sold through the years at prices varying from 3 cents to $3.00 per pound.

We are in a rubber crisis which may mean that all motor vehicles not used in the war effort will cease operating in order to be sure that all our fighting fronts will have sufficient rubber for ultimate victory.

Synthetic rubber must be provided at the rate of at least 1,100,000 tons a year called for by the Baruch Committee. Never again should the U.S.A. be caught short of rubber whether in war- or peace-time.

Aviation Developments.

Scientific, technical, and industrial miracles are taking place throughout the U.S.A., not the least of which is in the airplane industry. In a few years production of airplanes has stepped up from less than 1000 per year to over 48,000 in 1942, with 100,000 projected for 1943. It is not solely a question of the number of planes, but their design, quality, and size based on incorporating the knowledge gained on the fighting and research fronts.

Extraordinary strides have been made in the fabrication of airplane engines, propellers, and bodies. The materials of construction are now of aluminium, magnesium and their alloys, stainless steel, plywood, and plastics. These will be highly competitive after the war. Aluminium alloy forgings for cylinder heads stepped up the horse-power of the engines 15 per cent. as well as decreasing its weight. Seversky reported that a 32,000 horse-powered airplane was in the making, using four 8000 horse-power engines. A Flying Fortress, the U.S. Army B-19, is an 8800-horse-power airplane, with a 36,000-lb. high explosive carrying capacity. In contrast, " Air Jeeps " of 65–100 horse-power are in our fighting forces on the Pacific and African fronts. They are used for fighting, since they carry Stokes mortars and heavy machine guns, as well as 100-lb. bombs, and have a range up to 500 miles with an altitude averaging about 1000 feet. They are also used for observation in place of the old-type balloons, for courier duty, auxiliary scouts, and as advanced guards by the striking forces. In peace-time these planes were the well-known Piper Cubs, Aeroncas, Taylor Crafts, Fairchilds, and Stinsons.

The giant strides made by the airplane industry are at least matched by the oil industry in producing the 100 and higher octane gasoline and the necessary lubricants to operate the hundreds of thousands of aviation engines.

There are many chemical processes involved in the production of our aviation gasoline. The 100-octane gasoline is a 100 per cent. development of the oil industry of the U.S.A. We have far superior aviation gasoline and lubricating oils than the Axis Powers have available. The octane ratings of aviation gasoline which were collected from shot-down German planes averaged about 87. It has been reported that the German invasion of England in September 1940 was stopped by the R.A.F. because their fighting planes were powered with 100-octane fuel, while the German planes were fueled with 87-octane.

The importance of high octane ratings in gasoline for airplanes is strikingly shown in the performance of 87-octane compared to 100 in a bombing plane, particularly as to speed, rate, and time of climbing to maximum ceilings and manœuvrability of the plane. Comparative tests of 87 versus 100-octane gasoline in a bombing plane showed that it took nineteen minutes to reach an altitude of 26,000 feet for 87-octane, whereas the 100 required only twelve minutes. The absolute ceiling of the plane in round numbers was 37,000 versus 33,000 feet for the lower octane-fueled plane.

The newest transport plane, called " The Constellation," just tested, will carry fifty-two passengers with a speed greater than the Japanese Zeros. The plane can fly at about a seven-mile ceiling far above storm conditions, while ordinary cruising altitudes are about four miles. The Constellation can cross our continent in one eight-hour hop using more than 8000 horse-power with the remarkably low fuel consumption of one gallon of gasoline per mile.

Conclusion.

World War II may not be a total loss for humanity. A tempo never before attained in the U.S.A. has been reached with a collaboration and exchange of knowledge between heretofore highly competitive groups. New materials now in war production will have great peace-time values. We will also have access to a vast amount of knowledge and experience which has been accumulated as the result of hectic years of war. Man's life will be prolonged, his health, mentality, imagination, and productivity increased, and the pain and irritations of life will be reduced to a minimum.

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

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

Geology and Development.

399.* Production Outlook for 1943. D. R. Knowlton. *World Petrol.*, January 1943, **14** (1), 34.—The proved oil reserves of U.S.A. are about 20,000,000,000 brl., which would take 30–50 years to produce, and the present, or an increased, rate of production cannot be maintained for long unless additional reserves are discovered at a rate at least equal to the rate of production. It seems likely that U.S.A. will have to supply more than its proportionate share of oil production during the war, and it is agreed that the demand for all types of products in 1943 will exceed the demand of 1942.

A general and substantial increase in the rate of production from most of the present fields must be considered as an emergency measure which should be adopted only as a last resort. A limited number of fields in the south-west have an important excess of unused efficient producing capacity, but this is not readily accessible because of transport difficulties arising from the war. Production in excess of the maximum efficient rate accelerates the decline in productive capacity, and reduces the recoverable reserves in many cases. Hence the maintenance of reserves at a level sufficient to meet demands is encouraged.

In the last four years wildcatting results have been disappointing, with a diminishing discovery of reserves per wildcat. In the three-year period, 1936–1938 inclusive, an average of 2263 wildcats were drilled each year, and an average of 806,000 brl. of new reserves were discovered per wildcat. The corresponding figures for the three-year period 1939–1941, inclusive, were 2963 wildcats per year, and only 216,000 brl. of new reserves per wildcat. Since 1934 the number of fields discovered per year has increased, but the average size of the new fields has fallen from nearly 20,000,000 brl. per field in 1934 to 1,200,000 brl. per field in 1941.

About 3100 wildcats were drilled in 1942, and based on the poor results of previous years 50% more will be required in 1943. 11,500 development wells are planned for 1943. The order of priority in the allotment of materials will be first wildcatting and related exploratory wells, repair and maintenance of producing wells, and lastly development wells.

In order that the smaller number of development wells in 1943 will give adequate production, locations must be carefully selected, and the most efficient production technique applied. Old wells must be reworked, and repressuring, pressure maintenance, and water-flushing applied. G. D. H.

400.* Well Completions of 1942 34% under 1941. Anon. *Oil Wkly*, 11.1.43, **108** (6), 33.—21,217 wells were completed in U.S.A. in 1942, 34% fewer than in 1941. In the Middle West and Upper Mid-Continent, drilling in 1942 was curtailed by 25–50%, in Kansas 28%, in Oklahoma 34%, in Indiana 32%, in Illinois 46%, in Ohio 36%, in Kentucky 50%, in Michigan 25%, in New Mexico 3·5%, in Arkansas 32%, in North Louisiana 40%, in South Louisiana 44%, in Mississippi 50%, in Texas 50%, in California 27%, in Colorado 28%, in Montana 23%, and in Wyoming 29%.

Tables give, by States and districts, details of drilling activity on 1st January, 1943, and the numbers of rigs operating on 1st January and 1st December, 1942; also the types of completions in December 1942, cumulative data for 1942, and the changes which have taken place as compared with 1941. G. D. H.

401. The Petroleum Shortage in the United States. B. T. Brooks and L. C. Snider. *Oil Gas J.*, 21.1.43, **41** (37), 26.—If the rate of finding new oil shown in the U.S.A. in the last three years continues during the next three years, and production is forced to meet current needs, the damage to many fields will rapidly accentuate the oil shortage, while estimates of net ultimate producible oil from known reserves will have to be revised sharply downwards. R. K. Davies, W. V. Howard, W. P. Cole, E. L. DeGolyer, and H. B. Soyster have all pointed to declining discovery rates and other signs of a possible shortage. However, it is almost certain that sufficient oil can be produced to meet requirements in the next two years, but with the declining discovery rate and decline in production from existing fields it is equally certain that the critical rate of production of many fields will be exceeded, with consequent damage and reduction of ultimate recovery. In this sense a shortage has already developed.

Proven reserves are generally agreed to be 19,000,000,000 to 20,000,000,000 brl., or 5,000,000,000 brl. more than in 1936. The existence of a critical rate of production has been recognized, and to obtain a high recovery by means of the optimum rate of production calls for a much larger reserve than when the old flush methods of production were practised.

For many years about 50% of the U.S. production has been from new flush wells constituting about 2% of the total producing wells. Since the greater efficiency of restricted production has been demonstrated the estimates of recoverable oil have been revised upwards, both for old and for new fields. But this revision would be nullified if efficient rates of production are exceeded.

After allowing for shrinkage and connate water, it is now estimated that the ultimate recovery of oil in some fields has been as high as 80% or even 90%.

It is not certain that substantially increased production would be obtained by raising the price of oil to induce greater discovery effort.

Venezuela's oil output might be restored to its former level if adequate transport with naval protection were available. There is little likelihood of a substantial rise in Mexico's oil production in the immediate future.

It does not yet seem necessary to turn to oil from coal and shale to avert a shortage, and such a step would not be profitable while oil prices are at anything like their present levels.

The question of an adequate supply of crude oil during the war is further complicated by the need to manufacture enormous quantities of high-octane aviation fuel, to meet an increased demand for fuel oils, and to provide raw materials for the manufacture of synthetic rubber, toluene, and other special products. G. D. H.

402.* Alberta Reached Top Production in 1942. Anon. *Oil Wkly*, 25.1.43, **108** (8), 42.—The Alberta oil production is estimated to have been 10,150,000 brl. in 1942, compared with 9,908,000 brl. in 1941. The 1942 peak rate of production was in February and March with 30,000–31,000 brl./day. At the end of the year the production was at the rate of 27,600 brl./day, due to a slump in drilling in proven and prospective oil areas.

Much of the Alberta production has gone to aid the construction of the Alaskan highway, while 87-octane fuel has been provided for the Commonwealth Air Training plan. Preparations have been made for the production of 100-octane fuel.

G. D. H.

403. Proven Reserves. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 64–66.—On 1st January, 1943, the U.S. proven oil reserves were estimated to be 20,675,899,000 brl., 543,140,000 brl. less than the revised estimates for 1st January, 1942. New fields added 322,808,000 brl. to the reserves in 1942, and extensions added 518,580,000 brl. The corresponding figures for 1941 were 486,935,000 brl. from new fields and 1,009,175,000 brl. from extensions. During 1942 the reserves of Colorado, New Mexico and North Louisiana increased. In California the reserve figure fell during 1942 from 14·5 to 12·8 years' supply, due to lack of discoveries and to increased rate of production. Transport difficulties caused production to be reduced in parts of Texas, and therefore in most of Texas the reserves rose in terms of years' supply. The new additions to reserves in Oklahoma were 60% below the output, and in Kansas the discoveries were 50% of the output. There was decided over-production in Illinois, Indiana, Michigan, Mississippi, and Nebraska.

The revision of the reserve estimates of 1st January, 1942, have been upward throughout the U.S.A., but this revision does not increase the estimates of immediately recoverable oil, since most of the fields involved are either producing to capacity or producing at a rate consistent with good engineering practice.

While the discoveries in 1942 were as numerous as in 1941, the average reserve of each was only two-thirds of the 1941 figure. No major fields were found in the northern extension of the production in the San Joaquin Valley. California's ability to produce has been increased by re-drilling several old heavy-oil fields. In Wyoming deep pays discovered in old fields were the greatest in interest, except for an oil find on the northern side of the Denver basin. New trends parallel to the main Artesia–Vacuum fields have been found in New Mexico, Square Lake being the most important discovery. The Ellenburger is proving of increasing importance, and production is extending to the north-west in the Permian pays. Many small fields have been found in North Central Texas.

Many areas have been tested to the lowest possible producing horizon. In the

Eastern States no important production has been found below the top of the Trenton, and this formation has given little oil east of the Cincinnati Arch. Illinois and Michigan have production possibilities within a few thousand feet of present levels. No Cambrian production has yet been found in Oklahoma, but Kansas has some Cambrian production. The Ellenburger possibilities are of prime importance in North Texas and in West Texas. Lower Cretaceous and Jurassic horizons have not been tested in East Texas and in the adjacent parts of Arkansas and Louisiana. Much Tensleep and Embar production has been found in the Rocky Mountain area, where the Palæozoic offers lower possibilities.

A table gives by States and districts the estimated reserves as of 1st January, 1942, and 1st January, 1943; the reserves due to 1942 discoveries and extensions, and the total years' supply as of 1st January 1942, and 1st January, 1943. G. D. H.

404. Discoveries and Extensions by Districts. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 66–71.—The discoveries and extensions are listed by States and districts, with their names and locations, producing horizon, proven acreage, formation thickness, and estimated reserves. Maps show the positions of the new discoveries and extensions. G. D. H.

405. Wartime Regulations Sharply Reduce Drilling Operations During 1942. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 72.—In 1942 18,150 wells were completed, 40% fewer than in 1941. The fall was due to unsatisfactory prices, M-68, and a lack of locations.

Except for the new Burbank field in Kentucky, wells in that State, and in most of Ohio, West Virginia, and in all of New York and Pennsylvania, are small producers, so that wells drilled under present price conditions are generally unprofitable. The initial outputs in Illinois, Michigan, and Indiana are generally higher, but the lack of locations affects the position. Multiple completions in these three States make profitable wells when all the producing horizons are within depths wherein the 10–20-acre spacing ruling operates.

In Kansas, Peace Creek and Lindsborg were active throughout 1942, and many extensions are reported from the older fields, chief among which was the merging of several smaller pools into the Kraft-Prusa field. It is possible that Hall-Gurney, Gorham, and Big Creek may eventually merge. Drilling dropped by nearly 50% in Oklahoma in 1942, and it also fell sharply in the Gulf Coastal district. The decline in drilling was less in the Rocky Mountain States and in California than elsewhere. The average footage of the wells drilled in California last year was 1704 ft. less than in 1941.

There seem to be few areas in U.S.A. where there is much possibility of increased drilling in 1943, and unless there is price relief, increased transport, and some relaxation of drilling restrictions, it is unlikely that many more than 16,000 wells will be drilled in 1943.

A table gives by States and districts the total completions in 1942; the numbers of oil, gas and dry wells, and the footage; the total number of wells in 1941. Curves show the total completions, numbers of dry holes, and the average prices year by year since 1910. G. D. H.

406. Production Stays at Peak Level. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 78.—During 1942 U.S.A. produced 1,384,542,000 brl. of oil, 7,378,000 brl. less than in 1941. 85·8% of the 1942 total came from Texas, California, Oklahoma, Louisiana, Illinois, and Kansas. Louisiana and Kansas had their peak outputs in 1942, and California approached its 1938 peak. During 1942 the Illinois and Oklahoma outputs declined by 22,268,000 brl. and 16,406,000 brl. respectively, in spite of heavy demands. The Kansas output rose by 14,980,000 brl. in 1942, while the New Mexico production fell by 6,567,000 brl., a fall which can easily be removed when transport is available. Indiana gave more oil in 1942 than in any year since 1905. The development of several good fields caused a substantial rise in production in Michigan in 1942. The Montana output was at a peak, and Wyoming's production at its highest level since 1924, while Colorado gave more oil than in any year since the late twenties.

The production is tabulated by States yearly since 1935, and curves show the annual production of the leading States since 1930. G. D. H.

407. World Production Slumps but Revival this Year is Indicated. J. P. O'Donnell. *Oil Gas J.*, 28.1.43, **41** (38), 94.—It is estimated that in 1942 the world oil production totalled 2,062,500,000 brl., compared with 2,227,125,000 brl. in 1941. The effect of lack of transport was 75% greater than that of destruction of fields in reducing the total output. Thus lack of transport reduced the production of Venezuela and Colombia by 86,500,000 brl. in 1942. The North American production fell by 24,360,000 brl., the bulk of the decline being in U.S.A., although Mexico experienced a further decline, largely due to transport difficulties. The Canadian output rose by 3%.

Venezuela's production fell 32% (72,350,000 brl.) and Colombia's production fell 57% (14,050,000 brl.) in 1942. Until tanker movements are easier neither country is likely to return to a state of higher production. Both countries had new discoveries in 1942. Trinidad's output of oil rose in 1942, and Argentina had a 7% rise.

During 1942 the Maikop fields were captured by Germany and the pipe-line outlet from Grozny was interrupted. The Germans also gained partial control of the Volga. A doubling of the Ural–Volga production to 100,000 brl./day offset these Russian losses to some extent. The Hungarian oil output is said to be 12,000 brl./day, and possibly 15,000–17,000 brl./day.

The Netherlands and British East Indian and Burmah fields were captured by Japan in 1942, and this increased Near East development. Japan has probably derived little oil so far from her conquests.

The 1943 world oil production is unlikely to reach the 1941 level. G. D. H.

408. Permian Basin, Panhandle: Ellenburger and Clear Fork Provide Important Discoveries in Basin. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 113.—During 1942 two new Ellenburger pools, Monahans in Ward County and Embar-Ellenburger in Andrews County, gave some indication of the deeper possibilities in the Permian Basin. Fullerton in Andrews County was the major Clear Fork discovery, the discovery well being completed at a depth of 7280 ft. for 707 brl./day of 44-gravity oil. This pool now has ten wells averaging 600 brl./day initially, with a pay-zone 150–500 ft. thick; it may become a major pool and establish a new trend between two lines of major development. The Embar–Permian pool, another Clear Fork find, came in at 6210 ft. for 264 brl./day. Ellenburger production has been developed in the same pool. The Clear Fork Monahans discovery was made in a well which was intended to test the Ellenburger. The Monahans (Ellenburger) pool has 280 ft. of pay, topped at 10,082 ft. in the discovery well which came in at 2852 brl./day. Geophysical work has shown the Monahans structure to be large.

Nine more Ellenburger producers have been completed at Barnhart. At the end of 1942 the Slaughter pool covered 72,000 acres, and it has not yet been defined on the north side. The San Andres lime pay averages 100 ft. in thickness.

Fifty-nine exploratory wells were drilled in the Permian Basin in 1942 to an average depth of 3500 ft. Lack of outlets curtailed production in this area.

Tables give the cumulative production and estimated reserves on 1st January, 1943, and the number of wells in each field of West Texas and the Panhandle, together with the completions in 1942, and the number of completions and footage each month. G. D. H.

409. Square Lake Develops into Major Pool. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 117.—Ninety-nine oil wells and a small gasser have been completed at Square Lake in South-east New Mexico. The discovery well was completed at 2903–2978 ft. for 200 brl./day. Maljamar has thirty-five new producing wells in the Whitehorse and the Queen lime. During 1942 interest was revived in the Jackson–Grayburg area, which has a pay zone in the Whitehorse lime at about 3300 ft.

Oil is found at about 500 ft. in the Shallow Red Lake district, where twelve wells were completed with average initial outputs of 50 brl./day. At East Lusk seven oil wells have been completed at a depth of 2700 ft. with an average potential of 200 brl./day from the Whitehorse lime. The Arrowhead pool has been extended to the north.

Shows have been found at about 5000 ft. in the Permian at Langlie in Lea County, and another Lea County well has swabbed a little oil.

The 1942 well completions in South-east New Mexico are tabulated, along with the cumulative production and estimated reserves on 1st January, 1943. G. D. H.

410. Four Small Fields Found in California in 1942. L. P. Stockman. *Oil Gas J.*, 28.1.43, **41** (38), 118.—California's crude oil reserves were substantially reduced in 1942, in which year two gas-fields and the Antelope Plains, East Strand, Buena Park and Holser oil-fields were discovered. These fields are not of major importance. The reduction in reserves was aggravated by the lack of permission to drill to the Tar zone at Wilmington. A similar situation obtains at Inglewood, where drilling in the Sentous (Miocene) zone has been suspended. The Wilmington Tar zone may have a reserve of 50,000,000 brl., but this is not yet proved.

Production in 1942 in California was at the highest rate for a number of years, and it may be at a still higher rate in 1943. 556 oil wells and 25 gas wells were completed in 1942 out of a total of 828 wells. If the percentage of failures in 1943 is as high, 1000 wells will have to be drilled. None of the wildcats shows great promise, and interest in the Cretaceous has declined since gas only has so far been found. Several fields have proved deep zones which will have to be produced if new prolific fields are not discovered in 1943.

California is not producing to capacity, because of bottlenecks.

It is intended to use the Playa Del Rey field for storage of the surplus gas produced in the summer.

The cumulative production and the estimated reserves on 1st January, 1943, are tabulated by fields, and there is a summary of the types of completions in the various fields, and the numbers of completions and the footage drilled each month.

G. D. H.

411. Oklahoma : Pauls Valley and East Watchorn Pools are Leading Discoveries in 1942. C. Hoot. *Oil Gas J.*, 28.1.43, **41** (38), 125.—The 1942 oil production in Oklahoma was bolstered to some extent by edge wells and reworking programmes. Oil wells constituted only 46% of the completions. Fifty new oil- and gas-fields, extensions, and new zones were opened in 1942, with Pauls Valley probably the best find. Pauls Valley produces from the Wilcox and Pennsylvanian, and the field has been defined at its northern and southern ends.

The Apache pool has been extended to the north-west. Late in 1942 the Ardmore Springer sand pool was opened at a depth of 3079–3302 ft. Further wells have been completed in this pool. The Cumberland pool has been extended to the west, and a new pay was discovered at a depth of 5472 ft.

Tables give the cumulative production and the estimated reserves by fields on 1st January, 1943, together with the total well completions and types. G. D. H.

412. Western Side of Illinois Basin Produces Outstanding Fields of Year. H. David. *Oil Gas J.*, 28.1.43, **41** (38), 131.—The high discovery rate was maintained in the southern half of Illinois in 1942, but no large flush pools were found. Hence the oil reserves declined for the first time since 1937. 106,282,000 brl. of oil were produced in 1942, and 1809 wells were completed, compared with 3838 wells in 1941. During 1942 there was an increase in activity in the Louden and Centralia–Salem areas and on the western rim of the basin, where the Devonian and Trenton limes were the main objectives. Devonian production was found at Boulder and Bartelso South, and Trenton production at St. Jacob. Late in December 1942 a 700-brl. well was completed in the Devonian 50 ml. north-west of the nearest Devonian production at Louden.

The Boulder field has been producing from the Benoist, but late in 1942 a second Devonian well was completed. St. Jacob is the most prolific Trenton field in Illinois, and has encouraged the drilling of further Trenton tests on the western rim of the basin.

The Covington pool covers 1200 acres, and produces from the Aux Vases, Levias, and McClosky. It has already given 1,159,000 brl. of oil. The Blairsville and Markham City pool wells have high initial outputs from the Aux Vases and McClosky. Oil is obtained from the Cypress, Aux Vases, and McClosky in the Iola field.

A new pay, the Glen Dean limestone, has been found in the middle of the Chester series, and is giving oil at South Sailor Springs. Early in 1943 Devonian production was discovered in the Patoka field.

The cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, and there is a summary of the types of completions and the number of completions each month in 1942. G. D. H.

413. North Central Texas : Bend and Mississippian Pays Yield Many Discoveries. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 137.—Forty-one of the 105 wildcats completed in North Central Texas in 1942 opened new pools or extended old ones. Bend discoveries were made in the Wasson, Forestburg, Sanders, Joy, Hoefle, Spring, Worsham-Steed, East Bryson, Eanes, McKnight, Park Springs, Kisinger, Garvey, Daws, and Hobart pools, while Mississippian pays were opened at Joy, Alma, Mathews, Padgitt, Ragland, and Knox, with the wells averaging about 1000 brl./day initially. Several Ordovician tests were drilled at various points in the basin, production being found in the Ellenburger and Simpson. During 1942 fifty-nine wells proving 2400 acres in the Ellenburger have been drilled at K.M.A. The presence of the Viola has been proved in North Central Texas, but the formation has not yet been shown to be as productive as in Kansas and Oklahoma.

Strawn production has been obtained in many fields which yield oil from the Caddo and the Marble Falls. The chief Strawn developments were at Joy, Illinois Bend, Mount View, Ketchum, Talbot, and Watson.

During 1942 the principal additions to reserves were made at Watson, Forestburg, Padgitt, Joy, K.M.A., Strawn, Ellenburger, New York City, Ringgold, and Ross, but the numerous small additions made in other fields make up an important total.

Tables give by fields the cumulative production and estimated reserves by fields on 1st January, 1943, and the numbers of completions of various types.

