EDUCATION AND THE PETROLEUM INDUSTRY.

By Professor V. C. Illing [Member].

Introduction.

It is a sound instinct that has raised the cry for a broader and better education in the Britain we hope to build after the war, sound because it indicates a true searching of hearts, a deep dissatisfaction with some features of the world of yesterday, and a clear conviction that we must and can build better in the future. So far as education is not the mere accumulation of unassimilated facts, but is rather a moulding of character by knowledge rightly used, it cannot be denied that more education for all would lead to a much better world. We must, however, beware in this mood of disillusion and endeavour, lest in our eagerness to improve we fail to value all that was good in the past and destroy some of our most valuable heritages; nor should we forget that the building of new systems needs hard labour, money, and time.

The incidence of heavy taxation which has borne unduly on the middle classes has raised financial problems in the public schools, which see in prospect a considerable reduction in the number of their pupils unless State-endowed Bursaries can provide a solution. At the same time criticism of these schools, merited perhaps in some few instances, but on the whole biassed and mischievous, has given the iconoclasts an excuse to indulge their instincts for destruction, whilst others have visualized one common type of education in the future to which all must conform. These are bewildering thoughts to those of us who see much good in the present system, even if it be capable of great improvement, and we can only hope that the natural instincts of our people to hasten by degrees will preserve and improve our educational system rather than destroy and attempt to rebuild it.

It is mainly in the home and in the school that the basic foundations of character and knowledge are laid. On these foundations the Technical Colleges, Universities, and eventually Industry may build structures of imposing dimensions, but their security will depend on whether the foundations have been truly laid. It is therefore to the homes of England and her schools that we must look if we want our future citizens to be worthy of her traditions and leadership.

The members of this Institute, whose interests are intimately bound up in the well-being of the petroleum industry, cannot but be vitally concerned in the quality of the young men and women who are to carry on in the future. It is one of our first duties to ensure that they be carefully selected, properly trained, and well led, for if we believe that our industry is unique, as we all most certainly do, then nothing but the best is good enough.

Integration of the Petroleum Industry.

Before we consider how this ideal of education is to be achieved, it is necessary that we examine our own industry in detail, to find out what is expected of the men who enter it and what kind of training will best fit them for the type of work they are asked to do.

In speaking of the petroleum industry above, the word " unique " was used advisedly, for it can be claimed that no other industry has harnessed the sciences so completely in the service of the community. Its function has been to turn the natural product petroleum to purposeful use, but it has taken so broad a view of its duty that it might well write as its motto " From the depths of the earth to the door of the consumer." What other industry controls so completely every phase of the development of its products? It searches the wide world for its raw materials, drills for and produces them, and then converts them into a galaxy of products, each of which is carefully controlled in its manufacture to suit the purpose for which it is made. It carries these products in its own ships, pipe-lines, and tank waggons to wherever people congregate, and watches men's needs so carefully that it anticipates rather than answers their demands. It has revolutionized transport with the fuels which it has developed for the internal-combustion engine, and now it bids fair to multiply enormously the range of its products in every phase of life. No other industry can claim such breadth of achievement, such versatility in application. Yet the oil industry is still young—barely eighty years, if we exclude the primitive efforts of antiquity. Its main vigorous growth has been achieved in the last thirty or forty years, and has been largely bound up with the development of the motor-car.

No chart of oil production nor catalogue of the numerous oil-fields discovered can convey more than a glimpse of the real history of its phenomenal growth, the enormous difficulties which it has overcome, the unfaltering courage and perseverance which it has shown. These virtues have produced the great oil companies with their ramifications over the wide world, the sturdy, independent companies which maintain their position by being deeply anchored in their environment, the innumerable individualists who are prepared to back their skill and their opinion against all comers. They have created the community of oil-men who, though scattered through the world and speaking many languages, are bound together by their common problems.

There are, it is true, other sides of this picture which are not so pleasing. The early rhythm of boom and slump, the wastefulness of primitive methods of production, the unfortunate features of intense competitive drilling—these were the growing pains of a young and vigorous industry, and most of them have been removed or are being eliminated by the good sense and spirit of co-operation which, curiously enough, can live side by side with vigorous competition. We have learned in the hard school of experience that co-operation brings good to all, and we can justly claim that in its relative freedom from strikes and lock-outs the petroleum industry sets a standard of which it can well be proud.