G. D. H.

414. Wimberly Expansion Leads in West Central District. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 139.—The extent of the Wimberly field has now been fairly well determined, twenty-nine new oil wells having been completed. Oil is obtained from the lower Tannehill sand, Flippin lime, lower Hope lime, possibly from the Bluff Creek lime, from the Brookover lime and the Gunsight lime. Acid treatment of a Hope lime well raised its production from 20 brl./day to 500 brl./day.

The Coker field, a 1942 discovery, produces from the Strawn series at a depth of about 3000 ft. The structure is believed to be small, and the pool's limits have been defined in the south and west. The Reddin pool was opened with production from the lower Hope lime of the Cisco series at a depth of 2250 ft.

Nine other less important fields were found during 1942.

The cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, together with a summary of the completions. G. D. H.

415. Texas Gulf Coast : Mercy Field Developments Most Important on Gulf Coast. T. F. Smiley, *Oil Gas J.*, 28.1.43, **41** (38), 142.—The Mercy Wilcox sand field came in in 1942 at 8273–8279 ft. for 583 brl./day. Mercy is believed to embrace a greater area of Wilcox sand than any other field on the Gulf Coast except Joe's Lake.

The North Bay City field was opened at 7870–7873 ft. with a flow of 309 brl./day. Three miles south-east of Orange Hill a well was completed at 9052–9067 ft. for 105 brl. of oil and 8,750,000 cu. ft. of gas/day. The Mayo field discovery well was brought in at 5408–5414 ft. for 115 brl./day, and this field now has 23 wells, 21 being oil wells and one a gas well.

The Harmon field of Jackson County was opened in May at a depth of 5356–5374 ft., and nine producers have been completed.

Tabulated summaries are given of the wildcats completed in 1942, and of the other completions, while the production in 1942, the cumulative production and the estimated reserves on 1st January, 1943, are also listed. G. D. H.

416. Kansas Wildcat Completions Increase 64 per cent. over 1941. C. Hoot. *Oil Gas J.*, 28.1.43, **41** (38), 147.—During 1942, 351 wildcats were completed compared with 214 in 1941, and of these thirty-four were oil wells and three gas wells. The 1519 field completions of 1942 were 28% below the 1941 figure. During 1942 production rose from 265,000 brl./day to over 310,000 brl./day, an all-time high.

The Peace Creek Viola lime pool was the outstanding Kansas development of 1942. It was discovered in 1941 and developed rapidly in 1942 to give over 280,000 brl./month from 100 wells. This stratigraphic trap pool is now nearly nine miles long, and has been defined only on the south and south-east margins.

There were important developments on the Barton Arch during 1942, a number of wildcats having located oil, generally near existing pools. The Kraft–Prusa area has spread to include a number of adjoining fields and is approaching the Breford–Bloomer area. Trapp has taken in Susank and North Ainsworth. The trend running from Burnett and Bemis–Shutts to Bloomer–Wilkins and Stoltenberg may eventually merge into a continuous producing area.

The Lindsborg pool has expanded rapidly, and now produces from the Simpson and Viola. A show of oil has been reported in the Mississippian chat at a depth of 2379–2383 ft. in south-east Saline County, where there have been many dry holes.

The 1942 production and the cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, and there are summaries of the types of well completions. G. D. H.

417. South-west Texas: Subnormal Exploration Yields Few Discoveries. T. F. Smiley. *Oil Gas J.*, 28.1.43, **41** (38), 149.—Twenty-three oil wells and three gas wells were completed in South-west Texas in 1942 out of 319 wildcats, and the small number and general unimportant character of the strikes may cause an increased use of geophysics in this area. South Caesar was an exception as regards importance. Its first production came from the Carrizo at 6552–6557 ft., and this was followed by an extension and a new sand discovery at 6611–6655 ft. Both sands are over 50 ft. thick. Twelve producers and three dry holes have been completed.

During 1942 there were 1026 completions, against 1841 in 1941. The greatest decline in drilling was in the south-central area, which also had seventy-four failures out of ninety-five completions. About a third of the lower Gulf Coast area completion wells were dry in 1942.

The discovery well of the Sarco gas-field gave 180,000,000 cu. ft. of gas on open flow together with 50 brl. of distillate per day.

The Nordheim and Yorktown discoveries in De Witt County did not start a drilling campaign in that region. The first well of a gas-field in Victoria County gave 162,000,000 cu. ft. of gas/day through open tubing. 2 ml. west of the South Sun field distillate and gas have been found in a drill-stem test at 8542 ft.

The cumulative production, 1942 production and the estimated reserves on 1st January, 1943, are listed by fields, together with a summary of the completions.

G. D. H.

418. Forest City Basin. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 153.—During the past four years about eighty dry holes have been drilled in the Forest City Basin, but in December 1942 the first deep production was found in the Bartlesville in the centre of Atchison County, Missouri. The well was 1440 ft. deep. During 1942 nineteen dry holes were drilled in Missouri. No important addition was made to the Polo gas-field in Caldwell County. Richardson County, Nebraska, the principal producing area of the Basin, had fifteen new oil wells and nine dry holes, compared with forty-five oil wells and twenty-three dry holes in 1941. Five wells were added to the Dawson pool, three of them finding oil in the Viola. Nine wells were drilled in the Barada pool, which is north of Falls City. G. D. H.

419. Michigan: Exploration Extending North of Present Production. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 156.—Although more oil discoveries were made in Michigan in 1942 than in 1941, most of the new pools were small in reserves. The production record for 1942 was better than for any other year except 1939. The total reserves added in 1942 were about 10,690,000 brl., only half of the 1942 production.

The Evart field was the best 1942 discovery, and it has already provided 169,000 brl. of oil. The Fork field is believed to have good prospects.

One of the most significant exploratory trends in 1942 was the work in the northern part of the State. Three oil areas were opened in Missaukee County, where there had not previously been commercial production. Other fields were developed in northern Roscommon County and in western Lake County. In 1943 there will probably be prospecting still farther north.

The chief feature of 1942 was the opening of commercial production in the deeper horizons of some of Michigan's oil-fields. Five deep areas (Richfield, Headquarters, Norwich, Adams, and Winterfield) are producing, and two others (Enterprise and Foster) have good prospects. Wildcatting to the Traverse failed to give a single major discovery. Richfield and Foster have no upper Traverse or Dundee production.

Tables list by fields the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, and there is a summary of the 1942 well completions.
G. D. H.

420. Eastern Texas : Wood County Paluxy Sand Discoveries Start Big Play. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 158.—Interest in East Texas was revived in 1942 by the Paluxy discoveries at Coke and Quitman in Wood Country. Coke was opened by a well at 6262–6350 ft., which flowed 920 brl./day initially, and now the pool has twenty-five oil wells. The Quitman field discovery well came in at 726 brl./day. In the Larissa pool the discovery well in the Pettit lime yielded 37 brl. of oil and 65,000 cu. ft. of gas/day from 10,160 to 10,212 ft. Eight wells have been drilled in the Kildare pool, which produces from the Glen Rose at a depth of 5992 ft. The pay section is about 200 ft. thick. The Weiland field has been defined almost completely. Its discovery well came in at 266 brl./day from 2761 to 2773 ft.

About 270 wells were abandoned in the East Texas field in 1942, and only six were drilled. Lack of transport held back the production in the early part of 1942. Salt water injection increased during the year.

In 1943 it is likely that interest will centre on Wood County and on pre-Woodbine zones.

Tables give the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, as well as the types of completions during 1942.

421. Louisiana Gulf Coast : Gas-Distillate Fields Lead in Importance in Quiet Years. T. F. Smiley. *Oil Gas J.*, 28.1.43, **41** (38), 161.—Thirty-six out of the forty-eight wildcats drilled in the Louisiana Gulf Coast area in 1942 failed, and there were ten oil wells and two gas wells. Only 434 wells were completed—about half of the 1941 total.

A wildcat in Acadia Parish blew out of control in October, and in December it was blowing 523 brl. of distillate and 49,220,000 cu. ft. of gas/day from a total depth of 10,447 ft. A relief well is being drilled. Three miles south-west of Krotz Springs a new gas and distillate pool was opened at a depth of 9316–9326 ft. in December.

The construction of a recycling plant has been begun in the Erath field, Vermilion Parish. Nineteen wells have been completed in the Bayou Sale field, which was opened in 1941. Development has extended southward, and it may join the Bateman Lake field. Gas-distillate production was opened in the extreme south of the field in a new sand at 10,703 ft., and this may be the same sand which produces in the Bateman Lake field.

A new shallow upper Miocene sand has been opened in the Whitelake area of Vermilion Parish, and a new sand at 9567–9572 ft. has given production in the University field. The Bay De Chene discovery well came in 7470–7500 ft.

Tables show by fields the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, together with a summary of the 1942 well completions.
G. D. H.

422. North Louisiana, Arkansas : Large Discoveries Made in Pettit and Smackover Pays. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 164.—Development has shifted north from the Wilcox trend, which was dominant in 1941, to the deeper Pettit and Smackover limes. The 446 completions of 1942 were 44% below the 1941 figure. 60% of them were oil wells.

121 wells were drilled at Haynesville in 1942, and the field was extended into Arkansas. The Midway pool was the most active pool in Arkansas, but it had little drilling at the end of the year. This pool has been defined by dry holes on all sides except the east.

A wildcat in Pope County, North Arkansas, flowed at 26,000.000 cu. ft. of gas/day from sands at 2475–2512 ft. and 2802–2817 ft. A new field, 15 ml. from the nearest production, has been opened in Catahoula Parish, Louisiana. Oil is obtained from the Sparta at a depth of 1810 ft. A good Pettit lime pay was discovered north of the old Carterville pool. The discovery well flowed 400 brl./day from 6029–6122 ft. The Gary field in Sharky County came in at 2400 brl./day from 3263–3265 ft.

The 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, together with a summary of the 1942 well completions.

G. D. H.

423. Rocky Mountain Area : Tensleep Production at Elk Basin Is Most Important Discovery of Year. T. R. Ingram. *Oil Gas J.*, 28.1.43, **41** (38), 167.—362 wells were completed in Colorado, Wyoming, and Montana in 1942, 115 fewer than in 1941. 226 found oil and seventy-six found gas. Eleven discoveries were made from twenty-four important wildcats, four being deeper horizons and three gas finds. All of the seven Colorado wildcats were dry, and Montana had two oil and two gas finds out of six wildcats.

In the southern part of the Elk Basin field, Wyoming, deep production was found in the Tensleep. This excellent structure has given 11,000,000 brl. of light oil from shallow pays, and the Tensleep discovery may place it among the State's largest black oil-fields.

A 580-brl. well was completed in the Dakota at Horse Creek, but later it showed water. This well is on the north-west rim of the Denver Basin, and it may lead to wildcatting in North-east Colorado. A deep Tensleep pay was opened in the Pilot Butte field, and later an Embar discovery was made.

A small Wasatch well was completed in the North Hiawatha field.

The most important discovery in Montana was a Madison lime producer on the Twin Rivers structure north-west of Cutbank. This made only 85 brl./day, but it opens up an area with favourable prospects.

Tables give the 1942 production, and the cumulative production and reserves on 1st January, 1943, by fields, together with a summary of the 1942 completions.

G. D. H.

424. Canadian Production at Peak. V. Lauriston. *Oil Gas J.*, 28.1.43, **41** (38), 169.—Canada produced 10,359,267 brl. of oil in 1942. This is a record.

Turner Valley has been extended ½ ml. to the north. It has more than ninety undrilled well locations in proven territory, with good prospects of an extension of the productive area. Ten additional producers have been completed at Vermilion, which gave 66,720 brl. of oil in 1942.

A well at Taber came in at 330 brl./day from a depth of 3181 ft. An 80-brl. well has been brought in at 3180 ft. at Tilley.

The plant for recovering oil from the Athabaska tar sands has now been reconstructed.

Considerable new drilling is understood to have been done at Fort Norman, and 35,000 brl. of oil were obtained in 1942, against 14,119 brl. in 1941. The construction of a pipe-line from Fort Norman to Whitehorse in the Yukon Territory has been considered.

Tables show the oil production by fields in 1941 and 1942, the number of wells producing in January and in December 1942, as well as a summary of the types of completions in 1942.

G. D. H.

425. New Indiana Pools Small in Extent. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 169.—No important new oil-field was discovered by widespread wildcatting in Indiana in 1942, although twelve new fields and pay zones were opened, all of them in the south-west of the State. Devonian lime production was found in the Shelburn field, where five wells came in for 150–200 brl./day each initially. In all other instances the results have been disappointing, only single-well pools resulting in most cases.

Much of the 1942 development was in the Hazleton, Griffin, and Caborn fields. Interest in Trenton and sub-Trenton production in North-east Indiana increased throughout the year, and many deep tests were under way at the year end. Two miles east of the old Trenton gas-field two tests have found Trenton lime production. The wells are 1 ml. apart, and gave 120 brl./day. In Adams County a deep test showed oil in the Jordan sand at 2261 ft. The Jordan sand lies well below the St. Peter.

Most of the proven acreage in the older fields has been developed and there are no prospects of increasing reserves in sight. Exploration in the near future will be mainly in the south-west and north-east.

G. D. H.

426. Gas Discoveries Take Lead in Ohio. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 170.—Most of the new pools and extensions in Ohio in 1942 were gas discoveries. The Clayton oil-field was extended ½ ml. north by a 55-brl. producer, and westward by three 100-brl. wells. It may possibly join the old East Somerset field 2 ml. to the west. The small Thron pool has been extended ¼ ml. to the south-east. There is a possibility of a southward extension of the Hinckley gas-field. The Gaysport gas pool and the Clinton oil-pool were extended during 1942. A new Oriskany sand gas-field was opened in Guernsey County, but it is not expected to be large. No commercial production was found in sub-Trenton tests. G. D. H.

427. The Nation's Major Fields. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 171.—Over half of the U.S. oil output in 1942 came from fields giving more than 10,000 brl./day. Many of the production declines of the major fields reflect market and transport conditions, and this is particularly noticeable in West Texas. Of the thirty-seven fields listed as having recoverable reserves of more than 100,000,000 brl. of oil, only Hawkins is a recent discovery, and these fields possess more than half of the nation's recoverable reserve.

California, Texas, and New Mexico are dependent on major fields, but Louisiana and Kansas get the bulk of their oil from medium-sized fields. Texas and New Mexico are the only States with more than half of their original reserves still underground.

Tables give the production of the seventy-five major fields in 1941 and 1942, the age, estimated ultimate, and remaining reserves. G. D. H.

428. December Completions Show Gain Over Previous Months. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 205.—1454 wells were completed in U.S.A. in December 1942, 101 more than in November. The Mid-Continent area led in the increased activity, Oklahoma, and Kansas having seventy-eight additional completions, with thirty-two more oil wells. 494 dry holes were completed during December, an increase of fifty-eight over November. California had thirty dry holes. Illinois suffered a decline of thirty-three completions.

A table summarizes the operations in December 1942 by States, showing the total completions, numbers of oil, gas and dry wells, the footage, and the numbers of wells in various depth ranges. G. D. H.

429. Study Reveals Imperative Need for Increasing Nation's Oil Reserves. H. J. Struth. *Petrol. Engr*, January 1943, **14** (4), 31.—In 1942 the U.S. crude oil production was only about 1% below the 1941 figure; the refinery runs were about 5% lower than in 1941. In 1943 it is expected that 1,475,000,000 brl. of crude will be required compared with the 1,385,000,000 brl. produced in 1942. The indications are that not only is the new oil discovery rate insufficient to offset the heavy withdrawals from underground reserves, but the available supplies are being used 22% faster than under the efficient rate of utilization realized in peace-time.

The known U.S. oil reserves have fallen by more than 3,000,000,000 brl. since 1938, and the reserve additions in 1942 were only 55% of that year's production. While the number of wildcats drilled in 1942 was almost the same as in 1941, the number of dry holes was 30·6% of the total, against 22·2% in 1941. The total number of wells was 48% below the 1941 figure. The oil demand is now three and a half times the demand during the last war, when 118,000 brl. of oil were found per dry hole drilled, whereas the corresponding figure for 1941 was 60,000 brl., and for 1942 49,000 brl.

Crude oil prices were practically stationary during 1942, when production fell in Texas, Louisiana, Oklahoma, Illinois, and New Mexico, while it rose in Kansas, California, Arkansas, and the Eastern States. Illinois had a 61% decline in completions and Oklahoma a 57% decline. Texas provided 35% of the nation's 3100 wildcats, and these formed 22% of that State's completions. Illinois had 18% of the nation's wildcats, which constituted 30% of that State's 1942 completions. Only 125 wildcats were drilled in California last year, whereas there should have been twice that number had materials been available. Throughout the nation there were 442 successful wildcats which added 750,000,000 brl. of new reserves.

While the demand for gasoline fell by 67,875,000 brl. in 1942, the fuel oil demand rose by 53,963,000 brl.

In 1938 the discoveries reached a peak of 1,650,000,000 brl., giving total reserves of 21,813,000,000 brl. at the beginning of 1939, but the reserve was only 18,586,000,000 brl. at the beginning of 1943, for the average annual discoveries since 1938 have been only about 500,000,000 brl. Since 1935 the ratio of discoveries to production has declined steadily. The number of dry holes drilled per 1,000,000 brl. of new oil discovered has increased nearly nine-fold since 1935, and the reserves in terms of years' supply have fallen from 19·1 years in 1935 to 12·6 in 1943. In 1935 the average cost per exploratory well was about $31,000 and the cost per barrel of new oil was 13·3 cents, while it took 4·3 exploratory wells to find 1,000,000 brl. of new oil. In 1937 the cost was 6·3 cents/brl. of new oil, but in 1942 the cost/brl. of new oil was 37·6 cents and the average cost per exploratory well was $47,000, eight exploratory wells being required to find 1,000,000 brl. of new oil.

There are eight diagrams and eleven tables giving statistics. G. D. H.

430. Wildcat Drilling in California. W. A. Sawdon. *Petrol. Engr*, January 1943, **14** (4), 100.—Last year a few small fields were discovered in California, and extensions were made to some old fields. Production increased and drilling decreased. Many shallow wells were drilled in proved areas to increase the supply of heavy oil. The light-oil production is not yet at its maximum effective recovery rate, and careful gas conservation is being practised in the light-oil production. Depleted oil-fields are being used to store excess summer-gas production for use in the winter.

During the period 1939–1942 the discovery of new fields and the extensions to proved areas were not enough to maintain the known reserve. The number of exploratory wells declined in this period, and was restricted last year by material shortages as well as by economic factors.

The Riverdale field, discovered at the end of 1941, came in at 6665–6685 ft. for 558 brl./day of 34° A.P.I. crude, with 1,375,000 cu. ft. of gas. Lower zones tested wet. The Williams field gave 1725 brl./day of 16·5° A.P.I. oil from 2340 ft. in the discovery well which later went over to water. The Williams field is a sharp anticline with a productive area of less than 1000 acres. The deeper zones, such as the Wagon Wheel and the Eocene, have not yet been tested.

The Anaheim–Buena Park area discovery well came in at 9660 ft. Two wells have been completed, but one is giving much water. The Paloma field has been extended 1 ml. to the north by a well which gives 34·4° A.P.I. oil instead of 50–55° A.P.I. oil as in the high gas–oil ratio area. The new well was drilled to 11,043 ft. The Aliso Canyon field has been extended to the west by a 9086-ft. well, of which the initial production was estimated to be 2393 brl. of oil/day with more than 1,000,000 cu. ft. of gas. The oil is from the upper Lusian rock with closure against a fault.

A new field may have been found east of the Strand field. The discovery well was drilled to 8207 ft., and initially gave 1553 brl./day of oil and 1,250,000 cu. ft. of gas. Very heavy oil was found on the Rancho Corral de Quatti, north of Los Olivos, and this oil has to be thinned with distillate to permit pumping it to the surface. The structure is anticlinal with the oil in fractured siliceous shales (Miocene).

The Bowerbank field discovery well produced 11,000,000 cu. ft. of gas/day from 4253–4262 ft. G. D. H.

431. Future Development of North-west Wilmington Field. W. R. Cabeen and A. L. Hunter. *Oil Gas J.*, 4.2.43, **41** (39), 60.—Marked changes in stratigraphy in going from the Wilmington field north-west towards Torrance, coupled with complicated faulting and flattening of the structure, influence the amount of vertical and horizontal oil saturation in the North-west Wilmington field. Therefore the possible recovery from each part of the area must be estimated separately. Block A, the most north-westerly fault block, has 136 ft. of producing sand in the Ranger and Terminal zones, each of which has an average porosity of 15% and an average saturation of 75%. Block B, the next fault block to the south-east, has 467 ft. of producing sand in all, with similar porosities and saturations to Block A. Block C, still farther to the south-east, has 90 ft. of producing sand in the main Tar zone, which has an average porosity of 30% and a saturation of 85%. The Terminal and Ranger zones have similar properties to those of Blocks A and B. The Ranger and Terminal oils have gravities of 16° and 18–20°, respectively.

In North-west Wilmington the recoveries range 250–400 brl./acre-ft., depending on the local sand conditions and the relation to other wells. The recoveries per acre range 25,000–75,000 brl. These figures are based on a five-acre spacing, which seems to be best from an engineering and economic standpoint. The present ten-acre spacing may not drain the field adequately. On a ten-acre spacing the maximum that the field could yield in its first flush production year would be under 2,000,000 brl., assuming that there are 650 undrilled productive acres to be developed. The actual figure is likely to be well below this because of time and supply difficulties.

G. D. H.

432. Possibilities of the Cotton Valley Formation in Arkansas. C. H. Thigpen. *Oil Gas J.*, 4.2.43, **41** (39), 62.—The Cotton Valley series and the Smackover lime have been the two main objectives in most of the Arkansas wildcats since 1936, for the overlying formations have been thoroughly tested and their possibilities fairly well exhausted. The Cotton Valley formation includes dark shales, limestones, and sandstones at Cotton Valley, but is a red series at Schuler. Its northern edge runs through the middle of Hempstead, Nevada, Ouachita, Calhoun, and Bradley Counties, and it attains a thickness of 2400 ft. at the Arkansas–Louisiana State line.

The first Cotton Valley production in Arkansas was obtained in April 1937 in the Schuler field at 5500–6000 ft. The producing sand (Morgan) was lenticular. In September 1937 production was found at the base of the Cotton Valley in the Jones sand. The original reserve was estimated at 56,000,000 brl., and 146 wells have been drilled.

At the beginning of October 1942 the Arkansas Cotton Valley pools were giving about 19% of the State's production. Cotton Valley wells have been completed at Dorcheat and Macedonia, but these are closed in at present. Generally the producing horizons in the Cotton Valley formation are lenticular and irregular. Frequently the lenses do not cover the whole pool. At Schuler the producing zones are at 5500 ft., 6900 ft., and 7500 ft. Several oil and gas-distillate zones are indicated at Dorcheat and Macedonia down to a depth of 8000 ft.

The original reservoir pressures were approximately normal for depth, but as the sands are lenticular the flowing life of most Cotton Valley pools will be short, due to the lack of effective water-drive. Up to the beginning of 1943, 181 Cotton Valley wells had given 29,000,000 brl. of oil, 25,500,000 brl. being from the Jones sand of the Schuler field. Sand porosities range 15–25% and permeabilities range 200–2000 millidarcys.

Two cross-sections, a stratum contour map, and a table giving data about the Cotton Valley pools are included. G. D. H.

433. Analysis of P.A.W. Estimates Confirms Previous Conclusions. W. V. Howard. *Oil Gas J.*, 11.2.43, **41** (40), 26.—The P.A.W. estimates of reserves discovered in 1942 amount to 144,697,980 brl. in the drilled parts of new fields, and in undrilled parts there may be a further 172,411,332 brl. of reserves. The possible maximum is 516,744,349 brl. New pay horizons found in 1942 may give reserves of 104,018,740 brl., with a possible maximum of 284,114,280 brl. Thus the maximum possible estimate of reserves from 1942 discoveries and new pays is only about 60% of the output for the year.