As an industry grows up and becomes more complicated its members inevitably pay the price of a gain in efficiency by a loss of independence. They lose, too, the mental stimulus of being able to visualize the organization as a whole as they become immersed in their own immediate problems. In a vague and general way each of them is aware of the fact that in the body of the industry there are other members, other limbs which carry out different functions. They are also aware, perhaps more dimly, that without these other limbs they would be unable to function properly; that their work might even cease to exist. They know, of course, that it is the chief concern of the refiner to transform the crude into a series of products which will satisfy the public needs; that the production engineer is mainly concerned in the recovery of the oil from the depths of the earth, whilst the geologist plays his part in discovering and developing new oil resources without which the industry would die. Few, however, are sufficiently familiar with the difficulties which are associated with each of these separate operations and the way in which they have grown to their present stature. To appreciate these difficulties and how they have been overcome is the true foundation for that perfect co-operation based on mutual respect.

The fact is that our industry has grown rapidly and almost spontaneously wherever oil could be found or a market could be served. To do this it attracted to itself in its early days adventurous spirits of every type and training. Only as it has grown up has it segregated itself, so far as its staff is concerned, into bands of technicians, such as geologists, chemists, engineers, etc., each particularly concerned with one phase of its activities. This is a great source of strength so long as it is associated with safeguards, but it carries within itself certain latent sources of weakness which need to be watched carefully. Where operations are uniform and stereotyped a form of procedure can be adopted which meets the case, and it can be carried out by the individual whose training fits him peculiarly for the particular work; but where the factors are changing or new difficulties are continuously being faced, it is the exception rather than the rule to find that the solution lies completely within the boundaries of a single science. This is particularly true of the oil industry, in which progress has become more and more a matter of team work, not only between similar scientists, but among scientists and engineers of very different training.

For purposes of effective study, Science has been segregated into a series of units—physics, chemistry, botany, zoology, geology, etc.—wherein matters which have a common field of interest are considered separately. By so doing the interest and training can be concentrated in those directions which are most effective for the particular field of inquiry. This is essential for success where the field of interest is so vast and knowledge is expanding at such a rapid rate, but the partitioning must not blind us to the fact that there are no real boundaries between the sciences. They are merely different aspects of the one natural world, convenient sub-divisions of a single universal truth. There is, moreover, an undoubted danger in building up these stereotyped units, for a No-man's-land is apt to emerge in the boundary areas which can eventually only be bridged by the creation of new scientific labels, new fields of study. Normally there would be no harm in this were it not for two tendencies: firstly, the growth of knowledge leading to a much greater degree of specialization, and still further segregation; and secondly, the development of scientific jargon which makes one science almost unintelligible to another. Both these processes are inevitable, but their effects should be carefully controlled, and one can only hope that the second tendency will be kept within reasonable bounds by the good sense of our scientists. It is all very well to coin a new word in order to attain a greater precision of expression, but we should never forget that in so doing we are creating a new language which is bound in the end to limit our audience.

It would, I think, be generally agreed among scientists that progress in the sciences is apt to be exceedingly irregular, the slowest rate of advance being usually in the boundary areas between the sciences. Collaboration between the different sciences, which is essential in these boundary zones, is apt to be less effective than it is within the bodies of the sciences. This is not due to a lack of the co-operative spirit, but rather because it requires the merging of different trains of thought and different methods of attack.

The impact of this partitioning of the sciences on an industry like petroleum, which casts its net over so broad a field, is bound to have interesting and far-reaching results; nor can one fail to note that these results are only in the main beneficial. The problem is solved by collaboration, by creating teams of workers whose flexibility and breadth of knowledge are ideal weapons with which to solve the problems, and by developing societies in which all branches of some particular industry are studied.

It is not, however, always easy for the scientist to find his feet in these industrial fields, especially if his training has been on highly specialized lines. He may, of course, be needed for his own particular field of study alone, though his contribution will be the better for his appreciation of its rôle in the general picture. The main body of scientists in the petroleum industry are, however, members of teams, and the value of their work as a whole depends not only on their own contributions, but on the building of separate units of work into a composite picture. The success of this process depends not only on the guiding hand, but on the ability of each worker to appreciate the contributions of the others and to work with them effectively. Thus we may see physicists, chemists, geologists, and engineers all making their individual contributions to achieve the one desired result. As examples of this collaboration between scientists and engineers it will be appropriate to make a rapid survey of some of the sections of the petroleum industry, in order to obtain a picture of the processes at work.

(*a*) *Exploration.*

The search for petroleum is not the prerogative of any particular science. Indeed, with such an elusive substance, discovery is often the result of several lines of attack. On the other hand, there can be no doubt that, in so far as it is the function of geology to study the natural history of petroleum, the intelligent search for oil must largely be guided by the philosophy built up by the geologist. The tools, however, which are used by the scientist and engineer in the search for oil are many and various, and they are daily increasing in their scope. It is important to discriminate between the guiding principles on which a search for petroleum should be based and the tools by which this end is accomplished. In a new area of exploration it would undoubtedly be the function of the geologist to assess the chances of success and to draw up the general strategy of attack, but the plan of campaign would inevitably require more than the mere application of geological method. The help of geophysicists using various selected methods of delineating buried structure, that of the chemist in examining surface samples, and finally that of the engineer in the final drilling campaign would probably all play their part in an efficient scheme of testing.

Where the general geological picture is already well known and the area has previously been examined by geological means, it may afterwards be combed over with success by new prospecting tools. Thus, for instance, in many parts of the U.S.A. areas have been successively attacked by geologists, torsion-balance crews, refraction and finally reflection seismic parties. In each of these campaigns it must be remembered that the party is not attempting to find oil directly, but to discover geological structures, which, on the principles worked out as a part of geological philosophy, are favourable to the accumulation of oil within the rocks known to exist in the area. Thus, whatever the tool used in the attack, we always come back to two geological requisites for success, the stratigraphy of the area and the details of the structure. Both of these come directly within the purview of the geologist, and without a sound geological training it is impossible to appreciate their true significance in any given area.

This latter point cannot be too strongly stressed, not merely because it illustrates the true function of geophysics in exploration—*i.e.*, the discovery of buried geological structures by physical measurement—but because it calls attention to another feature recognized freely by eminent geophysicists : that their methods of attack have advanced at a greater rate than their theories of interpretation. The reason for this is the simple fact that interpretation of geophysical data must require the insight of a geologist, because the final picture in which they are portrayed must be in geological terms.

The collaboration of geologist and geophysicist is therefore one of those typical examples of the blending of the sciences with which our industry abounds. Short of drilling, the physicist possesses the only tools for direct measurement into the earth, but the results which he obtains must be presented in geological terms, and therefore need geological control, particularly if they are to be obtained as economically as possible. The geologist's knowledge of the stratigraphy of the area and the general structure, together with other indirect methods of structural interpretation, enable him to reject or select the various possibilities suggested by the physical data, and the collaboration of the two sciences during the period of the survey is undoubtedly the best method of carrying out any form of geophysical examination.

This point has been gone into at some length because the relations of geology and geophysics in oil-finding have been much misunderstood. They are often regarded as rivals, instead of as allies. Faults undoubtedly have been present on both sides, each science failing to realize the immense help to be obtained from the other. The differences are, however, more deep-seated in their origin. They go back to the different methods of training in the two sciences. The physicist is trained to measure with great accuracy, and is interested only in the physical side of the picture he is creating; the geologist is keenly alive to the living meaning of the picture depicted and is interested mainly in what it represents in terms of geological history. The points of view are fundamentally different, and they can only be brought together by mutual understanding between the two groups of scientists.

That there have been exceptions to these sweeping statements is happily true, and the expanding use of geophysics in oil geology has owed a great deal to the encouragement of far-sighted geologists, among whom the writer remembers with gratitude the names of de Böckh, De Golyer, and Barton. These and many others laboured patiently to bring the new weapons into successful use and put them on secure foundations.