The reserves of fields found during the period 1935–1940 inclusive amounted to 160–300% of the estimates made at the end of the year in which they were discovered. Hence the P.A.W. estimated maximum possible reserve for 1942 discoveries is in line with experience during recent years.

P.A.W. gives 261 new fields and seventy-four new pays for 1942.

Regardless of the number of commercial or near commercial discoveries made in 1942, it now appears that only five can be considered as important fields. These are Square Lake, New Mexico; Pauls Valley, Oklahoma; Midway, Arkansas, and Coke and Quitman, East Texas. G. D. H.

434. Possibilities of Smackover Limestone in Arkansas. C. H. Thigpen. *Oil Gas J.*, 11.2.43, **41** (40), 85.—At Smackover the Smackover formation consists of 700 ft. of dense to oolitic limestone. In the south of Arkansas the upper part of the formation is oolitic to chalky, and the lower part dense with argillaceous bands. The Smackover dips south-west at about 85 ft./ml. Its thickness ranges 450–900 ft. in Arkansas, and at Rodessa it is 1230 ft.

The first Smackover lime production was obtained in April 1936. Numerous Smackover lime structures have been located by seismograph, and Smackover lime-pools were opened at Schuler and Buckner in 1937; Magnolia, Village, and Atlanta in 1938; Dorcheat and Big Creek in 1939; McKamie in 1940; Macedonia and Mount Holly in 1941; and Midway, Texarkana, and Columbia in 1942.

At the beginning of 1943 Arkansas' Smackover lime pools were producing about 48% of the State's total output, and some 70% of the prorated output. Thus the Smackover is Arkansas' most prolific producing horizon.

The Smackover lime pools in Arkansas are generally symmetrical anticlines, elongated east–west. The fields are 1–1½ ml. wide, and the largest, Magnolia, covers 4500 acres. Nine of the fields give 32–45° A.P.I. gravity oil, while six produce gas-distillate of 52–70° A.P.I. gravity. Usually the gas has a high H_2S content, and is very corrosive. The production control allows effective water-drive. The gas/oil ratios are about 300 cu. ft./brl. in under-saturated pools, 750–1250 cu. ft./brl. in saturated pools, and 10,000–30,000 cu. ft./brl. in gas-distillate pools. The reservoir porosities range 14–20%, and the permeabilities 50–1500 millidarcys.

Only three of the twenty-nine Smackover wildcats drilled in 1942 were successful, and gave the Columbia, Midway, and Texarkana fields. New London was the only Cotton Valley find, apart from dual completions and reworking at Macedonia, Dorcheat, and McKamie.

Tables give the Smackover fields with discovery date, depth, number of wells, oil gravity, and cumulative production; the thickness of the Smackover limestone at various points and the thickness of the two constituent members; the porosity, permeability, and oil and gas reserves. A map shows the structure of the top of the Smackover limestone. G. D. H.

435.* Compaction and Some Oilfield Features. G. D. Hobson. *J. Inst. Petrol.*, February 1943, **29** (230), 37–54.—Compaction of sedimentary rocks is studied analytically in the light of Ortenblad's equations, which are used to deduce the following inferences: (1) For sediments of identical grain size, but for different rates of sedimentation, those being laid down most slowly will be most compact. (2) After sedimentation ceases the hydrodynamic pressure at a given point—*i.e.*, the pressure component driving liquid from the sediment—and also the porosity at that point decrease with time, comparatively rapidly at first, and then more and more slowly. As the hydrodynamic pressure decreases the intergranular pressure increases correspondingly. (3) At a given reduced depth the porosity in a thick deposit will be greater than at the same depth in a thinner deposit, until compaction ceases. The paper discusses the following variables: porosity, permeability, reservoir pressure, fluid movements, the time of oil formation as compared with the time of sedimentation and compaction, and finally closure as developed by compaction over buried hills. The paper is well illustrated and is detailed in treatment. A. H. N.

Geophysics.

436. Radioactivity and Geochemical Well Logging. L. C. Uren. *Petrol. Engr*, January 1943, **14** (4), 50.—Measurements of the radioactive emanations from the strata exposed in a well permit the distinguishing of shales, sands, limestones, salt, anhydrite, etc. These measurements are recorded at the surface while the instrument which detects the emanations is in the well. The recorded intensities give patterns which may permit correlation between wells. This type of logging can be carried out even when the formations have been cased off.

Adsorption phenomena and the compaction of sediments under water may be responsible for the fact that shales usually exhibit greater radioactivity than sands and sandstones.

The detecting instrument consists of an ionization chamber suspended on an electric cable. The chamber contains a gas of high molecular weight, and above it is an amplifier. Current flows in the circuit only when the ionization chamber is influenced by radioactive emanations, and the current is proportional to the emanation intensity. In making the log the instrument is drawn upwards from the bottom of the well.

The recorded variations in the lateral position of the radioactivity profile are only relative, and lack quantitative significance. Low radioactivity is shown by sand, sandstone, or limestone, while clay and shale give a high intensity. The logs do not indicate the porosity and permeability of the rocks or the nature of the fluids the rocks contain, although the indication of clay or shale naturally implies low permeability. Thin clay streaks can easily be detected, and unconformities and faults may be shown. The position of the bottom of the casing or of the cement plug is clearly shown. Open hole logs give rather better differentiation and more detail than logs from cased holes. The presence of fluid in the well does not affect the logs. Possible oil-sands can be detected behind casing, and this feature is useful for wells drilled before electrical logging was introduced. Well logs may be checked.

In neutron logging the formations are bombarded with neutrons generated from radioactive material in the surveying instrument, and the intensity of the gamma rays so produced is measured by an ionization chamber above the part of the instrument carrying the radioactive material. The method may be able to show the porosity and the fluid content of the rocks, for hydrogen nuclei have a special action on the neutrons.

Delicate methods of chemical analysis allow the presence of minute amounts of hydrocarbons, hydrogen, etc., in rock samples to be determined quantitatively, and on plotting the values so obtained against a depth scale, a geochemical well log results. Often the patterns are characteristic, and they may indicate the presence of oil or gas accumulations in underlying or nearby beds. Thus the probable success or failure of a well can often be predicted before it is completed.

Within geological time slow migration of hydrocarbons has occurred through the beds overlying oil deposits. Thus even surface soil may show minute amounts of hydrocarbons. Systematic soil analyses may show a "halo" of hydrocarbons around an oil deposit. In geochemical well logging the sampling intervals depend on the detail required, but are commonly about 30 ft. Cores or drill cuttings may be used. A complete analysis gives hydrogen, total hydrocarbons, methane, methane–butane, pentane–decane, carbonate, sulphate, halides, and acid-soluble sand. The source of the hydrogen is uncertain. The methane may not be from an oil accumulation. The hydrogen maximum on the logs generally occurs above the oil, commonly several hundred to 1000 ft. above, and then the amount of hydrogen diminishes rapidly nearer the oil. The total hydrocarbons increase with depth, and show a rapid rise as the oil is approached. When oil is present the pentane–decane content is high; when gas alone is present the content of methane–butane is high. The advance indications of the presence or absence of oil or gas facilitate completion planning, and prevent premature abandonment. Dry holes generally give low hydrocarbon values. If the well is off-structure the hydrocarbon values show a maximum and then decrease at greater depths. G. D. H.

437.* The S.P. Dipmeter. H. G. Doll. *Petrol. Tech.*, January 1943, 6 (1), A.I.M.M.E. Tech. Pub. No. 1547, 1–10.—The S.P. dipmeter consists of three electrodes set 120° apart in a horizontal plane when the instrument is vertical, and connected through separate insulated conductors to potential measuring devices at the surface, with the circuit closed through the earth and a ground electrode. Above the electrodes, and always in the same relative position, is the photoclinometer, consisting of a compass needle and a ball free to set in its equilibrium position on a graduated glass of known curvature. A camera is so situated that it photographs the needle, ball, and a marker showing the position of one of the electrodes.

When a formation is not bedded in planes at right angles to the axis of the borehole, the three S.P. curves obtained simultaneously will be substantially alike in form, but not alike as regards the depths of particular features. These depth discrepancies correspond to, and are a measure of the dip of the boundary plane separating two beds, and coupled with the orientation of the electrodes and the inclination of the well as shown by the photoclinometer, provide data whereby the dip and the strike of the beds can be calculated or determined on a special instrument.

Normally the dipmeter-photoclinometer is lowered in the hole to 10–15 ft. below the desired section, the S.P. curves being observed all the way down, to make sure of the movement of the instrument. The latter is then pulled up to about 3 ft. below the section, stopped, and after allowing the instrument to settle, a picture is taken by the photoclinometer. When this has been done, the section is surveyed by the three dipmeter electrodes. At the upper end of the section a second photoclinometer picture is taken to find whether the instrument has rotated while being pulled upwards. A series of observations of this type can be taken in a single run.

An example of an actual measurement is given in detail.

Dip measurements can be made in the above manner cheaply, easily, and quickly. Good results are obtained with dips over 10°, and fair results with dips between 5° and 10°. The measurements are valuable in permitting the detailing of structures, and are very useful in the investigation of salt dome structures. G. D. H.

438.* Use of Neutron Curves. A. B. Winter. *Oil Wkly*, 25.1.43, **108** (8), 20.—The neutron type of radioactivity well logging measures the effect of the bombardment of the formations by neutrons from a strong source. Neutron logging seems to be of value as a companion curve to the gamma-ray logging, and used alone to solve certain subsurface problems regarding the formations behind casing. The effect of the neutron bombardment is measured in an ionization chamber situated above the neutron source. The source of neutrons in the logging instrument is a mixture of radium and beryllium, and most of the neutrons are fast and penetrating. The neutrons are able to pass through many inches of iron without much loss, and they are slowed down mainly by the hydrogen present in the rocks.

The logging device is connected by cable to recording apparatus at the surface, and the average surveying speed is 1000 ft./hour. Satisfactory logs can be made with or without fluid in the hole, but the position of the liquid level relative to the zone of interest should be known accurately, for the presence or absence of liquid in the hole shifts the curve as a whole. Dense limestones or hard sandstones give high intensity values on the curve. Oil or water in the pores shows the occurrence of porous zones in limestones or in clean sandstones by giving low intensities. Shales also give low intensities generally, due usually to the greater amount of hydrogen in the shale, either as connate or chemically combined water. Consideration of gamma-ray and neutron logs together permits shales to be detected by their high gamma-ray intensities and low neutron log intensities. The position of the casing seat is usually shown clearly on neutron logs.

A neutron and a gamma-ray log are given, together with the corresponding well log. G. D. H.

Drilling.

439.* Making the Most of Drilling Materials. J. S. Montgomery. *Oil Wkly*, 7.12.42, **108** (1), 14–16. *Paper Presented before American Association of Oilwell Drilling Contractors.*—The paper describes, in a general manner, precautions to be taken with drilling equipment and methods of maintaining them for longest use under efficient conditions. The life of drill-pipe varies with areas in which it is used, as some areas encounter formations which develop a very corrosive fluid, and the drill-pipe deteriorates before the tool-joints are worn out. Other wells encounter abrasive formations in which the tool-joints are worn and the drill-pipe is in good condition. There are services companies making satisfactory internal inspection of drill-pipe to advise when joints of pipe should be laid down or the entire string laid down. Experience indicates that this service has been satisfactory. Where pipe is worn out from corrosion, tool-joints should be salvaged and used on other pipe. It would appear that a programme would be most applicable whereby tool-joints in corrosive areas would be transferred to pipe used in abrasive areas, thus reducing the requirement of purchasing new tool-joints. It is, of course, appreciated that some types of tool-joints are not salvageable. The outside wear of tool-joints has given a great deal of concern to rotary operators, and reports are made of the building up of tool-joints by welding on a hardening material. However, it seems that the most practical method to-day is to apply a sleeve to the tool-joint. Where tool-joint threads are worn and the body of the joints is still in good condition, it is very practical to turn new threads. Uneven wear on tool-joints may be attributed to crooked drill-pipe. Above all other things, an operator should be very careful in seeing that his drill-pipe is straight at all times, or he may expect undue wear which will be first noticeable by uneven wear on the pipe and the tool-joints.

There has been some experience in building up and in re-sleeving drill-collars. However, this experience so far leaves some question as to its success. Where bits have not been badly worn, and their bearings are in good condition, there is every reason to have them re-tipped, as they have proved satisfactory in most operations. The greatest care that can be exercised on the kelly joint is to see that it is straight at all times and properly handled in moving from one location to another. A. H. N.

440.* Improved Casing Recovery Method Reduces Cost. W. L. Baker. *Oil Wkly*, 21.12.42, **108** (3), 16.—The method consists of making a series of cuts at pre-determined intervals with one trip into the well, then going in with a washover string and recovering each section of cut casing without withdrawing the string from the hole. When the recovered casing is being removed, the washover pipe is suspended from slips, and the casing is withdrawn through it. This method of recovering casing from dry holes has the following advantages over methods formerly used : (1) Rig time spent in breaking down and picking up the wash pipe is very greatly reduced. (2) Rig time is further reduced by making all the cuts before washing operations are started. (3) The rental on wash-pipe and special tools is reduced through decreased rig time. (4) There is less expense of conditioning mud due to the smaller number of trips into the hole and the shorter time required for the entire operation. (5) More casing can be recovered at a cost equivalent to or less than the value of the casing.

Examples are given for five wells where the method was used. The procedure recommended may be summarized as follows : (1) Select as large an interval between cuts as is feasible, taking into account the quantity of wash-pipe available and the clearance between the casing collars and the original walls of the hole. An interval up to 1000 ft. for 5½-in. casing and up to 500 ft. for 7-in. casing is suggested. (2) Run a cutting tool and cut the casing a short distance above the theoretical top of the cement. Make additional cuts progressively upward at the predetermined interval. (3) Make up the string of wash-pipe slightly longer than the interval between cuts, run an overshot between the top and the next to top joint. (4) Wash over the casing until the overshot will latch over the top collar. Then pull the pipe up until the overshot is above the rotary table, break the joint between the overshot and the balance of the wash-pipe, and set the wash-pipe on slips. (5) Pull the casing through the wash-pipe, break it out and lay it down, then screw the top of the wash-pipe back on the overshot, and proceed to wash over the next section of casing. A. H. N.

441.* Progress in Drilling. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 142.—The paper is written in English and Spanish, and reviews drilling practices in 1942. One of the principal advances in drilling concepts during the past year was the increasing importance placed on the necessity of drilling the bore-holes to gauge. It has become increasingly evident over the past few years that many of the major troubles of drilling and production operations have been due to this factor. For instance, investigation in one case of a deep well, which was bothered extensively by twistoffs at 2000–2700 ft., showed that washouts of the hole in this interval were allowing the drill-pipe to assume an eccentric and whipping motion. Mud conditioning to prevent erosion and dissolving of the shale in this section eliminated twistoffs.

Troubles with casing failures have on numerous occasions been due to this cause. This is principally due to the fact that when the cement was placed back in the pipe, the presence of a cavity allowed the cement to channel. It has also been found that there was sufficient cavitation of the formations to affect greatly the height of the cement behind the pipe.

Mud problems are reviewed in some detail. The greatest advance in the handling of drilling fluid, and one of major importance as far as drilling in general is concerned, has been the development during the past year of a satisfactory treatment for the reduction of the water loss and filter-cake in salt-water contaminated fluids. The main ingredient required is an organic colloidal material. The material (Impermex) is a special organic colloid which is added to the drilling fluid containing salt. The salts (calcium, magnesium, sodium) in the fluid are a partial preservative, but it is necessary to add other chemicals to prevent growth of organisms which will cause the mud to lose some of its desirable properties. The application of this material and the results to be obtained with it have been known for a number of years, but there were numerous details concerned with its use which were not thoroughly understood. One of these was the souring or fermentation of the drilling fluid. The hydrolyzed starch material would be added, and the desired results obtained. After a few days the water loss would again increase and the drilling fluid would get steadily worse. It was found that bacterial action caused fermentation—something not formerly experienced when using inorganic drilling fluids.

Now that the fermentation can be prevented by addition of recently developed preservative chemicals, it is possible to take a salt-water drilling fluid with a water loss of 150 c.c., treat it with the organic compound, and bring the loss down to 10–12 c.c. It can be brought even lower if desired. From 2–5 lb. of the commercial material barrel of drilling fluid is the amount used. The cost of the material is reasonable in view of the results obtained.

Slim-hole drilling and multiple-zone completion are reviewed. At the end of the paper the interesting method of disintegrating mud cake—which is found to be negatively charged—by applying electricity to it, through the use of casing as an electrode, is briefly discussed. A. H. N.

442.* Electrical Logging to Determine Character of Formations. L. C. Uren. *Petrol. Engr*, December 1942, **14** (3), 46.—The development of electrical logging methods is first given. Resistivity measurements are then discussed. In comparing the electrical properties of rock strata exposed in the wall of a well, a system of electrodes, lowered into the well from the surface on a multi-conductor cable, is employed as a means of establishing a flow of electricity into each stratum, whereas the relative conductivities of different beds are determined by measuring the inverse values of their relative resistivities. The electrode system usually comprises three electrodes suspended at different depths, a few feet apart. One electrode is used as a means of passing direct current through the intervening well fluid into the surrounding strata. The other two electrodes, connected through a potentiometer at the surface, record a certain difference in potential which, considered in relationship to the spacing of the electrodes, the temperature, and the conductivity of the well fluid, indicates the resistivity of the formation immediately surrounding the input electrode.

The electrode system is slowly lowered into the well, and a continuous record showing variation in resistivity as indicated on the potentiometer is automatically recorded on photographic film in the form of a profile on a depth-scale that can be directly compared with a driller's graphic log of the well. Values of resistivity are expressed in ohms/cu. m. of rock mass, and range from as little as one to several thousand ohms, depending on the electrical conductivity of the material. The factors influencing the conductivity are discussed.

When a liquid is forced through a porous solid medium, a difference in potential between two points in the porous solid is observed. Thus, drilling fluid filtering through the porous rock strata exposed in the wall of a well develops an electro-filtration effect that creates an electro-motive force that may be measured by the single-electrode circuit described. Also, an electro-motive force is generated whenever two different electrolytes come into contact in water solution in a porous medium: as when drilling fluid enters a permeable stratum from the well and develops contact with the native fluid in the formation. The electro-motive force developed increases as the interfacial surface of the fluid in contact increases, and inasmuch as this interfacial surface of contact increases with the depth of penetration of the drilling fluid into the formation, it follows that a greater electro-osmosis effect is developed in highly permeable strata than in those less so. Electro-filtration e.m.f. and electro-osmosis e.m.f. both result from migration of drilling fluid into the wall rocks, and, as migration occurs more readily and to a greater degree in highly permeable strata than in those less so, it follows that the observed values of the self-potential generated become a measure of the relative permeabilities of the formations that give rise to them.

The equipment of electrical logging, together with the application and interpretation of this method, are discussed at length.

In discussing the future of the method, Prof. Uren points out that the art of electrical logging is young and many opportunities for its further development and application doubtless still exist. Up to the present time, electrical logs have been used primarily in making relative comparisons of rock properties. The data have been regarded as having only qualitative value. Yet it would seem that the resistivity and self-potential records should have quantitative significance, and that if we had sufficient information, or understood them well enough, we could begin to interpret them in terms of actual sand permeability, porosity, oil or water content. Perhaps, also, they will find new applications, as in determining the depth of penetration of drilling fluids, the effective thickness of clay wall-sheaths, proximity of wells to edge-waters, location of unconformities, gas-oil interfaces in gas-cap areas, etc. A new method of obtaining electrical records while drilling is in progress, by making the logging equipment a part of the regular drilling "string," has been proposed and partly developed. Present methods of electrical logging are applicable only in open hole, but some way of procuring resistivity and self-potential records through casing or outside of casing may yet be developed, using perhaps more complex circuits in which the casing plays a part—such as that employed by the "stratagraph."

Twenty-nine references are appended. A. H. N.

443. Directional Redrilling of Piercement Type Dome to Increase Recovery. J. Zaba. *Oil Gas J.*, 14.1.43, **41** (36), 31–33.—The method of directional drilling of wells for oil is studied. The practical application of the method may be divided into three groups. The first group includes cases in which directional drilling is used as an emergency measure. The best example of this application is directional drilling of a relief well to control a burning or a cratered well. The second group covers application of directional drilling as a development measure. In this group would be included drilling of multiple wells from one surface location, completing of a well under an inaccessible location from a satisfactory surface location, drilling in highly faulted areas, and other similar cases. The third group comprises application of directional drilling for the purpose of securing additional oil recovery from apparently drilled-out properties. In this application directional drilling is used with particular success in the old piercement-type salt-dome fields of the Gulf Coast. Considerable additional recovery is being obtained in this area in fields which were considered as drilled out with normal development methods.

Directional re-drilling of a property appears to violate the generally accepted concept of advantages of wide spacing. It should be remembered, however, that a re-drilling campaign, to be economically successful, can be applied only in special cases, and that piercement-type dome oil-fields constitute just such a special case. The producing area of such fields is usually a narrow rim surrounding the salt mass. Steep dips, faulting, and abrupt lateral changes of the lithological character of the producing formations make the location of the bottom of the well of primary importance. Conditions encountered are illustrated by the case of a well drilled in one of these fields. The problems to be studied are explained. A. H. N.

444.* Effects of Certain Gums and Starches on Filtration of Salt-Water Muds at Elevated Temperatures. F. Perkins and B. C. Craft. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1551, 1–4.—It is important to control filtration or water loss from drilling muds, for this affects the analyses of side-wall cores, the interpretation of electric logs, and the amount of cementing needed. Salt-water and/or high temperatures seriously affect the filtration characteristics by increasing water loss, a trouble which can be reduced by adding starches and gums to the muds. In testing the effects of adding gums and starches the viscosities were measured in a Stormer instrument at 600 r.p.m., and water loss in a Baroid wall-building tester at 80–250° F. under a pressure of 500 lb./in.^{2} for 30 min. The mud was formed of 150 gm. of commercial Louisiana mud, 50 gm. of salt and 300 gm. of tap water. Gelatinized starch (1% caustic soda, 10% dry starch and 89% water) or gum was added with stirring to give a mud viscosity of about 50 centipoises. In the fermentation tests germicides such as trichlorophenol and pentachlorophenol were added.

The most favourable amounts of gum karaya, gelatinized starch, commercial starch, and gum ghatti (0·25%, 1·0%, 1·5%, and 1·0% respectively) gave filtration rates less than a quarter of those for the untreated muds, and with a much smaller increase of water loss with rise in temperature. The effectiveness of the two starches increased greatly above 175° F. Gum-treated samples had much better filter cake textures than those treated with starch. The addition of more than 0·25% of gum karaya gave very high viscosities. More than 1·5% of commercial starch markedly increased the mud viscosity.

Gums karaya and ghatti had slight fermenting tendencies, while muds with commercial starch fermented under all conditions except when germicides were added. Commercial starch seems best for field use since gums are too expensive under present conditions. Germicides should always be added except with gelatinized starch in highly alkaline muds. G. D. H.

445. Patents on Drilling. A. G. Bodine. U.S.P. 2,304,793, 15.12.42. Appl. 9.6.41.— Method and apparatus for cutting pipe.

D. G. C. Hare. U.S.P. 2,304,910, 15.12.42. Appl. 29.5.40. Determination of specific gravity of fluids whilst passing through containers, such as pipes, etc.

W. L. Church and R. R. Crone. U.S.P. 2,305,062, 15.12.42. Appl. 9.5.40. Cementing plug for well-casing.

A. P. Heldenbrand. U.S.P. 2,305,079, 15.12.42. Appl. 10.9.38. Pipe-thread cleaner with rotating brush.

H. W. Sitton and T. H. Sitton. U.S.P. 2,305,200, 15.12.42. Appl. 25.2.41. Drilling tool with two drills, one solid and the other tubular.

M. M. Kinley. U.S.P. 2,305,261, 15.12.42. Appl. 23.11.40. Method of removing pipe from wells.

P. W. Lange and H. A. McFarland. U.S.P. 2,305,624, 22.12.42. Appl. 22.4.39. Power-driven pipe-tongs.

G. D. Johnson. U.S.P. 2,305,709, 22.12.42. Appl. 8.7.40. Releasable pin tap for engaging in an object in wells.

R. E. Wiley. U.S.P. 2,305,944, 22.12.42. Appl. 23.9.40. Inclination indicating device having a suspended marking element capable of universal movement and clock mechanism.