Returning to the question of oil exploration, whilst geology sets the field and conducts most of the search, it is not alone responsible for the discovery of oil. The true function of geology is rather in the elimination of unnecessary risks, the balancing of the main chances, the planning of the drilling campaign to test the area as economically as possible. Many oil-fields have been found without geological help, and undoubtedly many oil-bearing structures still buried beneath the earth will be found in the future by random effort rather than by applied geology, with or without the help of geophysics. The plain fact is that there are some types of pools which cannot be discovered by any known method of scientific approach, but can only be found by the courage of the oil operator who is prepared to accept very great risks. It is the duty of the oil companies to reduce their risks in oil-field exploration, and geology offers the soundest method of achieving this end. This is shown by the fact that geology has been responsible for the major number of oil discoveries, and also that, in spite of the relative exhaustion of the shallower pools and those which are easy to discover, the general percentage of failures in wildcat drilling has not tended to rise. It would be churlish, on the other hand, not to pay a great tribute to the success of the geophysical tool, particularly in recent years, and the writer would regard future oil discovery as a form of geological investigation in which geophysics plays an essential part.

Until recently we have been discovering new oil-fields at a rate which has kept pace with the increased demand, though we cannot guarantee how long this happy state will continue, and for the time being the war has sadly interfered with the rate of new discovery. This success has been due to the great expansion in our knowledge of the types of structural conditions which tend to produce and conserve oil-pools, to the improvement of our methods of direct and indirect attack, and to the great advances in the efficiency of drilling operations. To these we must also add the new methods of geophysical investigation when the drilling has actually reached the oil-bearing formations, notably the Schlumberger surveys giving a simple and rapid means of recognizing the positions of the reservoir rocks and of identifying their contents. Above all, the progress is due to the teamwork of groups of scientists and engineers who form the nucleus of the staffs of operating companies. Such exploratory teams are only built and welded into successful instruments of discovery by years of experience. Their strength depends largely on the perfect co-ordination of each individual's contribution, and the wise oil company treasures such teams as the best insurance for its future success.

Teams such as these are only built by men who understand the functions of each individual member, and they are only possible where the individuals know how to work together to obtain a combined result. For the success of such work each man must know the part he has to play and its function in the general scheme. He must also value the help he can obtain from his colleagues and that which he himself can contribute to their work.

The foregoing does not imply that oil cannot be discovered by the individualist, but only that it is getting more difficult as the fields to be discovered get fewer and more deeply buried. The task demands more and more help from all possible methods of investigation, and therefore it needs scientists of broad vision, who not only know their own work, but can call on brother scientists to help them out of their difficulties. The demand is therefore for two almost contradictory attributes: a broad basis of scientific knowledge and a greater degree of specialization in one particular direction. Whilst these two requisites appear mutually antagonistic, they need not necessarily be so if we choose to make the first the prime objective of our educational system, and allow the second to be built up largely by experience.

The author has dwelt at some length on the need for co-ordination of the sciences and engineering in oil discovery in order to exemplify the problems common to every phase of the industry and as a basis of his plea that though we need the highest quality of technical preparation yet this must not be bought at the price of too early and extreme specialization. The foundations of our knowledge must be broad and deep if the work is to reach the highest levels.

(*b*) *Oil Production.*

The succeeding sections need not be dealt with at such length, because they each and all point the same moral. Production combines the two problems of drilling for oil and collecting it at the surface. This is essentially the task of an engineer, but it is not one in which engineering alone can solve all the involved problems. The successful extraction of the largest possible quota of oil from an oil reservoir demands an intimate knowledge of the structure of the reservoir rock, its porosity, and its permeability. Associated problems are the presence of water-bearing formations, of free gas, gas in solution, the sources of reservoir pressure, and the type of movement of gas, oil, and water within the structure as the pressures and the contents change. These are studies in which geology and physics are intimately concerned, so that exploitation calls for an intimate knowledge of both these subjects if it is to be carried out with full efficiency. The modern conception of unit production, the conservation of reservoir pressure, systems of re-pressuring, gas drive, and water drive, are all the outcome of the collaboration of the sciences. Furthermore the recent application of electric logging of wells has revolutionized well completion methods by its clear-cut identification of the levels at which gas, oil, and water exist in the formations. It has also revolutionized the methods of subsurface geological investigation in some fields, rendering it possible to obtain a clearer picture of correlation than by any other means. Nor can the production problems within a field be adequately faced without the use of chemical science. Modern processes of drilling are greatly dependent on efficient mud control, and a whole science of the doctoring of muds has arisen as a consequence. The tendency of many rotary holes to become oblique has led to a careful control of their verticality, or alternatively to special methods of three-dimensional survey wherein the deviation can be carefully checked and placed on record. The great depths of modern drilling and the high pressures encountered have brought new problems to metallurgy to provide equipment and casing which will stand up to the new demands, and great ancillary industries have grown up to cater for the needs of oil production. Engineering problems change from field to field, and include problems of transport, of surface terrain, of drilling under the sea, in swamps, in dense forests or arid deserts, of drilling to depths of two miles and more through formations of every type and character, drilling which must be done speedily and with efficiency if costs are not to become prohibitive. That this has been successfully achieved is a great tribute to the work of oil-field engineers, but they would be the last to claim that this is due to their efforts alone. It is again the result of the same team work but of a different balance in the relative importance of the contributing technicians.