A. J. Penick and K. T. Penick. U.S.P. 2,306,102, 22.12.42. Appl. 17.2.41. Casing head.

A. H. Graham. U.S.P. 2,306,118, 22.12.42. Appl. 20.3.41. Earth-boring device having a tool with cutting flights of different diameters.

S. W. Long. U.S.P. 2,306,130, 22.12.42. Appl. 27.3.40. Well-drilling apparatus having bushings with central openings for the drill pipe.

L. R. Brown. U.S.P. 2,306,368, 29.12.42. Appl. 25.6.40. Cementing tool for oil-well cementing.

D. D. Anderson. U.S.P. 2,306,369, 29.12.42. Appl. 22.9.41. Coring apparatus with a central core-barrel.

W. B. Noble and J. F. Shaw. U.S.P. 2,306,491, 29.12.42. Appl. 15.6.40. Core-bit with rotary cutters.

W. B. Noble. U.S.P. 2,306,492, 29.12.42. Appl. 23.11.40. Reamer in a well-forming tool.

P. Talmey. U.S.P. 2,306,509, 29.12.42. Appl. 2.10.39. Gas detector using heated wires covered with catalysts.

M. D. Carleton. U.S.P. 2,306,522, 29.12.42. Appl. 18.5.40. Drilling apparatus having roller cutters.

D. M. Smith. U.S.P. 2,306,647, 29.12.42. Appl. 9.2.42. Kelly-driver assembly in combination with a rotary machine.

A. R. Maier. U.S.P. 2,306,739, 29.12.42. Appl. 24.4.41. Locking mechanism for well-drilling rotary.

A. S. Volpin. U.S.P. 2,306,838, 29.12.42. Appl. 2.11.40. Slush-pump piston with removable packing and ring.

G. D. Johnson. U.S.P. 2,307,275, 5.1.43. Appl. 24.1.41. Drilling safety joint for oil-well drilling.

P. W. Appleby. U.S.P. 2,307,658, 5.1.43. Appl. 13.10.41. Well-washing tool with rotary cutters.

C. J. Haynes. U.S.P. 2,307,887, 12.1.43. Appl. 28.12.39. Rotating contact device to be used as a borehole electrode.

W. M. Hamon. U.S.P. 2,307,927, 12.1.43. Appl. 6.11.40. Jar with rotatable and longitudinally telescopic elements.

P. H. Granger. U.S.P. 2,308,072, 12.1.43. Appl. 27.5.41. Method of cementing oil-well casings.

J. C. Ballagh. U.S.P. 2,308,147, 12.1.43. Appl. Protector for drill-pipes and the like.

A. E. Cuthrell. U.S.P. 2,308,157, 12.1.43. Appl. 8.4.38. Derrick supporting member with extensive undersurface.

L. G. Howell. U.S.P. 2,308,176, 12.1.43. Appl. 1.2.41. Operations in boreholes consisting of placing materials in the wells, each material containing radioactive materials of short and different life, this to be used in locating the materials.

W. G. L. Smith and A. M. Graham. U.S.P. 2,308,316, 12.1.43. Appl. 17.7.41. Drill-pipe protector assembly.

R. E. Fearon. U.S.P. 2,308,361, 12.1.43. Appl. 10.11.38. Well-logging method and device. Using a neutron-emitting source.

C. L. Fox. U.S.P. 2,308,652, 19.1.43. Appl. 13.8.40. Oil-field derrick or the like structure.

W. P. Bulkley and J. E. Gough. U.S.P. 2,308,743, 19.1.43. Appl. 16.9.39. Barge for supporting well drilling equipment.

E. H. Olmstead. U.S.P. 2,309,004, 19.1.43. Appl. 28.10.40. Oil-well-logging winch-truck.

P. L. Phillips. U.S.P. 2,309,210, 26.1.43. Appl. 3.8.40. Platform supporting means to be used in derricks.

H. A. Raphael. U.S.P. 2,309,211, 26.1.43. Appl. 4.7.39. Rotatable dial for determining amount of weight on formation.

E. Ventresca and A. Ventresca. U.S.P. 2,309,225, 26.1.43. Appl. 19.12.41. Wire line pipe cutter to be used in severing stuck pipes.

J. G. Gratehouse. U.S.P. 2,309,310, 26.1.43. Appl. 23.1.41. Overshot for engaging and withdrawing an object in a well-hole.

C. A. Lundeen. U.S.P. 2,310,246, 9.2.43. Appl. 5.10.40. Pipe-tong with a multiple-size jaw.

M. Hokanson. U.S.P. 2,310,288, 9.2.43. Appl. 17.7.39. Drill-bit of a detachable two-piece type.

M. Hokanson. U.S.P. 2,310,289, 9.2.43. Appl. 23.10.39. Drill-bit for rotary well drilling.

A. P. Sullivan. U.S.P. 2,310,472, 9.2.43. Appl. 12.10.40. Gas analyser using a combustion cell and a comparison cell.

N. W. Wickersham. U.S.P. 2,310,483, 9.2.43. Appl. 1.3.40. Well-cementing apparatus.

H. A. Raphael. U.S.P. 2,310,597, 9.2.43. Appl. 13.4.40. Carriage-type weight indicator.

E. E. Blondean. U.S.P. 2,310,611, 9.2.43. Appl. 23.12.38. Electrical exploration of geological strata by borehole logging.

A. H. N.

Production.

446.* Duplex Power Pumps for Oil Field Service. F. B. Applegate. *Petrol. World*, October 1942, **39** (10), 28.—This part of the paper (to be published in three instalments) deals with the design of duplex pumps. The major factors affecting the design of pumps of all types are the characteristics of the materials used in their construction and the characteristics of the liquid to be pumped. The strength, casting, or forging properties of a material, its behaviour under stress, and its resistance to corrosion, affect both design form and design proportions of pump parts. The physical characteristics of the liquid to be pumped affect the design form as well as some of the design proportions parts in contact with the liquid. The chemical characteristics of the liquid, *i.e.*, whether it is corrosive or non-corrosive, affect the selection of the materials from which parts in contact with the liquid are to be fabricated. The strength, endurance, efficiency, and economy of a pump depend on the skill and ingenuity of the engineer in co-ordinating these factors when developing his design. A review of the more important characteristics of materials and liquids is made, to show their effect on the design of duplex pumps. The discussion includes brief notes on the metals used and on the viscosity, vapour pressure, and corrosion characteristics of the liquids to be met on an oil-field. The gearing of the pump, particularly the characteristics of herringbone gear, is studied.

Since oil-field pumps are designed primarily for pumping crudes at or slightly above atmospheric temperatures, it is evident that viscosity and capacity must be correlated in determining the design, form, and proportions of a liquid cylinder. Because the viscosity of a crude is a measure of its resistance to flow, and because power must be expended in overcoming this resistance, it is apparent that the power required to overcome viscous friction will depend on the area, form, and length of the liquid passages in the cylinder. For a given quantity of oil at a given viscosity, a reduction in the area of a liquid passage of as little as 10% may increase the resistance to flow as much as 90%, and an abrupt turn will offer from three to eight times the resistance of a long radius bend. Since the power expended in overcoming unnecessary resistance is an economic loss, it is necessary for the designer to use the utmost skill in developing " stream-line " cylinder passages of the most efficient area for the design capacity.

Viscosity and capacity affect the area of the liquid valves, particularly the suction valves. To be efficient, a valve must have sufficient area to assure a smooth, unrestricted flow of liquid to and from the piston chambers of the cylinders, and it must have a minimum differential area to reduce to the minimum the pressure required to open the discharge valve. The ideal pump-valve would be one having a knife edge seat and zero differential area, which is impractical. The design engineer must display considerable skill in developing a valve that will nearly approach the ideal.

A. H. N.

447.* Disposal Plant for Waste Water. J. H. Collins. *Petrol. World*, November 1942, **39** (11), 32.—New filtering process at Santa Fe Springs treats waste water, following oil separation by gravity, and completely purifies it. The requirements are : (1) oil, nil ; (2) turbidity, 50 parts per million, or less ; (3) hydrogen sulphide, one part per million, or less ; (4) colour, clear ; (5) odour, none objectionable. The paper describes in brief the research which went into the development of the plant and a certain amount of its economics. The plant cost $750,000, and its yearly maintenance and overhead charges are $100,000. The oil in the water is separated and sold.

A. H. N.

448.* A Method of Approach to Determine the Economics of Pressure Maintenance. N. van Wingen. *Petrol. World*, November 1942, **39** (11), 45.—In this paper a description is given of one possible method of determining the economics of a primary recovery, or pressure-maintenance operation, as applied to a deep, high-pressure, low-permeability reservoir. The primary intention is to attempt to demonstrate to what extent a consideration of relative increased recoveries for operations under various degrees of pressure maintenance need be predicated in order to justify economically pressure maintenance operations. The economics of four methods of exploitation for a given field are considered in the analysis : (1) Natural depletion method of operation. (2) Pressure maintenance operation, involving the return to the reservoir of only a portion of the solution gas produced, thus permitting some gas sales (partial pressure maintenance case No. 1). It has been assumed, in this instance, that during the life of the project 50% of the solution gas produced will be returned to the reservoir, thus permitting some gas sales after allowing for plant fuel and shrinkage. (3) Pressure maintenance operation where gas, in addition to that produced, will be returned to the reservoir (partial pressure maintenance case No. 2). (4) Complete pressure maintenance. The problem is worked out in full. A summary of the data shown in a table, indicates that net profits increase in almost direct proportion to the amount of gas returned to the reservoir, to an extent that a purchase of "make-up" gas, which is necessary in order to achieve the higher degrees of pressure control, appears to be profitable. It is apparent from the tabulation that the increased revenues obtainable as gas injection volumes are increased, and derive from the correspondingly greater oil recoveries which were estimated. For the second part of the investigation an estimate was thus made in which the recovery for all degrees of gas returned was assumed to be the same as for the natural depletion method of operation. These data are again tabulated. It is apparent from this tabulation that the net profit on this basis is essentially the same irrespective of the manner in which the field is to be produced. Hence, any increased oil recoveries obtainable under pressure maintenance essentially represents merely a proportional amount of additional income, so that even though the increased profit may be less than is indicated in the table given, progressive additional revenues should result for higher degrees of pressure maintenance operations.

These considerations would seem, then, to resolve the entire problem of determining the economics of pressure maintenance operations to a consideration of the following: Determination of increased recoveries for various degrees of pressure maintenance, as against deferred sales for the gas, including a consideration of the economic feasibility of purchasing gas for injection purposes. It is emphasized, in conclusion, that the foregoing calculations have been predicated on the assumption that it will be possible to control the expansion of the secondary gas-cap, so that no significant by-passing of the recycled gas will take place. In any actual field problem, careful consideration should be given to this factor, as it is undoubtedly one of the most critical ones on which the success of primary gas-injection schemes is contingent. A. H. N.

449.* Performance Factors in Pump Operations. F. B. Applegate. *Petrol. World*, November 1942, **39** (11), 56.—The effects of various properties of the liquid on the performance of the pump are studied. After certain fundamental terms are defined and evaluated, the effect of viscosity is studied. If a pump is operating at its maximum rated speed and a viscosity for which it is designed, any decrease in the viscosity of the oil will not affect the speed or the capacity. If a pump is operating below its maximum rated speed and the viscosity of the oil is decreased, the speed of the pump may be increased and the capacity increased in proportion to the speed. However, in no case should the increase in speed exceed the maximum speed for which the pump was designed. The effects of an increase in the viscosity of the oil are not so easily determined. An increase in viscosity will increase the friction losses in the suction and discharge lines, and the magnitude of these losses will govern the speed-capacity change. With the existing condition of suction-lift or suction head, if the increase in the friction losses are sufficient to reduce the capacity of the suction line, the capacity of the pump must be reduced in proportion to the reduction in suction capacity. This may be accomplished either by reducing the speed of the pump or by installing smaller lines and pistons in the liquid end. The friction losses in the discharge lines should be checked to determine the effect of increased viscosity on the discharge pressure and the horse-power required to drive the pump under the changed conditions.

The effects of vapour pressure are studied. The vapour pressure is important in conjunction with the vacuum created in the cylinder. When a liquid containing gas in solution is brought into a vacuous space, the gas will expand and fill a part of the space. It is difficult to calculate the exact volumetric expansion of gas in the suction, because it depends on the time the liquid remains in the vacuous space. This time is a function of the quantity of liquid, diameter, and length of the suction line. Other factors are the amount of gas in solution and the suction lift. However, calculations can be made which, if not accurate, will indicate if the volumetric expansion of the gas will affect the performance of the pump under certain conditions of suction lift. The total pressure required to force a liquid into the piston chambers of a pump is the sum of: (1) The pressure required to overcome the friction in the suction line. (2) In case of suction lift, the pressure required to support the weight of the liquid in the suction line. (3) The pressures required to overcome the entrance losses to the suction line, the inertia of the liquid, the pressure required to accelerate and maintain the rate of flow and to lift the suction valves from their seats.

The pressures for 1 and 2 are variable, and their value should be calculated for each case. The pressures required for 3 are quite small, 0·6 being sufficient for a full diameter suction line and a properly proportioned suction valve. The foregoing outline of the basic principles of pump suction emphasizes the necessity of avoiding suction lift whenever possible. If it cannot be avoided, every effort should be made to keep it to the minimum. A. H. N.

450.* Maintenance of Electric Motors in Wartime. E. Sterrett. *Oil Wkly*, 7.12.42, **108** (1), 17.—Many hints are given on the maintenance of electric motors. Tables are also drawn describing symptoms and cures for different types of troubles. Field motors are being equipped wherever possible with overload protection, and even, in locations where the known loading imposes temporary power peaks above the unit rating, with recording devices whereon is shown the actual motor temperature during each cycle of operations. Overload units, formerly remaining inoperative over periods of years under normal conditions of operation, are checked at frequent intervals to determine their accuracy and reliability, and fuses are calibrated against their ratings to insure against overloading or overheating a motor through excessive capacity of safeguards.

Reduction of load in certain types of drives has been found to introduce a type of motor trouble due to underloading instead of the opposite. Where reduced production on a well cannot be cared for by intermittent pumping, an induction motor may be underloaded to the point where the wattless current—that used in producing the magnetic field in the motor—is out of balance with that energy required to produce mechanical energy. Thus power factor, or ratio of real power to total power, is lowered. At underload, the induction motor is operated under a few disadvantages: it has higher line losses, higher voltage drop, and loses torque. This condition increases the load on the power line—a serious matter where purchased power is used, and results in higher energy/unit of work done. The motors tend to overheat and damage windings, due to the excessive current set up by the high proportion of wattless current carried. This is one of the conditions which may be indicated by excessive motor temperatures, especially when a change in operating conditions has lowered the actual work done by the motor. A. H. N.

451.* Recoveries Obtained Under Different Extraction Methods in Various Fields. Part 1. S. F. Shaw. *Oil Wkly*, 7.12.42, **108** (1), 25.—Different fields in the U.S.A. are studied and their recovery figures compared. Production methods and policies are outlined. The case of Powell field is interesting because of the conclusions reached in connection with well-spacing. The recovery/acre-foot at Powell was considerably higher than the general run of recoveries in fields discovered later in Texas. After the flush production was over, water-drive continued to wash the oil out of the sand, and aided materially in increasing the recovery. In July 1929 daily average production of liquid of one major company was 324 brl./well, of which 93% was water. In the later life of the field operation it became chiefly a matter of lifting large quantities of water to recover small quantities of oil, and continued operation was dependent entirely on the cost of lifting the large volumes of water, and on the price of oil. Casing sizes were 7-in. in the majority of wells, and 2½-in. tubing was employed, and during the flush production the oil was produced through the casing.

Thickness of sand in the Powell field is assumed as 45 ft. by engineers of the Bureau of Mines. With assumed porosity of 25%, the original void content is 87,273 brl./acre. This does not represent the quantity of residual oil present, since no allowance is made for gas content, temperature of the oil, connate water content, or degree of saturation, such as is attempted at the present time in making such estimates. With total recovery to the end of 1941 at 44,300 brl./acre, or 985 brl./acre-foot, which does not allow for the oil used in boilers in the field, nor for pipe-line deduction of 3%, and without taking into account the presence of gas or connate water content, the recovery is slightly above 51%. In the East Texas field, where the depth is about 3600 ft., the shrinkage factor is 0·8 to 0·7, and if 0·8 be applied tentatively to the Powell field, the recovery would be 63½%, or 66% when pipe-line deduction and fuel loss are considered. If connate water be assumed at 20%, the recovery would reach 82½%. Hill and Sutton state : "The above figures make it evident that recovery in the Powell field has been exceptionally high (based on about 50%), bearing out the theories that a high gas pressure, rapid development, and close spacing are the prime factors governing the ultimate production/acre."

Other fields are studied, with similar details. It is considered that up to the present facts are often mixed with "opinions and propaganda" to a large extent, and thus no final conclusions can be reached about the best methods of producing such a large field as the East Texas, for instance.

The paper is long and detailed. A. H. N.

452.* Problems in Selecting Proper Materials for Oil-Well Pumps. W. H. Jackson. *Oil Wkly*, 14.12.42, **108** (2), 15–18.—With the ever-increasing depth of new wells drilled, the extremely high pressures encountered have made it necessary to secure the very best materials possible to insure that "fittings" would stand up under these working pressures, since the limited space in which they are assembled requires that they be made of steels with heat-treating qualities. In many instances, pressures exceeding 2000 lb./sq. in. are exerted against fittings or parts having a wall thickness of less than ¼ in. The steels from which these fittings are made are of the nickel, chrome, molybdenum, and both high and low-carbon type, and often a combination of two or more types, depending on their position and use in the pump, whether in compression or tension in their relation to each other.

A breakdown of the types of pumps divides them into two distinct groups. First, the original design is known as the tubing pump, so named from the method of its installation at the bottom of, and lowered into, the well on the string of tubing. The plunger assembly is run through the tubing to its proper position in the barrel on the string of rods that actuates the movable parts of the pump when in action. The second is the rod type, since this pump is installed and removed in its entirety on the rods, making it less costly to pull for replacement or repairs. Each type is discussed separately and its problems are briefly analyzed. A. H. N.

453.* Recoveries Obtained Under Different Extraction Methods in Various Fields. Part 2. S. F. Shaw. *Oil Wkly*, 14.12.42, **108** (2), 22.—Since curtailment has become so general, the thought has become widespread that restricted extraction rates and wide spacing result in a greater recovery of oil. If this be the case, estimates for ultimate recovery/acre should be higher in fields found since 1930 than in those developed several years prior to 1930, particularly when the greater propulsive force generally found in the deeper reservoirs developed since 1930 is considered. In this part of the paper a further number of fields are studied in a similar manner to that adopted in the first part, and comparisons are made.

In order to make valid and close comparisons of ultimate recovery between different fields, it is first necessary to ascertain closely the approximate oil contents of the reservoir. This involves a knowledge of the sand thickness, porosity, saturation, connate-water content, and gas content. While progress is being made in measuring the factors, much remains to be done along that line, and in the older fields these factors are not obtainable to any degree of satisfaction. As wells reach to greater depths, the reservoir pressure is higher, and there is usually a greater quantity of gas dissolved in the oil, and the increased pressure and gas content increase the probability of obtaining a higher ultimate recovery than in the more shallow sands; on the other hand, the greater gas content tends to reduce the quantity of oil/acre contained in the reservoir, other factors remaining the same.

It is clearly recognized that a comparison between recoveries/acre without considering these other factors is subject to criticism; yet if the aggregate recovery from a sufficient number of fields in the same general area is compared with that from a number of other fields in the same area, but with different methods of production, it remains to be seen whether the comparison will go far wrong. The great difference in methods of operation between fields discovered in early days with those discovered since 1930 lies in the much closer spacing and in more rapid withdrawals in the earlier fields. The writer has endeavoured to recite the actual conditions applying to the various methods of producing oil in the fields listed, and his own conclusion at this time is that when producing through bore-holes, capacity methods and close spacing for the most part result in maximum recovery. The reader may interpret the conditions and results differently. Only the passing of time combined with a careful study of the results actually achieved will determine the correctness of the conclusions.

While the writer is of opinion that the evidence points to the conclusions stated, he by no means believes that a profitable outcome should be subordinated to high ultimate recovery; therefore it would seem as if the sane policy to pursue, when there is a large producible excess of supply over demand, is to restrict production and to space wells so that a profitable outcome will result. On the other hand, when the demand requires that more oil be produced, spacing should be closer, and rates of production up to the maximum should be extracted. A. H. N.

454.* Reworking and Sidetracking Oklahoma City Wells. N. Williams. *Oil Gas J.*, 17.12.42, **41** (32), 33.—(Part of the paper is cut out by the censor. Enough remains for understanding the main points.) It has become fairly well established that there exists in the reservoir of the Oklahoma City Wilcox sand-pool a condition in which fluid levels have experienced a substantial recession. This is attributed to the absence of an active hydrostatic head, and consequent failure of water movement into the reservoir to keep pace with withdrawals during a long period of the field's flush productive life. With the exhaustion of gas energy and the natural rock pressure of the reservoir, the remaining water and oil have been permitted to seek new levels in accordance with their respective volumes, thus creating the phenomenon of gravity drainage of oil down-structure.

For the time being it appears that the water level is more or less stabilized. There has been no change in the water-production status of the field for a considerable time, with water withdrawals remaining almost constant at about 14,000 brl. daily. This indicates that the daily withdrawals are about balancing the ingress of water into the reservoir. Recession of the oil level, however, continues in direct proportion to the oil withdrawals. This is creating a steadily thickening void in the top of the sand, spreading down-structure as the fluid level drops. In turn, the oil level has dropped below the respective producing depths of wells at successively lower structural positions, and the productive capacity of the wells and leases has steadily declined. With the limits of economic production at their respective existing depths reached, many such wells and leases have been abandoned or shut down. Prior to conception of the phenomenon of receding fluid levels it was believed that the productivity of these wells and leases was at an end, even though many were located at up-structure positions normally favourable for prolonged production. However, in the light of present knowledge of reservoir conditions, which has resulted from studies and work done by the Oklahoma City Wilcox Pool Engineering Association, the way is open for reclamation of many of these wells and leases by deepening the wells or re-drilling to lower points in the sand which might still be below the oil level.

Working over and re-drilling of old wells and reclamation of old leases constitute an active phase of work in the Oklahoma City field at this time. Results are proving highly successful. A large number of wells, some of which had been abandoned or shut down for some time and others the production of which had apparently dropped to about the point of exhaustion, have already been re-completed as good producers. In many cases entirely new wells have been drilled on old leases which had been considered depleted, although this type of work is limited due to war restrictions on new drilling in proved areas and difficulties of obtaining equipment and materials for that purpose. With few exceptions all these re-completions and new wells have come in good for from 250–700 brls. daily of sustained production with little or no water. Re-working and re-drilling work now in prospect is expected to play an important part in bolstering the field's daily output and ultimate recovery and forestalling premature abandonment of many leases. A. H. N.

455.* Concrete Blocks for Pumping Counterweights. E. Sterrett. *Oil Wkly*, 28.12.42, **108** (4), 17.—To allow for the increase in bulk required for replacing steel (or iron) counterweights of the riding type by concrete, it is necessary to allow for the fact that concrete weighs approximately 150 lb./cu. ft., as compared with 460 for cast iron, and thus 3 cu. ft. or more of clearance space must be allowed for one taken up by the iron counterbalance. This question of clearance has led to the use of hanging or swinging weights on many pumping units where the ground clearance permits such a plan. The concrete is cast into a rectangular block, or sometimes is simply shovelled into an oil-drum, the desired stirrup or supporting bolts placed before the concrete hardens, and the finished weight slung from a chain, hook, or link or other flexible attachment at the end of the beam.

Unless provision is made to guide this counterweight in a vertical plane during the working cycle, it frequently develops an oscillating action which imposes severe and often wrecking force on the pumping unit. Methods for curbing this side-sway range from casting pipe-guides in the weight, and the installation of properly placed slides for these to work over, to the provision of trunnion bearings at some point near the centre of mass of the weight, and the use of spacer bars to give the weight a prescribed vertical path of motion. Mechanical details are discussed at length.

Just as the operators found that the weight-box, whether filled with scrap metal, rock, sand, or gravel, required adequate drainage provisions to prevent the effective loading from being materially changed by prolonged rainy spells, so have they learned that the concrete block is much like a sponge in its tendency to absorb water and then to evaporate it. Concrete will take up as much as 30 lb., or 20%, during a long rainy period. Again, if a rain-soaked block be shifted to give proper balance, that same concrete, following a long dry spell, may fall under weight sufficiently to throw the well system so far off balance as to introduce damaging stresses. Severe winters may result in partial destruction of the blocks. Methods of water-proofing blocks are discussed. A. H. N.

456.* Oil Reservoir Behaviour Based Upon Pressure-Production Data. H. C. Miller. *Oil Wkly*, 28.12.42, **108** (4), 23.—This forms a reprint of an extensive Bureau of Mine's Report of Investigation (No. 3634) and is illustrated by many typical examples. The graphic method for exhibiting reservoir-pressure and oil-production data discussed in this report, where the cumulative decline of reservoir pressure (in lb./sq. in.) is plotted as ordinates on a logarithmic chart against cumulative recovery (in barrels) as abscissas, appears to have advantages in analyzing pressure-production data on petroleum reservoirs. By this method the relation between cumulative decline of reservoir pressure and cumulative recovery can be represented on a logarithmic chart by straight lines for large increments of liquid recovered. For some reservoirs one or two, and for most reservoirs not more than three or four, interconnecting straight lines will exhibit the pressure decline–oil recovery relations for their entire producing lives. The lines have different slopes, and the slope angles, when studied in conjunction with the physical characteristics of the oil and the type of reservoir, are shown in the report to reveal whether the source of energy driving oil through the sands and porous rocks to wells is the result of gas expansion, a combination of gas expansion and water-drive, or solely a natural water-drive.

As a change in the rate of oil production (or in gas–oil ratios for water-drive reservoirs in which the source of energy is the expansion of gas or a combination of gas expansion and water-drive) affects the efficiency of utilization of reservoir energy and is reflected in the size of the slope angle, the relative efficiency of oil-producing methods in a given reservoir can be determined by comparing the slope angles before and after a change in operating procedure. If the slope angle, after a change in field operating methods, is smaller than before the rates of oil withdrawal or gas–oil ratios were altered, the efficiency of utilization of reservoir energy must have increased, as the small slope angle indicates the recovery of a larger quantity of oil/unit decline of reservoir pressure. It does not necessarily follow, because decreasing slope angles mean increasing efficiency of utilization of reservoir energy under certain conditions, that a slope angle of 0° indicates maximum efficiency of recovery of oil from a reservoir. A change in the relation between cumulative decline of reservoir pressure and cumulative oil recovery from one exhibiting a positive slope angle on a logarithmic chart to one of 0° only indicates that the expansion of gas in the reservoir has been replaced by a natural water-drive. In general, however, a water-drive is a more efficient oil-motivating agent than gas expansion, and a reservoir in which a water-drive has operated throughout its producing life will usually yield more oil ultimately than if part of the oil had been recovered as a result of gas expansion. Nevertheless, in all reservoirs in which the oil moves through the sands and rocks as a result of a water-drive, the rate of advance of the water is a factor in the efficiency of oil recovery. Although a fairly rapid rate of water movement may permit the recovery of more oil than an exceedingly slow rate, edge-water will "finger" into an oil reservoir if the rate of encroachment is too rapid, and by-pass oil that might have been recovered if the rate of water movement had been slower.

The slope angle for gas-driven pools—gas-expansion being the immediate source of energy—should be about 45°. Water-drive alone is denoted by a slope of 0°. Mixed drives will have intermediate slope angles. A. H. N.

457.* The Laws of Gas-flow in a Gas Reservoir. Part 1. E. N. Kemler. *Oil Wkly*, 21.12.42, **108** (3), 26.—The laws governing the flow of a compressible fluid such as a natural gas are somewhat different from those for a liquid. In the case of a liquid, the volume of the fluid is essentially constant, and is independent of the pressure over the range of conditions encountered. The flow of a natural gas follows the gas laws over a considerable range of conditions, and within the limits of accuracy of other data can be considered as following them over the range of operating conditions to be studied. In the case of flow in reservoirs, the temperature of the reservoir, and hence the gas, will be constant, and so-called isothermal or constant temperature conditions can be assumed. For this condition the general relation for rate of flow as expressed in terms of the physical properties of the fluid, reservoir, and pressures will be :

$$Q = \frac{2\pi kb}{P_0\mu \log_e \frac{r_d}{r_w}}(P_m{}^2 - p^2) = \frac{C}{P_0}(P_m{}^2 - p^2)$$

The corresponding formula of flow of a liquid in a reservoir as given in a previous article was :

$$Q = \frac{2\pi kb}{\mu \log_e \frac{rd}{r_w}} (P_m - p) = C(P_m - p),$$

where k = permeability, b = sand thickness, g = 32·2, μ = viscosity, r_d = drainage radius, r_w = well radius, P_m = closed in reservoir pressure, p = pressure at well bore, Q = flow rate in cu. ft./day at pressure P_0.

Professor Kemler does not consider the variation of the permeability of rocks to gas with the pressure of the gas or its rate of flow, but, working on a constant value of permeability, evaluates the effects of increase in back-pressure on the rate of flow. The paper further deals with the calculation of bottom-hole pressure from top-hole pressure. It is graphically illustrated, and three references are appended.
A. H. N.

458.* Trends in Production Practices. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 157.—The paper is written in English and Spanish, and reviews the most important advances made in production in 1942. Steam-raising for power generation and hydraulic pumping are first briefly reviewed. A new instrument for measuring the instantaneous and sustained load on a sucker-rod string has been developed. The principal element is a magnetic strain gauge run on the bottom of the sucker-rods and a magnetic oscillograph at the surface. The complete unit consists of the magnetic strain-gauge control-box with filter, the recording and indicating instruments, and a supply of electrical current. The principle is the transformation of small displacements in the sucker-rods into the reading on an electrical instrument. The instrument was designed originally to determine the load on the sucker-rod string just above the pump. Two of the instruments were used in the field for 6 months, testing wells. A check of the instruments at the conclusion of the test showed that the calibration had not changed.

Electrical chlorination of salt water for disposal is reviewed, together with repairing and cleaning casing perforations by explosives, subjects on which the *Abstracts* 1942 may be consulted. Similarly, the storage of liquid hydrocarbons in depleted formations and multiple-zone productions are treated.

By placing the acid in the desired zones, the efficiency of an acidizing operation can be increased. Previously the carrying out of such a plan has been very difficult, because there was no way of telling into which portion of the formation the acid was entering. The use of a new tool, the electric pilot, now allows greater control while acidizing. It permits the introduction of the acid into the desired portions of the pay formations, while preventing it from entering the undesirable pay section. The tool is run on the bottom end of the tubing string, and an electric meter at the surface indicates whether the pilot is immersed in acid or oil. The electrical hook-up of the pilot is such that an electrical circuit is completed when the pilot is immersed in a conductive fluid, such as acid, but the electric circuit is not completed when it is immersed in a non-conductive fluid, such as oil.

In making treatments using the electric pilot, it is the general practice to pump acid down the tubing and simultaneously pump oil down the casing. By varying the acid and oil pumping rate, it is possible to maintain the level of the top of the acid at any desired point in the well. As the pilot has previously been placed in the well at the point where it is desired to maintain the top of the acid, the reading on the electrical instruments at the surface will immediately tell where the top of the acid is, and the respective pumping rates of the acid and oil can be adjusted in order that the acid level will be at the desired point. A. H. N.

459.* Rate of Withdrawal, Its Effect on Water Encroachment in the East Texas Field. J. N. Miles. *Petrol. Engr*, December 1942, **14** (3), 33. *Paper Presented before American Petroleum Institute.*—The time of the appearance of the first water and its rate of increase is dependent on several factors, such as sand thickness, penetration, oil–water interface, permeability, shale leases, and rate of production. An operator has no control over most of these factors, and consequently must apply his efforts to those over which he has some control, such as penetration and rate of production. Most of the wells in East Texas have been completed for several years, and they may have been drilled deep into the producing sand or only a few feet. If the penetration is in the order of 10 ft. or more, the opportunity for a successful plug-back job is good, and should be given serious consideration. The rate of fluid production is another important means of controlling the rate of water encroachment, and the factors involved in this criterion in Texas fields are discussed.

The principles of water-coning and in maintaining proper production rates to avoid such troubles are outlined, together with the use of chokes. Two types of bottom-hole chokes are used. One is the tubing type, in which the choke is screwed into the tubing string below the pump. The other is a removable type that is attached to the standing valve or insert pump and can be pulled with the rods. In both cases a packer is employed between the tubing and casing. The tubing is perforated between the choke and the standing valve, which permits the annular space between the tubing and casing to be used as a storage chamber. In this way a choke size can be chosen that will limit the withdrawal from the formation to a few brl./hour, whereas fluid from the annulus can be produced at a rate of 20 or 30 brl./hour. In addition, the rate of withdrawal is not affected by a pumper in need of some quick production.

The choke size is very important, and consideration should also be given to the well capacity or productivity index, rate of withdrawal desired, pump depth, and size of casing and tubing installed. A study is made of choked and unchoked wells.

The main conclusions of the paper are : (1) In areas where water underlies the oil in the same sand the rate of production affects the rate of water encroachment into the well bore. (2) The rate of production can be held to a minimum in both flowing and pumping wells by the use of surface or bottom-hole chokes. (3) In the East Texas field the additional production/well from the use of bottom-hole chokes may be as much as 10,000 brl. of crude oil. A. H. N.

460.* Gas-Lift Technique Employed in Trinidad Wells. S. P. King. *Petrol. Engr*, December 1942, **14** (3), 84.—The tubing-disc choke, perhaps the most important innovation in Forest Reserve gas-lift practice during the last year, has solved several local production problems and increased the overall efficiency of many gas-lift installations. The performance of this flexible and economical type of bottom-hole bean has been so satisfactory that it is now a standard item in the majority of wire-linen operated surface-controlled installations, and in all differential pressure-operated flow-valve installations. The geology of the field and the gas-lift technique employed are discussed, followed by a study of the tubing disc. When the well ceases flowing naturally, either an intermittent unit or the pressure differential controlled flow-valve system is used, depending on conditions. If the latter, a tubing-disc choke is always included in the design. Inasmuch as these valves operate through the back-pressure existing in the tubing, anything, other than the fluid in the tubing, exerting back-pressure will naturally decrease the amount of fluid lifted and at the same time usually increase the gas–oil ratio. Therefore, if the well is to be beaned to obtain a given rate of trouble-free production, the beaning must be done in such a manner that it creates little or no back-pressure in the tubing opposite the valves. If the well is beaned below the point of injection of the input gas, the back-pressure resulting from beaning is eliminated and the efficiency of the system is improved by utilizing all the available energy in the gas. Because these valves have full opening through the mandrel, an installation of this type can be equipped with a removable bottom-hole choke. Obviously this type of choke is used whenever available. The Otis removable bottom-hole choke is perhaps the best known of its type. The problems met are discussed.

To determine the correct size of disc-choke for a particular installation, it is necessary to have the following well information : (1) Static bottom-hole pressure must be known. (2) Productivity index should also be known. (3) Desired daily rate of production must be decided on. (4) Estimated working fluid level with available working casing pressure must be ascertained. The method is explained by solving a typical problem in full. A. H. N.

461.* Application of Recording Fluid-level Gauge to Oil Production. L. C. Halpenny. *Petrol. Engr*, December 1942, **14** (3), 133.—The applications of the instrument in gauging oil wells, in determining potentials, and in studies of pumping wells are discussed. In connection with pumping wells, it is used in the stock-tanks, and is found to reveal evaporation losses when the pump is stopped. The type of instrument used by the writer is one that has been used for years in the measurement of water behind dams, in irrigation ditches and canals, at river-gauging stations, and to record fluctuations in water level in wells. It consists of an horizontal cylindrical drum covered with a chart, and revolved by a cable attached to a float and counterbalance, and a pen or pencil moving horizontally along the drum and controlled by a clock. In gauging oil production, the float is controlled within the tank by being enclosed in a stilling well, to keep the float directly beneath the sheave attached to the drum, and to minimize false readings caused by waves and foam in the tank. The pen or pencil slides along two polished rods, and is attached by a flexible wire to the clock at one end and to a counterbalance at the other. As the clock unwinds, the counterbalance pulls the pen or pencil along the guide-rods, making an horizontal line on the chart on the drum. If the fluid level is rising, the line produced will be diagonal, as the drum will revolve slightly. Various combinations of gears are available for both the time element and the fluid-level element, so that the graph produced can be of any scale desired. The writer found that a time scale of 0·2 in./hour and a direct fluid-level scale (1 in./in.) were satisfactory for most tests. For tests lasting a week, a time scale of 0·05 in./hour has been found satisfactory. The circumference of the drum is 1 ft., and if the fluid level in the tank rises several feet during a test, the drum merely continues to revolve, and the graph produced will be a series of parallel diagonal lines.

An adjustable stand was developed for use on lease-tanks. It is made from light bed-rails for the frame, and of ¾-in. pipe and sucker rod for the telescoping legs. It is possible to adjust the legs to produce a level surface on a sloping tank roof, and also to raise or lower the frame barely to clear the open hatch. The stilling well is made from sections of 6-in. stove-pipe, the top section of which has two shelf brackets attached, so that it will hang vertically in the tank opening. Additional lengths of stove-pipe are attached with sheet-metal screws as needed to adjust the depth of the stilling well to the height of the tank being measured. A. H. N.

462.* Underground Gas-storage Project in California. W. A. Sawdon. *Petrol. Engr*, December 1942, **14** (3), 138.—The reasons for the project are outlined ; briefly, they are fluctuation in supply and demand, and conservation. The proved producing area of the portion serving as a reservoir is 310 acres in extent, of which approximately one-half is held by the Union Oil Co. ; the other half, a town-lot area, is controlled by about 200 small lease and royalty holders who are scattered over the country. There are nineteen producible wells on the Union Oil Co. property and eighteen on the town-lot area. Approximately one-half of these are now on production.

There appears to be no actively encroaching edge-water in the field. Depletion has been due almost entirely to gas-expansion, and it is believed that the reservoir sands originally containing oil and gas are still free from encroaching water. The original reservoir pressure at an average mid-point of the reservoir was 2750 lb./sq. in. and the temperature 235° F. The bottom-hole pressures at the beginning of the storage project were as low as 30 lb./sq. in. in some places. By laboratory tests the porosity of the sand was found to be 26% and the permeability 500 millidarcies. The interstitial water was estimated as 25% of the pore space. Using these factors and taking into consideration reservoir characteristics, correction being made for temperature but not for possible reservoir shrinkage due to encroaching edge-water, it was calculated that a gas storage of 2,000,000,000 cu. ft. would be provided by the 20,428 acre-ft. of sand estimated as effective for storage.

The actual volume available for storage is probably half as much again, but the 2,000,000,000 cu. ft. is believed to represent a volume of gas that may be stored and withdrawn with pressure conditions under which it is practicable to operate the project. The equipment required is briefly described. A. H. N.

463. An Electrical Device for Analyzing Oil-Reservoir Behaviour. W. A. Bruce. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1550, 1–13.—In the mathematical analysis of well and reservoir flow problems, the porous continuum of a reservoir is divided into small blocks of such a size that for a material balance on the fluids in a block an average pressure for the block can be applied. Instead of analytically solving the equations so formed, electrical units can be constructed which will behave in respect of the flow of electricity exactly as the reservoir units behave under various conditions of fluid flow. The electrical units are then wired together in the same way that the reservoir units are connected naturally by virtue of their geometrical locations and shapes.

The fluid-flow equations and the analogous electrical equations are briefly discussed for a single phase compressible fluid, a water-drive unit, an oil zone unit, and for gas flow.

The application of the electrical analyzer to a study of the performance of the Dix pool is described in some detail. Diagrams compare the electrically determined pressure contours with the observed pressure data at different dates in the life of the pool. Fair agreement between observed pressures and the analyzer results was observed.

The apparatus is capable of solving the water-drive problem of any reservoir performance for which a mathematical solution has been presented in the literature, either on the basis of steady or unsteady-state flow analysis. It should be capable of solving reservoir-performance problems previously thought too difficult for practical solution by mathematical means. G. D. H.

464.* Many Benefits Make Gas Return Project Exceptionally Profitable. J. C. Albright. *Oil Wkly*, 4.1.43, **108** (5), 14–18.—The paper discusses the operations in a particular field in the East Burbank Extension of Oklahoma, with the aid of graphs and statistics on production. Several interesting conclusions may be reached from a study of this gas-injection programme. It is apparent that the project is not a re-pressuring operation, but something resembling re-cycling, the success of which depends almost entirely on the sweeping action of the injection gas passing through the sand body to drive the oil from the pore spaces to the well. This is substantiated by the fact that when the volume of gas injected declines, even for a single day, a similar drop is quite noticeable in the production of both gas and oil the following day.

The entire property has shown a gratifying increase in (1) oil production, (2) gravity of oil produced, and (3) production of natural gasoline. As the decline curves show, the properties under a normal-expectancy decline curve should have produced only 315·58 brl. of oil/day in July 1942, if operated under conditions existing before gas injection was started. Instead the producing wells pumped an average of 599·38 brl./day, an increase of 253·80 brl., or 90%. Pumping time has been reduced materially, reducing fuel cost and wear on equipment. Indications at this time point to an increase of 1,500,000 brl. in ultimate recovery of oil above the normal expectancy, all of which can be credited to the gas drive. A. H. N.

465.* Closing High Gas-Oil Wells and Allowable Transfer A Success. F. Briggs. *Oil Wkly*, 4.1.43, **108** (5), 22.—In June 1942 the Texas Railroad Commission granted operators of the Goldsmith field, Ector County, permission to utilize their leases into 16-well tracts, shutting in as many as eight wells in each of these units, and assigning the allowable of each shut-in well to another well in the unit. The purpose was to conserve the physical energy of the field, and thus tend to obtain greater ultimate recovery. The plan has been remarkably successful, and attests to the advisability of shutting in excess gas and water producers and transferring the allowables to other wells. The purpose of the unit production plan was to eliminate the excess gas production from wells that were producing with high gas–oil ratios, thus tending to maintain the bottom-hole pressure. By so doing, the field, which previous to the adoption of the unit plan was producing as an incomplete gas-driven structure, was put in the category of an almost completely gas-driven pool, and thus greater ultimate recovery is anticipated. The paper discusses the advantages accruing from this practice, and gives long excerpts of the rulings of The Texas Railroad Commission and certain amendments to the rulings on this question. A. H. N.

466.* The Application of Build-up Pressures to Calculating Capacity and Reservoir Pressure For Gas Well. E. N. Kemler. *Oil Wkly*, 4.1.43, **108** (5), 28.—This paper may be taken as a continuaton of a series of papers by Professor Kemler on the study of production of wells, appearing in the *Oil Weekly* in 1942 (see Abstracts of 1942). The principles discussed here are the same as those discussed in Part 3 (not Part IV, as mentioned in references at end of paper). In the previous discussion formulæ for oil wells were studied : For gas wells it is possible to derive expressions that can be used to determine the reservoir pressure from data taken over a short period. The method can also be used to give an idea as to the capacity of the well to produce. Such methods are particularly adaptable to wells of relatively low permeability or productivity-index factor. When the permeability is low, the time required to reach full reservoir pressure may involve many days, and in some extreme cases may require a month or more to reach the true equilibrium condition. For such cases it is obvious that a means for determining the reservoir pressure from data taken over a short period would be very helpful.

The use of the open-flow method of determining well capacity has the disadvantage of wasting gas. Open-flow tests for establishing actual well-producing capacity under various conditions are not very reliable, particularly in wells of relatively low permeability. The capacities as determined from such tests will probably be high, because steady-state conditions have not been established. Open-flow tests and tests at high rates may be dangerous from the standpoint of their effects on the subsurface behaviour of the well. The back-pressure method has its own disadvantages, the chief one being the number of accurate points required to obtain correct conclusions. In addition to build-up of reservoir pressure, it is possible to obtain an index of the well capacity from building-up-pressure data. This method requires that bottom-hole or fluid-level data be obtained in oil wells. In gas wells the bottom-hole pressure, or its value as calculated from top-hole pressure, is necessary. The advantage of this method is that information applicable to general reservoir problems can be obtained at one time and over a short period. The method requires that the well be produced at or near some uniform rate for sufficient time to reach steady conditions. The length of time required for this condition to be met may vary from a fraction of an hour for wells of high productive rates to several days for wells of low permeability. The build-up pressure should be taken over a considerable period, but need not be so long as the time to reach steady-stage conditions. The only disadvantage of the method is that it requires that the well be shut-in for a time.

The paper gives a method calculating the reservoir pressure and well capacity from build-up data, using the author's method of successive approximation. A. H. N.

467.* Factors Affecting Changes in Crude Oil Gravities. R. Reaves. *Oil Wkly*, 4.1.43, **108** (5), 39–40.—In broad analysis the gravities of oil in stock-tanks are affected by the following factors : (1) The composition of the oil–gas mixture as it leaves the reservoir. (2) The pressure at which gas–oil separation occurs on the lease. (3) The separating temperature. (4) The number of stages of gas–oil separations through which fluid passes before going to the stock-tank. (5) The effect of the water produced. (6) The effect of gas lift. (7) The method and practices used in treating emulsions. (8) The impurities and content of the treated oil. (9) The accuracy of making determinations. The gravity of oil produced from a specific reservoir—that is to say, a sand of average thickness in any particular field, ordinarily varies a very small amount, provided the oil is either saturated or under-saturated with gas.

The chief factors of those enumerated are briefly discussed. A. H. N.

468. **Job Design As Applied To The Pumper's Daily Routine.** H. G. Thuesen and M. R. Lohmann. *Oil Gas J.*, 7.1.43, **41** (35), 115–118.—Job design consists of determining the essentials and selecting the effective elements for the accomplishment of the essentials. Improvements in the effectiveness of labour utilization are obtained by: (1) Eliminating unnecessary work elements. (2) Substituting effective for ineffective elements. (3) Eliminating periods of enforced idleness. By testing each element of work of the job against the criterion of whether it assists in the accomplishment of the work objective, the effective work elements are chosen. These work elements are then arranged in the proper sequence for smooth and uninterrupted performance. Opinions of workmen and supervisors are essential in analyzing the elements of a job, but as it is impossible to measure and test these elements by casual observation, it is necessary to make a detailed time study of the job. A stop watch, more commonly known as a decimal timer, is used, with which the duration of the elements of the job can be measured with considerable precision. In some instances a motion-picture camera is of considerable assistance in recording and measuring rapid action in jobs of short duration. Sufficient observations, including a detailed record of the elements of the work performed and the time of each element, must be made of the job in the field. The length of these observations may vary from hours to days, depending on the repetitiveness of the job, but sufficient studies should be made so that the observation is representative of the job. Jobs must be designed by the co-operative efforts of the supervisor, who defines the objectives, and an experienced job designer, who measures the job and designs it around the objectives.

For analysis, the objectives for which the pumper is employed may be classified as follows: (1) Detect trouble which would result in damage or loss of production and correct or report same to lease foreman. (2) Service, adjust, and make minor repairs to equipment on the lease. (3) Switch, top-out and gauge-tanks, report gauges and run oil to the pipe-line. (4) Maintain the lease and lease equipment to the desired standard of cleanliness and orderliness. The first three classifications embrace a large percentage of the pumper's activities, and most of these are performed during regular visits to the wells. The paper gives a method of estimating the economical number of visits to the wells to minimize production loss. A. H. N.