(c) *Transport.*

The oil industry is dealing with a crude product and with refined derivatives which may vary very much in their physical character. They may be highly viscous or exceedingly mobile, inert or highly corrosive. They are usually volatile and often highly inflammable. Quite wisely the oil industry has realized that the task of transporting such material is a special one, and it has therefore taken it into its own hands. For transport over the seas it arranges for the building of special fleets of tankers which are among the best examples of the genius of our shipbuilding yards. Overland, the oil is carried in great trunk pipe-lines which may transport it thousands of miles and collect it from innumerable feeders. Transport by rail or by road is provided by thousands of tank cars which are specially designed for the task. The industry has great tank farms, usually constructed of steel but sometimes of earth or concrete, which are necessary to preserve the millions of barrels of its products which must act as a buffer between the producer, the refinery, and the market. In addition to the problems of administration, there are problems of pipe corrosion, of evaporation, and a whole number of other complications which bring the engineer, the physicist, the chemist, and even the biologist into the picture before they can be finally solved.

(d) *Refining.*

There is little need here to dwell on the problems of refining, for they have been discussed in all their aspects in the pages of the Institute's *Journal*. There is, however, one point which cannot be stressed too strongly. The modern refinery, with its co-ordinated units, each devoted to particular reactions, fractionation, topping, cracking, alkylation, pyrolysis, isomerization, re-forming, and other processes, gives rise to engineering problems in its construction as numerous as the chemical reactions which take place in the units. Furthermore, without the innumerable physical instruments by which these reactions can be followed and controlled the plant could not be operated. Refining is as far removed from the laboratory apparatus of the chemist as a modern steamer is from its working model, and many a chemist who may feel at home in his laboratory finds it difficult to become acclimatized to the new world of a refinery because of the difference in environment. Yet, in spite of all this, the operations which are carried out in these highly specialized plants are basically chemical, following the principles worked out in the laboratory by chemical science. Therefore, though many different sciences contribute to the success of a refinery, the basic principles on which it works lie primarily in the field of the chemist.

It has always seemed to the author that the oil which the geologist and engineer have been at such pains to find and produce is too good to burn. That the same general view seems to be gaining acceptance in the chemical world is a welcome sign of the times. All honour to the men who are delving into its nature, breaking and re-making its constituents into new and more useful substances, and opening a new vista wherein oil bids fair to become the basis of a whole series of new chemical products.

(e) *Marketing.*

The oil industry prides itself on its ability to meet the demands of the consumer. This entails a close contact with those who are using its products, and, as petroleum is not a fixed and uniform material, it requires the development of a large number of standard tests to create standard products. For the efficiency of this testing and marketing trained scientists, in particular chemists, physicists, and engineers, are needed. Their work is mainly carried out near the consuming centres, and an important section of the research laboratories of the industry must always be associated with them. Much of the testing of the special motor fuels is an engineering rather than a chemical problem, and most of us are familiar with the great strides in the improvement of fuels which have taken place as the result of such examination and of the close collaboration between the engineer and chemist in the standardization of new fuels.

Finally, it is an essential pre-requisite for success in each of these sections of the industry that the technicians must be continuously reaching forward to new achievements. The very multiplicity of their problems creates a flexibility of view which is the finest foundation for future progress, and the environment engenders a research outlook which is the key to all advancement.

Education for the Oil Industry.

In the preceding review of the functions of each department of the oil industry it has been reiterated almost *ad nauseam* that in the main oil work is team work, the members of the team belonging generally not to one particular science, but to a wide range of the sciences and engineering subjects. If this claim be accepted, it must also be conceded that the average technician required by the industry must have a broad scientific basis as well as a specialized knowledge in his own particular branch of the subject. If he is to form a successful unit in a team, his fundamental knowledge in mathematics, physics, and chemistry must be sound. In no other way can he appreciate the value of the contribution which his colleagues can make to his work, and he to theirs. This is a generalization to which there are a few exceptions, but it is a good working hypothesis for the industry as a whole.