469. **Kansas Drawdown Productivity Tests Cut Well Costs and Equipment Needs.** N. Williams. *Oil Gas J.*, 7.1.43, **41** (35), 119.—With the draw-down method the productivity of a well is computed from measurements of the effects of production on the height of the fluid column in the well. Production at low rates serves as well as, if not better than, production at high rates in this calculation. In gas-free or pumping wells, characteristic of Kansas, the fluid column standing in the well is the only force within the well retarding movement of oil into the well-bore; hence, reduction in height of the fluid column is a function of rate of production and directly proportional to it, if the resulting values of equilibrium fluid height are plotted against their corresponding rates of production, a "draw-down" curve is obtained, which, extrapolated to zero fluid height, yields the theoretical maximum rate of production. The footage difference in height of the fluid column under static conditions and the height at a given rate of production is the draw-down for that rate of production. The slope of the draw-down curve determines the productivity index of the well, which may be considered as gross production/ft. of fluid draw-down.

Productivity as determined by this method is the indicated performance of a well at high rates, rather than a gauge of the actual volume of oil a well can produce. This accounts for some of the unreasonably high "potential" figures often attributed to Kansas pumping wells. However, although the indicated productivity of a well may appear excessive, it serves as a reliable basis for determining the relative importance or rating of wells for the purpose of production allocation.

As the tests require small rates of production only, the cost of the pumping unit and other equipment—necessarily smaller than those required by other tests using high rates of flow—becomes low, resulting in cutting the well costs.

The procedure prescribed by the Conservation Division for making the tests is as follows: "Three liquid-level points shall be established, in each case after the well has reached equilibrium. . . . Pumping speeds or flowing rates shall be sufficient to establish definite points for the extrapolation of the draw-down curve. The high rate shall be at least 15 brl. of liquid/hour. The low rate shall be at least 10 brl. of liquid/hour less than the high rate, and the intermediate rate shall be at least 4 brl./hour more than the low rate. Production gauges for each fluid-level determination shall be taken for at least 3 hours for each production rate point after equilibrium has been reached. The draw-down curve shall be a straight line plotted through the lowest production rate point and at a point which is the average of the two higher points established by the test. . . . The straight line shall be extrapolated to indicate the productivity of the well if pumped down to the top of the producing horizon, provided such indicated productivity is less than the maximum permissible productivity herein before prescribed. If such indicated productivity is greater than the prescribed maximum, the value shall not be extrapolated beyond such maximum."

A. H. N.

470. Job Design As Applied to the Pumper's Daily Routine. Part 2. H. G. Thuesen and M. R. Lohmann. *Oil Gas J.*, 14.1.43, **41** (36), 36.—In the second part of the paper the principles outlined in the first part are applied in a typical case and the problems met are solved in detail. A schedule is then outlined for the pumper. In this case example the average number of wells handled by one pumper was nine. After job design the same pumper could handle twenty wells, or an increase of 122%. On a per-well basis, annual pumping labour costs will drop from $700 to $315, or 55%. The schedules as worked out in this paper are applicable to the over 100 wells controlled by the operator in the field, making total labour savings in excess of $40,000. In addition, job design allows an equal distribution of work on the basis of the time and effort expended by the pumper. Savings of this proportion are not unusual, as similar applications of job designs in fields in other areas have shown percentage savings comparable to this case example. Where production/well is small, as is the case in many fields, similar percentage increases in the number of wells handled by one pumper, even though the pumper may now be handling more wells than in this case example, are possible by the application of study and design. Job design is not limited to pumpers or pumping, as successful applications have been made to well servicing, maintenance, and other production jobs. A. H. N.

471. Stripper-Well Surface Equipment. N. Williams. *Oil Gas J.*, 14.1.43, **41** (36), 46.—Subsurface equipment are important factors in determining the efficiency of pumping wells. Another factor to be considered in pumping efficiency, especially as it relates to stripper wells, has to do with surface pumping equipment and methods. Subsurface equipment can be in perfect condition, properly set and adjusted, and of adequate capacity, but if the surface equipment is not of suitable type or size, or is not properly operated, the maximum efficiency of the subsurface equipment cannot be realized, and the greatest possible volume of fluid the well is potentially capable of producing cannot be lifted. Speed and length of strokes are functions solely of the surface equipment. Hence, any increases in well output that is to be obtained by faster and longer strokes is entirely dependent on mechanical adjustments at the surface.

In many cases the surface pumping equipment on stripper wells is incapable of lifting more fluid. Much of it, by reason of the age of the wells and original installations not having been replaced, is old. Frequently it consists of assortments of more or less obsolete types of rig-fronts, makeshift central power hook-ups, or improvised units and jacks in multiple operation. Sometimes it is patched together with junk. Old assemblies and practices often do not permit flexibility in pumping individual wells to obtain the most effective results. Along with this, operating and maintenance costs of this type of equipment may be so uneconomical that profitable production of wells is difficult. Tests for determining the advisability of changing equipment are very briefly mentioned. A. H. N.

472.* Gravitational Drainage of Liquids from Unconsolidated Wilcox Sand. F. R. Stahl, W. A. Martin and R. L. Huntingdon. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1548, 1–8.—Vertical tubes of 2-in. and 4-in. iron pipe were equipped with water-jackets, and nipples at various levels for taking sand samples, while a drainage cock was fitted at the bottom. The tubes were filled with well-packed outcrop Wilcox sand, the porosity of which was approximately 32%. The permeability, measured with dry natural gas, averaged 7·5 darcys. The sand-filled tubes were filled with liquid forced in through the bottom, liquid being allowed to flow out of the top. Drainage from the base was permitted for a time, after which the tube was refilled ready for the drainage observations. In the experiments the bottom cock was opened and the amount of liquid collected was noted from time to time. Cores were taken by a cork-borer inserted through the nipples, the amount of oil in the cores being found by firing. The density, viscosity, and surface tension of each liquid (water, Wilcox crude, and heptane) were measured. The core samples were taken in the transient experiments to find the saturations at different levels at times before drainage was complete.

A slightly higher recovery was obtained with both Wilcox crude and with water at high temperatures than at low temperatures. In the intermittent drainage experiment flow of liquid from the bottom of the tube was stopped before drainage was complete, and the liquid distribution was determined immediately, and again after standing for some time. While shut in the upper part of the tube drained almost to equilibrium and the rest was enriched. On reopening the tube the initial rate of flow was greater than just before it was shut in.

Curves show the final vertical saturation distributions of the three liquids, the transient saturation distribution for Wilcox crude, cumulative drainage curves for Wilcox crude at different temperatures, drainage rates for water at different temperatures, and the data obtained in the intermittent flow experiment. G. D. H.

473. Patents on Production. A. J. Collins. U.S.P. 2,305,139, 15.12.42. Appl. 9.2.40. Firing means for well-perforating guns.

R. D. Alexander. U.S.P. 2,305,229, 15.12.42. Appl. 8.12.41. Signal apparatus in a well-tubing consisting of an electrode protruding outside the tubing.

H. U. Garrett and C. V. Temple. U.S.P. 2,305,250, 15.12.42. Appl. 23.2.39. Flow-valve in the side of well-tubing.

R. G. Taylor, Jr., and D. B. Hooser. U.S.P. 2,305,282, 15.12.42. Appl. 22.3.41. Swab-cup construction and method of making same.

R. B. Price and O. K. Hobbs. U.S.P. 2,305,388, 15.12.42. Appl. 9.5.41. Rodless bottom-hole pump with reciprocating cylinder and piston.

J. B. Van Horn. U.S.P. 2,305,648, 22.12.42. Appl. 15.12.41. Submersible motor structure having a dielectric in a motor housing and motor.

M. De Groote, B. Keiser, and C. M. Blair, Jr. U.S.P. 2,306,329, 22.12.42. Appl. 27.6.40. Process for breaking petroleum emulsions.

H. J. Pankratz. U.S.P. 2,306,558, 29.12.42. Appl. 6.5.41. Pump drive-head for use with a deep-well pump.

H. R. Pendleton. U.S.P. 2,306,560, 29.12.42. Appl. 21.6.42. Sand extractor for oil-well pumps.

W. N. Sutliff. U.S.P. 2,306,670, 29.12.42. Appl. 19.8.39. Well-casing perforating device comprising a motor driving a drilling bit at right angles to its own axis.

M. De Groote and B. Keiser. U.S.P. 2,306,718, 29.12.42. Appl. 27.6.40. Process for breaking petroleum emulsions.

C. M. Blair, Jr. U.S.P. 2,306,775, 29.12.42. Appl. 17.8.40. Process for breaking petroleum emulsions.

L. D. Mowrey. U.S.P. 2,306,828, 29.12.42. Appl. 23.10.40. Well flowing device, by gas lift.

K. Fischer. U.S.P. 2,306,940, 29.12.42. Appl. 22.10.41. Flow-meter using an orifice and turbulence creating means to make flow substantially independent of viscosity.

A. Boynton. U.S.P. 2,307,016, 5.1.43. Appl. 8.12.39. Differential stage lift-flow device, diaphragm type.

A. Moeller. U.S.P. 2,307,058, 5.1.43. Appl. 7.6.38. Breaking agent for emulsions from crude petroleum.

F. S. Tutton. U.S.P. 2,307,171, 5.1.43. Appl. 15.12.39. System and apparatus for flowing wells by means of flowing valves in the side of tubings.

A. J. Collins. U.S.P. 2,307,360, 5.1.43. Appl. 9.12.40. Well-perforating gun with firing by hydraulic pressure.

C. J. Coberly. U.S.P. 2,307,451, 5.1.43. Appl. 2.8.40. Hydraulic pump with mechanically actuated intake valve.

L. G. Davenport. U.S.P. 2,307,492, 5.1.43. Appl. 30.10.39. Adjustable beam-saddle for pumping beams.

M. De Groote and B. Keiser. U.S.P. 2,307,494, 5.1.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,307,494, 5.1.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

H. D. Woodmansee. U.S.P. 2,307,557, 5.1.43. Appl. 7.5.40. Apparatus for elevating fluids in wells.

A. S. Baylor. U.S.P. 2,307,662, 5.1.43. Appl. 22.7.39. Means for controlling wells by sealing its upper end.

A. D. Larson. U.S.P. 2,307,688, 5.1.43. Appl. 8.8.41. Combination sucker-rod guide and paraffin scraper.

J. L. Foster. U.S.P. 2,307,729, 5.1.43. Appl. 17.3.39. Well explosive in a projectile which is fired into the formation, wherein it explodes.

J. B. Picard. U.S.P. 2,307,952, 12.1.43. Appl. 15.6.40. Pumping jack in the form of a walking-beam structure.

C. H. Barnes. U.S.P. 2,307,983, 12.1.43. Appl. 22.1.40. Selective production means for wells, to be interposed in a tubing-string.

M. P. Burke. U.S.P. 2,307,991, 12.1.43. Appl. 21.4.38. Fluid lift-valve at bottom of tubings.

M. L. Hart. U.S.P. 2,308,004, 12.1.43. Appl. 10.1.41. Setting tool for bridging plugs for wells.

R. E. Hendrickson. U.S.P. 2,308,006, 12.1.43. Appl. 4.8.41. Perforation burr element in connection with a gun perforator used to reduce burr formation.

J. S. Crump. U.S.P. 2,308,156, 12.1.43. Appl. 29.8.40. Bore-hole sampler carried by a wire.

J. E. Eckel and G. M. McCarty. U.S.P. 2,308,160, 12.1.43. Appl. 16.3.40. Sand-filter for oil and gas wells.

E. L. Potts. U.S.P. 2,308,387, 12.1.43. Appl. 21.11.41. Tester to be used in oil wells.

O. F. Ritzmann. U.S.P. 2,308,390, 12.1.43. Appl. 9.12.40. Apparatus for detecting and exhibiting explosions in wells.

W. B. Campbell. U.S.P. 2,308,414, 12.1.43. Appl. 26.4.41. Treatment of wells prior to acidizing the formations.

C. A. Prince. U.S.P. 2,308,425, 12.1.43. Appl. 6.4.38. Treatment of wells to form an adherent cement lining on a section of a well-bore penetrating an acid-soluble formation.

A. B. Scott. U.S.P. 2,308,633, 19.1.43. Appl. 9.9.40. Sand-bailer and perforator cleaner.

O. E. Barstow. U.S.P. 2,308,668, 19.1.43. Appl. 28.8.40. Apparatus for treating wells by which two or more formations are treated simultaneously by fluids.

S. A. Brown and A. P. Ruth. U.S.P. 2,308,742, 19.1.43. Appl. 25.4.41. Pump in a tubular pump-casing.

M. De Groote and B. Keiser. U.S.P. 2,309,243, 26.1.43. Appl. 25.5.42. Process for breaking petroleum emulsions.

W. J. Crites. U.S.P. 2,309,383, 16.1.43. Appl. 8.3.41. Deep-well pump.

R. L. Kirkpatrick. U.S.P. 2,309,512, 26.1.43. Appl. 21.3.41. Gas-lift oil-recovery system.

C. J. Coberly. U.S.P. 2,310,397, 9.2.43. Appl. 24.1.38. Method of packing wells and removing sand grains from the production lines of wells.

C. E. Bodey, Jr. U.S.P. 2,310,507, 9.2.43. Appl. 22.11.40. Deep-well screen using helical wire and spreader members.

E. Burns. U.S.P. 2,310,572, 9.2.43. Appl. 26.9.41. By-pass-type liner hanger.

E. M. Wagner. U.S.P. 2,310,757, 9.2.43. Appl. 12.5.41. Means of preventing pitting of well-pumps. A. H. N.

Transport and Storage.

474.* Turbochargers Increase Output of Four-Cycle Diesel Engines. J. P. Stewart. *Oil Gas J.*, 24.9.42, **41** (20), 113.—With the object of utilizing all pipe-line facilities to the fullest extent, special attention is being given to obtaining more power reliably from existing pump-station diesel equipment.

As far as is known, superchargers installed at pumping stations are all designed according to the Buchi system, and the combined output of engines utilizing this method exceeds 2 million b.h.p. The system has been applied to numerous types and sizes of engines of conventional design, with substantial increases in output, generally of the order of 35–40%. Applications have been made successfully to both air and solid injection engines, as well as low, medium, and high-speed engines. In general the open-type combustion chamber with central injection has given the best results. A description is given of the turbocharger unit, and of its method of operation. Advantages to be obtained by the application of Elliott–Buchi turbochargers to existing engines are enumerated. In considering the application of a turbocharger to an engine, it must first be established whether the power increase can be utilized effectively by the driven machine. Since certain new engine parts are required when the turbocharger is installed, customary practice is to have such application sponsored by the original engine manufacturer. R. A. E.

475.* Study of Corrosion Aids in Protection of Pipe Lines. Anon. *Oil Gas J.*, 24.9.42, **41** (20), 191.—Selected portions of a review entitled "Corrosion in Soils" issued by the Bureau of Standards are presented. This review is a summary and restatement of observations related to underground corrosion that have been presented in publications of the Bureau of Standards and in technical journals, and is intended for the information of a non-technical enquirer who has a specific corrosion problem for which he requires a practical solution.

References to the more important books and articles dealing with corrosion are given. R. A. E.

476.* Chart Facilitates Determination of Tank Capacities. Anon. *Oil Gas J.*, 10.12.42, **41** (31), 44.—Charts and tables are presented to enable rapid determination of the approximate capacities of vertical tanks from a knowledge of the internal diameter, or internal circumference, and the height. The charts have been prepared by L. T. Monson of the Tretolite Co. of California and large reproductions of the scales are obtainable from the author and company. The scales cover a range of 8 ft. to 170 ft. internal diameter and 0·6 ft. to 65 ft. in height, and are divided into two sections, viz. below and above 55 ft. internal diameter. R. A. E.

Gas.

477. Compression Gasoline Recovery Combined with Pressure Maintenance. Anon. *Refiner*, December 1942, **21** (12), 473–474.—In order to take advantage of pressure maintenance in the reservoir of the Maljanar field, Lea County, New Mexico, compression recovery of natural gasoline was adopted for the co-operative project, which was completed in April 1942. Extraction is accomplished in four stages of compression from vacuum to 1600 lb., the requirement for the oil-producing sand. The plant is briefly described. A. H. N.

478. Methane Utilization in Italy. Anon. *Chem. Tr. J.*, 19.3.43, **112**, 271.—It has been stated that a large methane pipe-line is being erected in the Department of Emilia in Italy as a joint undertaking by the State Methane Co., the Azienda Generale Italiana Petrole and other companies. It will be about 168 miles long, and will carry 40,000 c. metres of methane daily at 200 atmos. pressure, half to Milan and about a seventh each for Reggio, Lodi, and Palma. The section from Milan to Piacenza has been placed in operation. C. L. G.

479. Butylene in Fruit Growing. Anon. *Chem. Tr. J.*, 9.4.43, **112**, 2916.—In the U.S.S.R., butylene is used to stimulate the growth and ripening of fruit trees such as apples, apricots, pears, plums, peaches, and walnuts, for which the growing season in many parts of the U.S.S.R. is too short to allow of full maturing. The tree is enclosed in a tent for two weeks before the growth-cycle starts, and butylene is passed into the tent in concentrations of 1 part in 100,000 of air, at a temperature of 69–100° F. for 1–2 hours. C. L. G.

Refining and Refinery Plant.

480. Boiler Plant Operation and Care. R. W. Machen. *Refiner*, December 1942, **21** (12), 451–454.—The problems of operating and maintaining boilers are discussed, the following recommendations being the main final conclusions : (1) Inspect the water level in the boiler frequently, not only by the visual means provided by the water-gauge glass, but also by using the try-cocks. The use of the try-cock will often show that the gauge-glass is not working properly. (2) Low-level instructions should be carefully followed. Water should never be pumped into a boiler that has a low water level, and it is advisable to cut the fire under that boiler until it has cooled sufficiently to permit the raising of the water level to its proper position. Continued firing and pumping of water into a boiler having a low water level may cause destruction of the boiler along with damaging effects to other parts of the equipment, and even loss of life. (3) Pressure-gauges and safety-valves should be inspected regularly and kept in shape to meet any possible emergency. (4) Boilers should be blown down properly and as a matter of routine. The number of times each tour that the boiler must be blown down is dependent on the concentration of chlorides in the boiler, and on the general overall condition of the feed-water. The percentage of blow-down will vary with the conditions under which the boiler is being operated. (5) Preparation and inspection of the boiler should always be made before it is fired up, to assure that the water level, draft, gas-free combustion box, and valve positions on incoming and outgoing lines are all in their respective correct positions and condition. It is important that the firemen know how to turn the boiler into the steam-header. The most common abuses are the ignoring of the safety precautions concerning the clearance of the combustion chamber of any accumulated gases, firing up with too high or too low water level, firing the boiler too rapidly, and cutting the boiler into the battery header before the boiler pressure is as high as the header pressure. (6) The correct routine for bringing a boiler out of normal service should include the sealing-off of steam, blow-down, and feed-water valves. Disconnection of fuel-lines from the burners and slow cooling of the boiler by leaving the fire-box and smoke-box doors closed should be emphasized. (7) Elimination of oil from the feed-water should be a prime requisite, and the scale accumulation should be kept at a minimum by proper treatment. The best policy is to start proper care of the boiler when it is unloaded and loaded for movement. Starting out with a new boiler means starting out with a clean boiler. Keeping it clean by blowing down frequently and washing periodically and regularly will increase its useful life.

The position of the burner has also a great effect and must be carefully studied.

A. H. N.

481. Installation and Servicing of Pumps and Compressors in Refining Service. J. F. Rollins. *Refiner*, December 1942, **21** (12), 455–462.—Detailed instructions are given for the correct procedure and precautions to be taken in installing compressors. Lubrication is discussed separately and at length, and maintenance is also discussed.

If there is excessive condensate in the gas being handled by the compressor, a knock may develop which might appear to be in the running gear of the machine. If the discharge is on the bottom side of the cylinder, the knock will be less pronounced than when the suction is on the bottom. When these conditions are encountered, several different measures may be taken to overcome the difficulty. If possible a condensate-removal pot should be installed on the suction line just before the machine; a leg with a drain may be provided for at the point where the gas enters the cylinder; a drain can be installed on the cylinder so that the condensate can be drained from the suction-valve pocket, or the cooling water to the compressor jacket may be heated so as to maintain the temperature of the metal above the dew-point of the gas. If this is done, care must be taken to ensure that the water is uniform in temperature, so as not to set up excessive stresses in the water-jacket metal. This may occur if the water is heated by the direct injection of steam. Where this method is used, the injection point should be sufficiently removed from the cylinder, and the line should be large, so that an even temperature is maintained. The injection of steam may cause the formation of scale in the lines or water-jackets. A heat exchanger is preferable to the direct injection of steam, as a more uniform temperature is assured. The heat exchanger method also eliminates the possibility of deposit, and will be found to be much more satisfactory.

The safety devices used on compressors have undergone extensive improvement, so that at the present time a very satisfactory control or alarm can be obtained for practically any purpose. This has eliminated the possibility of a hazardous condition developing from the leakage of inflammable gases in the vicinity of a machine. However, even though these accessories may be explosion proof, certain safety practices must be observed in order to ensure that an accident will not occur. If, after a thorough knowledge of the conditions, it has been deemed necessary to install explosion-proof equipment, all accessories should be of that type. If one device of several is not of the safety design, the advantage of the others is greatly diminished, and may eventually prove to be a definite hazard. Such a condition may cause the operating personnel to become careless, which is a situation the management of every plant wishes to avoid. A. H. N.

482. Maintenance Shop Prolongs Meter Usefulness. Anon. *Refiner*, December 1942, **21** (12), 463–466.—A description is given of a particular maintenance and repair shop. When any meter, regardless of time in service, shows that either the static or differential will not zero correctly, or that any other function is out of calibration, it is removed from the station and a reconditioned instrument installed in its place. All fittings, except the orifice flange, are removed from the setting. The levelling flange and support go with the instrument, so all parts can be inspected when it arrives at the shop. The shop operates on a production-line system, with the receiving dock at one side and the meter store-room at the other. Meters are broken down at the dock. All parts, after preliminary inspection, are placed in a wire basket and lowered into a vat of boiling chemicals to remove paint and field grime. Then a water-bath removes both chemicals and grime. After dyeing, each part is brushed to remove powdered residue, rust, and discoloration.

The batch of parts is sorted, with pen lifters, pen parts, " U " bends and check valves, floats, and pressure-tight bearings all laid out separately for inspection. The mercury pot is brushed on the inside, and any lumps chipped or ground down so that the interior surface is free of protuberances which might hinder the float from rising and falling with full freedom. The assembled by-pass piping and needle valves are cleaned on the inside by blowing with compressed air, after which this portion of the piping is tested for leaks. If none are apparent, the assembly is not broken down, but when pinholes or defective threads are indicated, new nipples are substituted. After the parts are brushed they are further inspected and repaired, painted or lacquered and assembled, so that it is difficult to distinguish between the new and the repaired meter. To ensure long service and correct recording of the flow of gas through the orifice fitting, repairs are limited to the meter-shop. Nothing of importance is done in the field towards adding or withdrawing mercury from the float chambers, and the only attention an instrument receives while in service is the care given it by the chart man, who only takes off and replaces charts and winds the clock. Protection is afforded the instrument at the meter station by a sheet-iron shield, which prevents the entry of rain when the chart door is opened. This shield is attached to the case by stove-bolts, employing the mounting holes in the flange of the case which may be used if the instrument is set on a board inside a building.

A. H. N.

483. Mechanical Performance of Hot-Oil Centrifugal Pumps. A. J. Stepanoff. *Refiner*, December 1942, **21** (12), 467–472.—The development of the modern hot-oil pumps depended on a satisfactory solution of the following problems : (1) Stuffing box ; (2) high speed for high heads ; (3) coking of pump passages ; (4) design of casing to stand high pressures, temperatures, and corrosion ; (5) heat expansion with seizure and scoring of internal parts ; (6) uneven heat absorption and radiation by pump casings. Each item is discussed separately. In connection with the stuffing boxes, experience has taught that a good metallic packing, rustless hard sleeves, and freedom from vibration are the prerequisites for successful stuffing-box operation. The number of rings should not be too great, as even with hot oils a satisfactory studding-box operation depends on a slight leakage for lubrication. To prevent hot oil spraying by the shaft-sleeve, a water-quench on the gland is used. Water-jacketing of stuffing-boxes is universal on hot-oil pumps. The application of centrifugal pumps to pumping of light hydrocarbons in recent years presented somewhat different stuffing-box problems, but with experience accumulated on hot oils, these were satisfactorily solved in a comparatively short time. In this case the liquid is cold, while the stuffing-box pressures are high, and the liquid flashes into gas at atmospheric pressure ; thus it is impossible to lubricate stuffing-boxes with the pumped liquid. In most cases sealing of the stuffing-boxes with a heavier oil at a pressure slightly above the vapour pressure of the pumped liquid is resorted to. In many cases heating of the stuffing-boxes through the jackets has been found helpful to counterbalance the refrigerating effect of the escaping expanding gas.

One of the more interesting problems discussed in connection with thermally caused troubles is that of a heated member being confined in space by an uninsulated casing. The diaphragm separating the suction-chamber from the discharge casing is closely fitted into the casing. A pump of this type when pumping oils at temperatures of about 800° F., when the casing is not insulated and exposed to outside temperature, will have the diaphragm at the temperature of the hot oil, while the casing is several hundred degrees lower. The expansion of the diaphragm being restricted by the cooler casing may result in a compression of the diaphragm and tension in the casing beyond the elastic limit, and both will receive a permanent deformation. When cold, the diaphragm will be loose in the casing. If the joint between the volute casing and suction chamber is made without a gasket (depending on metal-to-metal fit), loss of capacity will result when the pump is operated at a temperature lower than the maximum to which the casing was subjected. The magnitude of stresses developed under such conditions can be judged by the fact that steel casings were found cracked under such conditions with perfectly sound steel castings of normal wall thickness. Calculations show that if a steel bar is heated and its expansion is prevented by an outside force it takes 100° F. for the bar to reach its elastic limit of 50,000 lb./sq. in. If heating is continued, the bar will get a permanent deformation and will be crushed. On cooling, the bar will contract in a regular manner, and will be shorter than the original length. This is independent of bar section or length. A. H. N.

Chemistry and Physics of Petroleum.

484.* The Oxidation of Aliphatic Hydrocarbons. G. Egloff, D. V. Nordman, and P. M. Arsdell. *Oil Gas J.*, Part I, 24.9.42, **41** (20), 207 ; Part II, 1.10.42, **41** (21), 35 ; Part III, 8.10.42, **41** (22), 49.—The oxidation of hydrocarbons plays an important rôle in the oil industry, *e.g*, in corrosion, formation of gum in gasoline, deterioration of lubricants, combustion of fuels for heating and operation of engines, and production of oxidized derivatives.

The articles deal with the oxidation of the aliphatic hydrocarbons only. Theories of mechanism of reactions which have been propounded are presented and discussed. References to the literature are provided, and results obtained by investigations are briefly summarized under appropriate headings. Oxidation reactions of aliphatic hydrocarbons are characterized by induction periods and are sensitized by the addition of intermediate oxidation products. Alkane oxidation occurs at temperatures lower than are necessary for alkene–oxygen reactions.

Hydrocarbon–oxygen reaction rates are increased by increase of pressure, alkanes being more affected by pressure change than alkenes. Normal alkanes are more readily oxidized than branched isomers, and lengthening the normal chain facilitates oxidation.

Part I deals mainly with the thermal oxidation of alkanes. Effects of temperature, pressure, composition of reacting mixture, addition of substances which accelerate or inhibit the rate of reaction are discussed. A table shows reaction conditions and reaction products obtained from the lower members of the series. Oxidation of the higher-molecular-weight aliphatic petroleum fractions and solid waxes has been of considerable importance from an industrial aspect, *e.g.*, the manufacture of lubricant additives, soaps for use in textile industries, emulsion breaking agents, foam preventers, etc.

Part II. Alkane oxidation may be catalyzed by nitrogen oxides, metals, and metallic oxides. The use of oxidants other than oxygen, *e.g.*, metallic oxides, ozone, perchloric acid, etc., is also discussed. A table shows the types of reactions mentioned in these two sections, indicating the hydrocarbon treated, temperature of reaction, catalyst used, and reaction products obtained. From mixtures of hydrocarbon gases in the form of refinery and natural gases, *iso*propyl alcohol, acetone, ethyl alcohol, acetic anhydride, methylethylketone and ethylene glycol have been produced on the commercial scale.

Products obtained by thermal oxidation of alkenes up to C_8 are detailed, with information on the effects of temperature, pressure and other conditions of operation, the use of inert gases as diluents and effects of addition of oxygenated products.

Part III deals mainly with the effects of various catalysts on the thermal oxidation of alkenes, with the use of oxidation agents other than oxygen gas, *e.g.*, ozone, hydrogen peroxide, selenium dioxide, permanganate, etc., and with the oxidation of alkynes. Suitable tables summarize the principal data available on these subjects under the headings of hydrocarbon, oxidation agent, catalyst used (if any), temperature and pressure of reaction and reaction products formed. R. A. E.

485. Chemical Utilization of Natural Gas and Natural Gasoline Hydrocarbons by Oxidation. H. Linford. *Refiner*, December 1942, **21** (12), 439–446.—According to figures presented by the Bureau of Mines, the estimated production of natural gas in the United States in 1939 was 3,333,500,000,000 cu. ft. Of this amount 2,476,756,000,000 cu. ft., or about 74% was marketed; 856,744,000,000 cu. ft., or 26%, presumably being used in the oil-fields for pressuring wells or wasted. Roughly, 15% of the marketed gas was used in the production of carbon black and 85% used as fuel. The average value for natural gas in the United States in 1939 was 4·9 cents/1000 cu. ft. Some interesting calculations have been made to show the weight of natural gas produced in the United States. By making broad assumptions as to its average composition it is estimated that in 1939 about 100,000,000 tons of natural gas was produced. Assuming that all of the gas was treated for the recovery of natural gasoline there should have been produced about 9,000,000 tons of natural gasoline, including butane and propane, leaving approximately 91,000,000 tons of the dry gas. This is obviously a rich raw material source and justifies investigation of its possible chemical utilization. The paper discusses the possibilities of each of the lower members of the paraffin homologues and of natural gas.

The apparent slowness of the oil industry to enter the chemical field is attributed to the facts that (1) the industry has been so engrossed in producing huge quantities of crude oil and refining this material at a profit that consideration of chemical outlets, which at best would utilize relatively small amounts of petroleum, has not seemed desirable; (2) the costs of plants required for chemical production are, in general, far greater than the usual refinery construction costs; (3) the rapidly changing character of the chemical market makes it imperative that a manufacturer be ready to convert his plants and processes to meet the changing conditions. Thus, chemicals that to-day are novelties and of little commercial value, may to-morrow be required in large quantities, and others, which to-day are being used in large amounts, may be displaced to-morrow by better or cheaper substitutes. A. H. N.

486. Pilot-Plant Study of the Gray Clay-Treating Process. A. W. Cobb and L. Carlson. *Refiner*, December 1942, **21** (12), 447–450.—Early investigations are described and the reasons for building the pilot plant discussed. An experimental pilot plant was installed close to the large plant cracking equipment, taking vapours from the vapour line leading to one of the plant Gray units. In this way an entirely representative portion of the cracked gasoline and fixed gases was available for the experimental unit. It was also possible to compare directly the plant-scale-treating operation with the results on the experimental unit.

The experimental unit consisted of two complete clay-treating systems, each having its own after-fractionator, condenser, and receiver; the two systems were so arranged that they could be operated in series, in parallel, or singly. An important advantage of the double system and parallel operation provision resided in the fact that when investigating such variables as catalyst, time of contact, etc., it was always possible to compare the effect of the experimental conditions simultaneously and directly with the effect of standard operating conditions and on precisely the same feed-stock. Accurate determination of the effects of individual variables with a single experimental unit is not feasible, due to the normal variation in the commercially-produced feed to the experimental unit from day to day and from run to run. (The simultaneous operation of a control as described is somewhat analogous to running a blank in analytical chemistry.) A flow diagram illustrates the plant, and its operation is fully discussed. The results of the pilot plant are correlated with results of large-scale plant and compared with laboratory glass clay-treating apparatus.

In contrast to the direct correlation between pilot-plant and large-scale treating is the performance of a laboratory-glass clay-treating apparatus used for some earlier investigations. This apparatus operated at atmospheric pressure and about 300° F. with the rate of throughput in brl./ton/hour of treated gasoline being about double normal plant rates, but with the vapour velocity lower than normal plant velocities due to the shortness of the clay bed. In this case the copper-dish gum of the treated product was at all clay lives considerably higher than plant gasoline, and the colour of the treated product began to drop from 30 Saybolt at about 200 brl./ton clay life and reached about 23 Saybolt at 600 brl./ton.

Experimental results are studied in some detail. A. H. N.

487. Frictional Phenomena. VI. A. Gemant. *J. Appl. Phys.*, January 1942, **13** (1), 22–29.—In this part of the series of papers by the author the methods of measuring viscosity are reviewed. Capillary viscometry of Newtonian substances is discussed, and with it a new type of capillary viscometer, the oscillation viscometer. Instead of employing a stationary flow, it operates on the basis of maintained oscillations of the liquid in a tube of circular cross section. Thus it is not time, but simply the amplitude of the oscillation that is measured. Although the actual displacement varies periodically with time, the amplitude is constant, and can be made to be read directly. The amplitude in such a system is given by the pressure amplitude divided by the resistance of the liquid column. Generally, there are three elements of resistance—namely, gravitation, inertia, and viscous forces. In the apparatus designed by Southwell and the author, the resistance is mainly due to viscosity. The working of the apparatus and the formula used for calculation are given. The viscometer is direct reading.

Couette and falling sphere viscometers are then discussed with references to the literature on the different modifications made. Finally the principles of determining the viscosity of liquids by measuring the propagation and absorption of supersomics are discussed. A. H. N.

488. On the Resistance to the Uniform Motion of a Solid Through a Viscous Liquid. II. R. B. Block. *J. Appl. Phys.*, January 1942, **13** (1), 56–65.—This paper constitutes the answer to some adverse criticisms (*ibid.*, 1941, **12**, 257–258) of an earlier paper having the same title and reporting evidence for the assumption of liquid slip at the surface of a solid motion through a viscous liquid (*ibid.*, 1940, **11**, 635–642). The importance of the results contained in the earlier paper to viscometry by the rolling-ball method is emphasized. This relation exists because the author's apparatus was essentially a rolling-ball viscometer. References are given to independent studies by other investigators which also support the hypothesis of liquid slip. The possibility of the phenomenon being apparent only is brought out by presenting two other interpretations of the author's observations. A new and more accurate method of converting time of roll into viscosity of the liquid than the current graphical one is presented for the rolling-ball viscometer, together with an apparent reason for believing that the calibration curve of this viscometer may not always be independent of pressure. The author's reasons for considering this new source of error in the use of the rolling-ball apparatus for high-pressure viscometry to be actually non-existent are given. Finally, the author discusses an original method for checking the validity of the hypothesis of liquid slip in the case of the rolling-ball viscometer that is entirely different from the method he used in his earlier paper. A. H. N.

Analysis and Testing.

489.* The New Edition of the I.P. Standard Methods for Testing Petroleum and Its Products. J. Cantor, E. P. Driscoll, and A. Osborn. *J. Inst. Petrol.*, January 1943, **29** (229), 21–35.—The new edition of the " I.P. Standard Methods for Testing Petroleum and its Products " is discussed by the authors, new or modified sections or tests being particularly mentioned, and the reasons for the modifications being explained. The paper is followed by a discussion by various members of the Institute. A. H. N.

490.* The Analysis of Trinidad Crude Oils. F. Morton and A. R. Richards. *J. Inst. Petrol.*, February 1943, **29** (230), 55–74.—The method developed in the laboratories of Trinidad Leaseholds, Ltd., for detailed examination of crude oils consists essentially of three separate analyses designated : (*a*) Primary Evaluation, (*b*) Naphtha Characterization, and (*c*) Supplementary Analysis. Each of these items is discussed separately and illustrated diagrammatically where necessary. The normal crude oil evaluation methods have been intended to include detailed analysis of a number of fractions obtained by precise fractionation of the naphtha (F.B.P. 200° C.). The graphical representation of this analysis is shown to be characteristic of the oil, and can be used for the correlation of crude oils, as well as for the detection of minor differences in crude oils produced from the same zone. Details are given of the characteristics of the crude oils from the established producing horizons at the Forest Reserve Field of Trinidad Leaseholds, Ltd. A. H. N.

Special Products.

491. Comparative Toxicity of Kerosines. J. K. Finnegan, E. L. McCawley, O. L. A. Strait. *U.S. Federation Proceedings*, March 1942, **1** (1).—In a study of the effect of type of kerosine vehicle used in fly-sprays, comparative toxicity tests were carried out on a Mid-Continent and a West Coast kerosine by administering to mice a daily oral dose of 5 c.c. per 12 gm. With the Mid-Continent kerosine after six doses, six out of ten mice were killed, and all were dead within two weeks, there being progressive and marked weight loss. With the West Coast kerosine, all were alive after six doses, and six out of ten were alive after four weeks, there being no significant weight changes. Spectroscopic examination of the kerosines revealed chemical differences, but the toxic factor has not yet been isolated. C. L. G.

492. Toxicity and Antiseptic Action of (Petroleum and Coal Tar) Cresylic Acids. J. Campbell. *U.S. Federation Proceedings*, **1** (1).—Comparative tests on petroleum and coal tar cresylic acids indicate that (1) an hour's inhalation of air saturated with cresylic acid (either type) causes local irritation of the eyes and upper respiratory tract, repeated exposure producing several reactions. (2) The petroleum acids are less toxic on oral administration and less irritating to the skin than the coal tar acids,

though both may be absorbed with toxic symptoms. (3) Standard disinfectants from saponified petroleum acids at a concentration of 0·05% are bactericidal at 20 min. application to standard cultures of *S. aureus* and *B. coli* and have no effect on embryonic chick heart, whereas those from coal tar acids at the same time/concentration are not bactericidal and reduce growth and activity of embryonic chick heart.
C. L. G.

493. Gulf Coast Refineries are Abundant Chemical Sources. W. L. Nelson. *Oil Gas J.*, 25.6.42, **41** (7), 165.—The Gulf Coast area is favourably placed for the manufacture of petroleum chemicals, owing to the presence in the crude of relatively high proportions of aromatic hydrocarbons and to the large amounts of natural gas and distillate well fluids available. There is enough butane available to make 400,000 tons of synthetic rubber per annum, or to make the alkylate required for 50,000 brl./day of 100 octane gasoline. Toluene is being manufactured by (*a*) distillation from high aromatic crudes, (*b*) catalytic dehydrogenation and cyclization of *n*-heptane, and (*c*) as a by-product in catalytic cracking processes. While the volume of new chemical products is very small compared to that of normal petroleum products, the cost of production is very much higher, as shown by the following plant costs per brl. daily capacity: complete topping plant $100–150; complete refinery $250–400; 100 octane gasoline $900–1400 and synthetic rubber $20,000–27,000. Not only are the chemical operations involved more lengthy and complicated than normal plant operations, but a high degree of purity of product is required, necessitating further expensive and troublesome operations. The C_4 hydrocarbons are likely to form the largest source of chemicals, as the lower hydrocarbons must be handled at high pressures, while the higher hydrocarbons are very difficult to separate. In general the lower boiling paraffins, unsaturateds, particularly dienes, and aromatics are likely to be the basis of the petroleum chemical industry. C. L. G.

494. Wide Variety of Chemicals Made from Refinery Gases. W. T. Ziegenhain. *Oil Gas J.*, 25.6.42, **41** (7), 185.—The present trend towards greater correlation of oil production and refinery operations resulting from lower crude oil prices, is likely to lead to greater utilization of refinery by-products for the production of chemicals. A list of typical petroleum chemicals available is given and a tree showing derivatives of pentanes by pyrolysis, oxidation, and chlorination. Details are given of the chlorination process. C. L. G.

495. The Comparative Toxicity of 2-Chloro-2-Butene, 1 : 2 : 3-Trichlorobutane and 1 : 2-Dichloroethane. E. L. McCawley. *Univ. of California Publications in Pharmacology*, 1942, **2** (8), 89.—In view of the better solvent properties for industrial purposes of 2-chloro-2-butene and 1 : 2 : 3-trichlorobutane over 1 : 2-dichloroethane (ethylene dichloride), the toxicity to mice of their vapours and the irritating effect on the skin of rabbits of the liquids have been compared. It is suggested that these materials show the same order of toxicity for human beings as for mice, and that the industrial hazards can be estimated from the following data for the three products: (A) 1 : 2-dichloroethane, (B) 2-chloro-2-butene, and (C) 1 : 2 : 3-trichlorobutane: Concentration detectable by smell (parts per million), (A) 300–1000, (B) 300–1000, (C) 300–1000. Maximum concentration that can be inhaled for 1 hr. without serious disturbance (parts per million): (A) 3000, (B) 10,000, (C) 2500. Dangerous after 30 mins./1 hr. exposure (parts per million): (A) 6100, (B) 48,800, (C) 3000–10,000. Rapidly fatal for exposure less than 15 min. (parts per million): (A) 24,400, (B) 73,200, (C) 10,000. Thus 2-chloro-2-butene is the least dangerous. It is pointed out that 1 : 2 : 3-trichlorobutane has a relatively low volatility, and may therefore be apparently safe, but if the temperature is raised it becomes very dangerous, death occurring without preliminary anæsthesia. This product is also the most irritating, causing considerable erythrema after 1 hr. contact, resulting in inflammation after 24–48 hr. with hematoma and later ulceration. The other two products cause much less irritation and recovery is more rapid. C. L. G.

496.* Styrene for Rubber made from Benzene, Alcohol, or Ethylene. Anon. *Oil Gas J.*, 26.11.42, **41** (29), 34.—The two main processes in commercial use for the production of ethyl benzene for styrene consist of the alkylation of benzene with (*a*) ethylene or (*b*) ethyl alcohol. In the former process (Dow) ethane is cracked to ethylene which is freed from propylene and contacted with nitration grade benzene (boiling range 1° F.) at about 190° F. and 15 lb. pressure in the presence of anhydrous aluminium chloride catalyst. The crude ethylene used may be as low as 38% pure, and 2° F. boiling range benzene can be used with only a minor lowering of yield. 75–100 lb. of ethyl benzene is obtained per lb. of catalyst, of which 80% is recoverable. Sulphur has no adverse effect on the catalyst. The polyethyl benzenes formed as by-products can be dealkylated to give the monoethyl product. In the latter process, 95% ethyl alcohol and benzene are contacted with an inert solid catalyst saturated with phosphoric acid at 600° F. and 250 lb. pressure. Removal of the water of reaction is a difficulty, but has been attained by reacting only a part of the reactants at a time, removing the water, and recycling the unreacted components. Dehydrogenation of the ethyl benzene to styrene presents the difficulty of controlling the position of the dehydrogenation reaction (nucleus or sidechain) to reduce side products. This is done by preheating the ethyl benzene vapours with an excess of highly superheated steam; the use of catalysts (*e.g.*, oxides of aluminium, vanadium, chromium, and zinc chromate) gives successful results, but the process is not yet commercial. The styrene is prevented from decomposing or discolouring by the addition of 0·005% of inhibitors such as *tert.*-butyl catechol. C. L. G.

497.* Chemical Materials Used in Rubber Manufacture. Anon. *Oil Gas J.*, 26.11.42, **41** (29), 49.—In general, synthetic rubber requires similar types of plasticizers, softeners, accelerators, tack-producing agents, inhibitors, etc., to those used with natural rubber, but the conditions of application, proportions, etc., require investigation. Inhibitors such as dialkyl amines, diaryl or alkylaryl amines, and other amino-compounds, cresols, substituted catechols, hydroquinones, etc., are used to inhibit premature polymerization of butadiene and styrene. Vulcanization accelerators used include guanidine, thiazoles, sulphamines, and thiazolines and zinc dithiocarbamate, over-curing having less effect on the properties of synthetic rubber than on natural rubber. Tack agents used include pine tar, rosin oil, cumar, etc., and softeners used include coal tar, phthalates, sebacates, ricinoleates, aromatic ethers, triacetin, and various proprietary products. Synthetic rubbers being normally stiffer than natural rubber require more control in softening. Aromatic mercaptans are useful as plasticizers. The type of carbon black is very important in synthetic rubber production. The coarse thermal blacks have less reinforcing effect than the finer channel blacks, etc., but give easier processing, better hysteresis, higher rebound, etc. In general, ink and acetylene blacks are preferred for tyre tread stocks, owing to better strength and durability, and the finer thermal blacks and special reinforcing blacks for side walls where heat resistance is of great importance. Less sulphur is required for the vulcanization of synthetic rubber, accelerators such as tetramethyl and thiuram disulphide, and activators such as zinc oxide, fatty acids, etc., being also used. Inhibitors such as butyl and phenyl-β-naphthylamine are used to reduce ageing of the rubber, as well as heat-resistant anti-oxidants. C. L. G.

498.* Raw Materials for Synthetic Rubber Intermediates. W. L. Nelson. *Oil Gas J.*, 26.11.42, **41** (29), 34.—A review is given of the potential sources of supply, and the yields from them of the raw materials required for manufacturing the estimated U.S. requirements of the main synthetic rubber intermediates—viz.: (1) Styrene, 230,000 t.p.a., (2) *iso*butene, 143,000 t.p.a., and (3) butadiene, 710,000 t.p.a. (1) The styrene will be derived, mainly from the dehydrogenation of ethyl benzene prepared from ethylene or ethyl alcohol and benzene. 5,400,000 cu. ft. of ethylene p.d. will be required, some possibly from coal gas, but the suggested source is 6,400,000 cu. ft. of ethane (from 53,000,000 cu. ft. of natural gas per day). While the potential production of ethylene is 8,820,000 cu. ft. per day, the difficulty of transfer to central chemical plants renders the production from natural gas more likely. To produce the ethyl alcohol (100,000 gallons per day) as an alternative source of ethyl benzene, 13 million bushels of wheat will be required. The benzene also required (140,000 gallons/day) is more likely to be obtained from coal (43,000 tons/day) than from petroleum. (2) *iso*Butene is derived from petroleum only, the raw materials required being either (*a*) 60,000 brl./day of natural gasoline giving 4900 brl./day of *iso*butane, or (*b*) 16,000 brl./day of natural gasoline, including the isomerization of butane, or (*c*) the cracking and distillation of 220,000 brl./day of crude oil to give 143,000 tons p.a. of *iso*butene, both direct and via *iso*butane. (3) The butadiene required can be derived from petroleum in several ways—viz., (*a*) by direct dehydrogenation of 28,500 brl./day of butane from 115,000 brl./day of natural gas or 1,270,000 brl./day of crude oil (by the Houdry process-yield 67%), or a two-stage process involving cracking and dehydrogenation of the butenes, or (*b*) by high-temperature pyrolysis of 250,000 brl./day of naphtha or gas oil (from 420,000 brl./day of crude) yields 3·9% or (*c*) by best temperature pyrolysis of 2000 million cu. ft. of natural gas per day to acetylene (2·5% yield), from which acetaldehyde and butadiene can be derived, or (*d*) conversion of ethylene into alcohol, thence into butadiene (yields of 20% based on ethane are claimed). The alcohol required—2 million gallons/day—may alternatively be derived from 260,000,000 bushels of wheat, 10,000,000 tons of molasses, or 32,000,000 tons of sugar beet, cane, or potatoes p.a. Yields of 20–30% of butadiene by direct conversion from alcohol are claimed.

It is considered that ample stocks exist, without disturbing other requirements, of mixed butanes, natural gas, petroleum naphtha, and coal, whereas benzene and alcohol are deficient in quantity. Production of intermediates from petroleum has the advantage of giving rise to other valuable products, aviation gasoline, toluene, fuel oil, etc. The recovery of *iso*butene from cracked gases for polymerization appears to entail large amounts of equipment and high operating costs compared with direct production from, *e.g.*, *iso*butane. C. L. G.

499. Synthetic Rubber from Petroleum. G. Egloff. *Refiner*, December 1942, **21** (12), 114.—(N.B.—As this paper is in the non-continuous section of the *Refiner*, it may not be found in bound volumes of this journal after 1943.) The paper reviews the industrial as well as the technical significance of the synthesis of rubber. Synthetic rubber is compared with its natural prototype. The problems are viewed from war purposes standpoint. A. H. N.

500. Simple Tests for Estimating the Suitability of Mineral Oils as Mosquito Larvicides. W. A. L. David. *Bull. Ent. Res.*, September 1942, **33** (3), 195.—A specification for a suitable anti-malarial oil is given with details of the significance and method of carrying out the tests.

The proposed specification is: (1) specific gravity at 15° C./4° C.; not > 0·950 (*i.e.*, sufficiently below that of water), (2) Not > 5% should distil over at 200° C. (to control loss by evaporation and hence increase of viscosity which may affect toxicity and penetrating properties), (3) viscosity not > 10·0 centistokes, equivalent to 52 secs. Redwood I. or 1·83° Engler at 70° F. (to ensure adequate penetration of the tracheæ), (4) spreading pressure not < 16 dynes per cm. (to ensure that the oil will cover the surface evenly, displacing contaminating films), (5) the films produced by the oil must remain uniform and unbroken for at least 2 hours (some oils give unstable films, breaking up into lenses) and (6) when tested by the described method the oil should kill at least 50% of the larvæ when *Aedes ægypti* are used or 90% when *Anopheles maculipennis* are used.

Appendices are included, giving notes on blending procedure and of the ways in which defects in the product can be overcome, with general information on the average properties of petroleum oils used in anti-malarial oils. C. L. G.

501. The Utilization of Waste Lubricating Oil in Mosquito Larvicides. W. A. L. David. *Bull. Ent. Res.*, December 1942, **33** (4), 235.—The suitability of nine samples of waste lubricating oil from aerodromes for incorporation into mosquito larvicides has been examined. They varied in viscosity from 360 to 2520 secs. Redwood I. at 70° F., and had spreading pressures of 16 dynes/cm. or over, with one exception, which had been filtered, but still contained carbonaceous matter and water. Blends were prepared of 10–15% kerosine, 60% diesel oil, and 28–30% of waste oil to have a viscosity of about 52 secs. Redwood I. at 70° F., and these all showed a spreading pressure of 16 or over with good film stabilities. (The diesel fuel used had a spreading pressure of 16 dynes/cm., so that it does not follow that all waste oil could be used to the above extent with any diesel fuel.) Up to 1% of cresylic acids or crude castor oil may be added to improve spreading pressures, but crude palm, ground nut, coconut, and rape oils induced film instability. The toxicity of the blends against *Aedes* *ægypti* was unsatisfactory, possibly owing to the carbonaceous particles in the waste oil clogging the spiracles, and thus preventing spread into the tracheæ. Removal of carbonaceous matter by treatment with fuller's earth increased the kill to satisfactory proportions, but reduced the spreading pressure. To overcome this difficulty tests were carried out with an oil film of twice the thickness (4·4 fluid oz. per 100 sq. ft.), this giving very satisfactory results. High kills at the lower film thickness were also recorded against the more easily oiled Anopheline larvæ. It was established that by reducing the viscosity of blends to about 45 secs. Redwood I. at 70° F., by using 10–20% only of the waste oils, satisfactory spreading pressures, film stabilities, and toxicities could be obtained. It is concluded that blends containing 28–30% of waste oil are not as effective as approved commercial larvicides at the same dosage, but if this is increased from 2·2 fluid oz. to 4–6·7 fluid oz. per 100 sq. ft. (the highest dosage is required only against colicine larvæ), satisfactory results are given. Limiting the waste oil content to 10–20% gives effective larvicides. C. L. G.

502. Memorandum on Measures for the Control of Mosquito Nuisances in Great Britain. J. A. Sinton and P. G. Shute. Ministry of Health Memo 238/Med., 1943.—The habits, distribution, prevalence, and importance to man of the British species of mosquito are described and details given of the recommended methods of treatment of breeding grounds. While the different types require varying treatments, according to habits, breeding places, time of breeding, etc., the following general methods of control are given :—

1. *Against Adult Mosquitoes.* (*a*) Species which hibernate inside buildings are best controlled by spraying with 2–5% solution of carbon tetrachloride in kerosine, or 5% aqueous solution of cresol disinfectant, or preferably pyrethrum solutions in kerosine (100–120 mgms. pyrethrins per 100 c.c.). This should be done in the autumn at the beginning of hibernation and in spring before emergence. (*b*) Preparations containing citronella oil are recommended as mosquito repellents.

2. *Against Larvæ and Pupæ.* (*a*) Breeding places should be filled in, or drained wherever possible, water receptacles being kept covered or emptied and cleaned regularly. (*b*) In ornamental ponds the introduction of goldfish will keep down mosquitoes and in ponds, etc., cutting down vegetation causing shade will help, as will frequent sluicing of dykes, etc. (*c*) Larvæ and pupæ can be suffocated by spreading on the surface of the water special anti-malarial oils such as one part of crude heavy oil to four parts of kerosine. (The addition of 0·2% castor oil will increase the spreading power enormously and 1% of cresol will increase the toxicity.) ½ oz. of oil per sq. yd. or 15 gallons per acre should be used. Filtered waste crank case oil mixed with 10–20% kerosine and 1–2% castor oil can also be used. For large areas, spraying is the best method of distribution, but for smaller areas the oil may be spread with a bundle of rags or sacking on a stick. Oiling is useful where there is not too much vegetation, high winds absent along the edges of deep ponds and lakes, in prelighting water tanks, etc. Treatment should be repeated every two weeks during the breeding periods. Domestic water containers can be treated with 4 tablespoonfuls of petrol per sq. yd. or if fitted with taps at the bottom with 1½ teaspoonfuls per sq. yd. of liquid paraffin. Chemical larvicides recommended include: (1) sufficient cresol type disinfectant to give a concentration of 1 in 30,000 (economic only for shallow pools, etc.), (2) ½ lb. per acre of Paris green (copper aceto arsenite) mixed with an inert dust (only suitable against Anopheline larvæ, not Culicines), (3) 1½ to 2 gallons per acre of a stock pyrethrum-oil-soap emulsion containing 95 parts light fuel oil, 5 parts pyrethrum extract (containing 2½ grms. pyrethrins per 100 c.c.), 5 parts of coconut oil potash soap and 45 parts of water. This is harmless to fish, water fowl and plant life and as it does not spread well may require to be used in quantities of 6 gallons per acre, if there is much vegetation or floating debris. C. L. G.

503.* Wartime Chemicals from Natural Gas. G. Egloff. *Petrol. Times*, 6.3.43, **47** (1190), 110. *Presidential Address before American Institute of Chemists.*—Dr. Egloff discusses the various chemicals obtainable from natural gas, and in this, the first part of his lecture, synthetic aviation fuels and rubbers receive the most attention. In general, one can say that synthetic rubber is at least equivalent to the natural; the chemist's goal is not necessarily to synthesize a duplicate of natural rubber, but it is certain that whatever properties rubber has that are needed will not only be duplicated but radically improved and new ones added. Synthetic rubber is superior to natural rubber in gasoline, oil, and chemical resistance. The synthetic product is more stable to light and air and has greater wearing properties. Some trucks using synthetic rubber tyres have gone over 35,000 miles. Side-wall tyre strength is greater, meaning greater safety and better road gripability. The latter property has been tested out thoroughly on wet and muddy roads. Tests on hills with different trucks have shown that the synthetic rubber-tyred vehicle goes up a hill with very little side-slipping, whereas the tyres of natural rubber slipped all over the road. On curves, when operating the car at high speeds, the synthetic tyre is safer than the natural. With the number of research men in the field of synthetic rubber, with expenditure of millions of dollars yearly, one can feel confident that synthetic rubber tyres will evolve with a life of at least 100,000 miles, or, expressed another way, the tyres may well outlive the motor-car. The author believes that synthetic rubber will play a permanent part in the life of the U.S.A. A. H. N.

504. Synthetic Drying Oils. H. J. Wolfe. *Paint Manufacture,* March 1943, **13** (3), 59.—Much progress is being made in the improvement of slow drying oils by production of a conjugated double bond system by (*a*) conversion of isolated double bonds in the fatty oil to conjugated bonds, (*b*) dehydration of hydroxy acids in oils which contain them, and (*c*) dehydrogenation of oils by halogenation followed by dehydrohalogenation. A synthetic drying oil (marketed as S.D.O.) of particular interest is produced by the partial polymerization of divinylacetylene and the tetramer of acetylene, the product being prevented from completing the polymerization by dilution with solvents. On evaporation, polymerization is completed, being accelerated by oxygen and light, giving a hard transparent, amber coloured resinous film. The dried film is impervious to moisture, oils, ammonia and dilute acids, but lacks stability and has poor adhesion when pigmented. The synthetic oils obtained by co-polymerization of phthalic anhydride, glycerine, oils, and oil acids (alkyds) have exceptional toughness, flexibility, and adhesivity and require less oxygen for drying. It is said that a commercial process was in operation in Russia prior to the war for the production of drying oils from petroleum by chlorinating a hydrocarbon fraction from naphthene base crude and reacting it with another fraction which has been oxidized and saponified. Products obtained experimentally from cracking residues may be treated with catalysts to yield synthetic drying oils, but they have dark colours and unsatisfactory weather resistance. C. L. G.

PUBLICATIONS RECEIVED.

Institution of Automobile Engineers, Proceedings. Vol. XXXVI. Session 1941–1942. Pp. 513. Institution of Automobile Engineers, 12, Hobart Place, London, S.W.1.

Among the twelve papers presented before the Institution during the session 1941–1942 the following may be mentioned as being of particular interest to the Petroleum industry :—

The Performance of a Converted Petrol Engine on Producer Gas. (J. Spiers. Report of the Automobile Research Committee.)
Engine Bearing Temperature. (J. Spiers. Report of the Automobile Research Committee.)

British Standard No. 76 : 1943.—Tars for Road Purposes. Pp. 12. British Standard Institution, 28, Victoria Street, London, S.W.1. Price 2*s*. net.

A war emergency specification which takes into account the considerable advance which has been made in the development of modern road tars.
The road tars are divided into three types, based on road requirements, and not on viscosity as heretofore; type " A " having the most rapid setting properties, type " C " being slow setting, and type " B " occupying an intermediate position.
The viscosity range has been expanded, and a new system of indicating viscosity has been introduced, namely, the Equi-Viscous Temperature.
Changes have been made in the schedule of requirements, and the applicability clause now contains sufficient information to enable engineers to choose the tar they require for any purpose.

British Standard No. 463 : 1943.—Sockets for Wire Ropes for General Engineering Purposes. Pp. 12. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s*. net.

The sockets specified are of normal type for general engineering purposes, and are efficient and permanent terminal attachments for wire ropes, where other methods are precluded. Special attention is directed to the short parallel length and orifice radius at the smaller end of the " basket " in both the open and closed type sockets specified.

Reference is made to the following British Standards :
B.S. 24. Part 4 : 1930, Specifications 8 and 9.
B.S. 643. Capping Metal for Steel Wire Ropes.

British Standard No. 796 : 1943.—Rubber Hose with Cotton Braided Reinforcement. Pp. 18. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s*. 6*d*. net.

War Emergency Standard including specifications for oil, grease, and Solvent Hose, High Pressure Hose for use with Oil Emulsions, etc., and requiring reference to the following British Standards :

B.S. 903. Methods of Testing Vulcanized Rubber.
B.S. 924. Rubber Hose with Woven Fabric Reinforcement.

British Standard No. 924 : 1943.—Rubber Hose with Woven Fabric Reinforcement. Pp. 20. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s*. 6*d*. net.

British Standard No. 1102 : 1943.—Rubber Suction and Discharge Hose with Woven Fabric and Wire Reinforcement. Pp. 26. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s*. 6*d*. net.

British Standard No. 1103 : 1943.—Cotton Fabrics for the Reinforcement of Rubber Hose. Pp. 8. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s*. net.

War Emergency Standard dealing with cotton fabrics for use in the manufacture of all types of wrapped hose.

British Standard No. 1041 : 1943.—Temperature Measurement. Pp. 76. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 12*s*. 6*d*. net.

A temperature measurement code divided as follows : (1) General, (2) Expansion Thermometers, (3) Electrical Resistance Thermometers, (4) Thermocouples, (5) Radiation Pyrometers, (6) Electrical and other Auxiliary Instruments used in temperature measurement, (7) Change of State of Testing Body, (8) Calorimetric Measurement of Temperature, (9) Temperatures in the Interior of Solids, (10) Surface of Solids, (11) Liquids, (12) Gases, (13) Calibration Methods.

References are made to the following British Standards :—89, 593, 619, 691, 692, 695, 791.

British Standard Code of Practice No. CPI : 1943.—Protection of Structures against Lightning. Pp. 30. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s*. 6*d*. net.

It is considered that this code of practice will meet a wide demand for authoritative guidance on the subject of protection against the effects of lightning.

British Standard No. 1042 : 1943.—Flow Measurement. Pp. 64. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 12*s*. 6*d*. net.

A code setting out the conditions governing the design installation, and use of standard pressure-difference devices in order to obtain consistent and generally acceptable results from commercial instruments.

INSTITUTE NOTES.

May, 1943.

CANDIDATES FOR ADMISSION.

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

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

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

Bailey, Clifford Henry, Mechanical Engineer, Iraq Petroleum Co., Ltd. (*R. V. Browne ; A. J. Perks.*)

Chapman, Stanley Frank, Deputy Maintenance Manager, Middlesex County Council. (*R. F. A. Baldwin ; L. F. Moore.*)

Finnigan, Peter Francis, Engineer, Petroleum Board. (*S. J. W. Pleeth ; F. Tipler.*)

Fisher, John William, Designer-Draughtsman, " Shell " Refining & Marketing Co., Ltd. (*E. Le Q. Herbert ; Dr. C. G. Williams.*)

Ivey, Terence, Manager & Group Transport Officer, Middlesex County Council. (*R. F. A. Baldwin ; L. F. Moore.*)

Mackinder, Richard, Senior Asst. in Laboratory, " Shell " Refining & Marketing Co. (*P. M. Griffiths ; J. D. Hall.*)

Mulhern, John, Regional Technical Officer, Ministry of Fuel & Power. (*G. B. Pound ; Dr. A. J. V. Underwood.*)

Rumble, Victor Horace. Research Chemist, Anglo-Iranian Oil Co. (*Dr. A. E. Dunstan ; Dr. D. A. Howes.*)

Sharp, William Robert, Engineer, Petroleum Board. (*F. Tipler ; F. E. Chilvers.*)

Wandycz, Damian, Acting Chief of Office of Energetics, Polish Ministry of Industry, Commerce & Shipping. (*Dr. J. A. Kronsten ; Cecil W. Wood.*)

Windebank, Charles Stanley, Chemical Engineer, International Association (P.T.), Ltd. (*H. C. Tett ; W. E. J. Broom.*)

FORTHCOMING MEETINGS.

On 24th June, Dr. H. Ter Meulen will read a paper on " Solvent Refining of Lubricating Oils."

LUNCHEON.

A luncheon will be held at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2, on Wednesday, June 23rd, 1943.

Further details will be issued in due course.

ANNUAL GENERAL MEETING.

It is hoped to hold the Annual General Meeting on the above date prior to the luncheon.

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

Kindly mention this Journal when communicating with Advertisers.

LIST OF ADVERTISERS.

Kindly mention this Journal when communicating with Advertisers.

VALVES FOR THE PETROLEUM INDUSTRY

An oil well "Christmas Tree" equipped with Newman-Milliken Valves.

Newman-Milliken Glandless Lubricated Plug Valves are widely used in refineries and oil fields. These valves employ a parallel plug which is never raised from its seating during operation, consequently no grit or foreign matter can enter between the valve seating surfaces. Another unique feature is the absence of packing gland and gaskets, thus obviating the need for periodic attention. Newman-Milliken Valves are made in sizes from ½" to 12" and for working pressures to 3000 lbs. per square inch.

NEWMAN-MILLIKEN

GLANDLESS LUBRICATED PLUG VALVES

Sole makers under licence, excluding the U.S.A.

Newman, Hender & Co. Ltd.

WOODCHESTER NH GLOS. ENGLAND

CONTINUOUS WASHING

Holley Mott Plants are efficiently and continuously washing millions of gallons of Petroleum products daily. Designed for any capacity. May we submit schemes to suit your needs?

HOLLEY HM MOTT

Continuous Counter-Current Plant

Telegrams: "Typhagitor, Fen, London."
Telephone: Royal 7371/2.

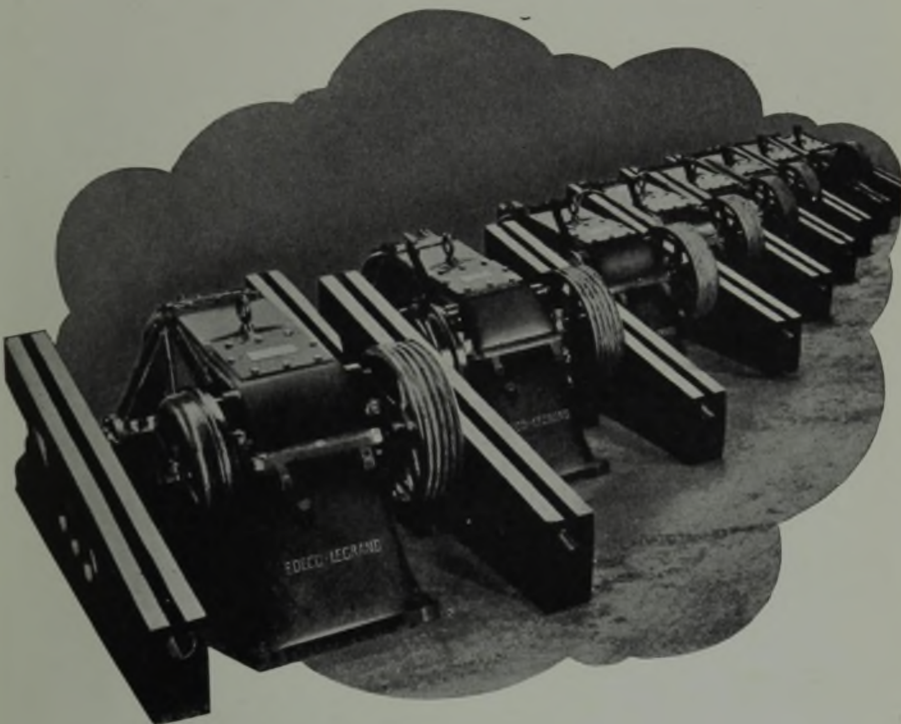
World-Wide Licensees, **H.M. CONTINUOUS PLANT LTD.**
FOUR LLOYDS AVENUE, LONDON, E.C.3.

Kindly mention this Journal when communicating with Advertisers.

EDECO LEGRAND

ESTD. 1872

EDECO-LEGRAND PUMPING UNITS



★ SPEED REDUCERS for pumping equipment, ready for testing

Manufactured in Association with David Brown & Sons (Huddersfield) Ltd. and The Power Plant Co. Ltd., West Drayton, Middlesex.

LEGRAND SUTCLIFF & GELL LTD.

SOUTHALL, MIDDX. Phone : Southall 2211

Associated with

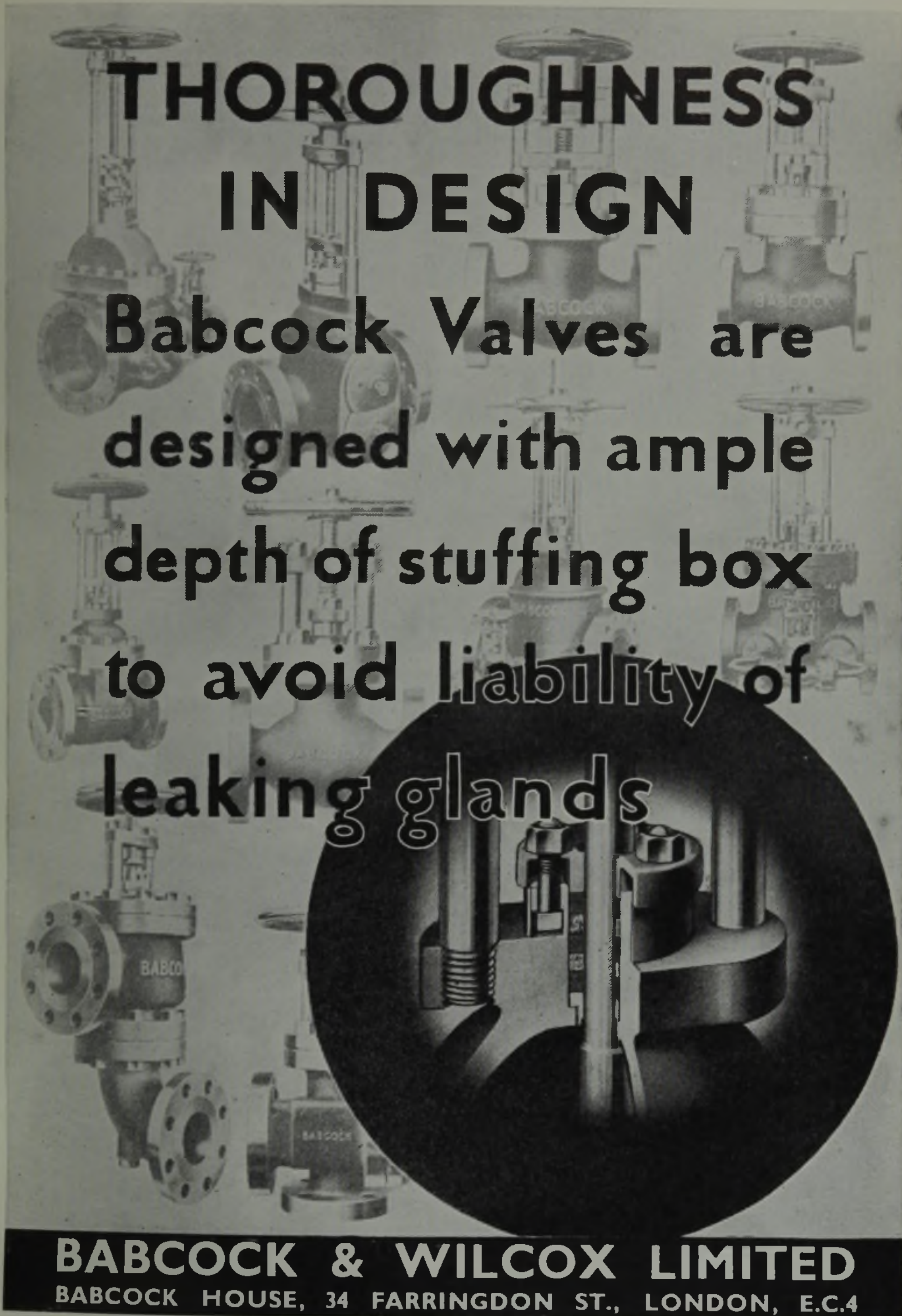
ENGLISH DRILLING EQUIPMENT CO. LTD.

WALTON-ON-THAMES, SURREY. Phone : Walton-on-Thames 860

GP. 6564

FOR OIL-FIRED FURNACES

Kindly mention this Journal when communicating with Advertisers.


THOROUGHNESS
IN DESIGN
Babcock Valves are designed with ample depth of stuffing box to avoid liability of leaking glands
BABCOCK & WILCOX LIMITED
BABCOCK HOUSE, 34 FARRINGDON ST., LONDON, E.C.4

Kindly mention this Journal when communicating with Advertisers.