One of the major difficulties with which the British oil industry is faced in its recruitment policy is the fact that the principal oil-producing centres are abroad. Refining and marketing do not suffer from this handicap, at least not to the same extent, but the net result of this condition is that there is no corporate community centralized in any part of our Islands which represents the life of the petroleum industry as a whole and could be expected to provide a local population from which recruitment for the industry could draw much of its material. Whatever may be our position in the future, this has been a serious handicap in the past, and on the whole the industry has done remarkably well in spite of it.

Those who have anything to do with recruitment for the staffs of the oil companies realize that the position is by no means easy. The appeal of a life abroad and of a change of environment is not as strong now as it was in the Victorian period. A student can satisfy his desire for adventure in many other ways, and furthermore, the trend of modern inventions has been to bring the conditions of foreign lands so close to us that their romance has worn somewhat thin. A further problem which is very material to the issue is the small size of the average middle class family in England at the present time, and the natural reluctance of parents to see their only son choose a profession which will inevitably lead to his separation from them for long periods. There is, however, no lack of the spirit of adventure in the rising generation, and imbued by the pioneering spirit which has always been part of the oil-man's heritage, new personnel are attracted by a type of work which affords opportunities for satisfying the desire to get out and see more of the world.

Whilst a certain proportion of those who enter the industry may only have reached the higher grades of a secondary school education, and in their case there is need for continuation courses in industry, most of the younger employees, particularly those recruited for foreign service, have received a University education, or at least have passed through a Technical College. Most of them take a University degree, and have specialized in one of the sciences or in one branch of engineering during their College career. In either case unless a University course is designed for the Petroleum Industry—and this is exceptional—there is little reference to petroleum problems during the training, though in most of the sciences a proper University course could not fail to make some reference to the subject.

It must, however, be realized that a normal University course in any of the sciences may suffer if adapted to the needs of a particular industry. It must treat the subject in such a way that a student gets an all-round balanced view of the basic principles of his science and of its general application. Unfortunately many of our sciences have become so unwieldy that even this general balance cannot be fully obtained, and the tendency is for a given subject to become strong in those sections which are of local interest or in which the staff of the College are carrying out research.

There is therefore, even in the Universities, a tendency to emphasize unevenly the different portions of the main subject. In a subject like geology, wherein there is a biological section, *i.e.*, palæontology, and a chemical and mineralogical section, *i.e.*, petrology, the student may take one course or the other up to the Honours standard, after a preliminary training in both. However, in other cases he may have little more than a nodding acquaintance with one of the sections, whilst his knowledge of the other may be exceedingly detailed. The same is in the main true of many of the other sciences, and although the general syllabus may be broad, the student rarely achieves the highest standard in more than a portion of the whole.

Inevitably that in all University courses, once the ground work has been acquired, there is a tendency to specialize in some particular direction. The student never really understands the difference between accepted explanations and the truth until he has chased that elusive goddess in one of the by-ways of his subject only to find her receding ever before him. This is research, and though, put in this form, the prospect may not sound very encouraging, the process teaches a valuable lesson to each and all of us, giving that due respect for the thoroughly proven fact and at the same time a divine inquisitiveness into all else, which is the beginning of true knowledge. Each and all of us faces life with two potential assets. There is what we can learn from others and what we learn by our own exertions. On the whole, what we learn by the latter means is of much greater value to us as individuals because it becomes part of our being. University education, therefore, should always be rounded off by independent study wherein the teacher keeps in the background encouraging and advising, but allowing the student to make his own way. This requires a close understanding between student and teacher without which a University course is a poor meal.

Unless a University is located in some area serving a community which has special industrial needs, it can rarely consider the requirements of any particular industry in its curriculum. However, where it is so located it is both right and proper that a strong bias should be given in its training for the benefit of the local industry. Such a process is inevitable in any case, for the mere fact that there is a strong local demand for trained students and good facilities for their industrial experience is bound to create a bias in favour of a particular type of training. Universities in such areas must, of course, be on their guard lest this training should exclude the legitimate requirements of those students who desire to follow other branches of learning, but the idea that every University should teach universal knowledge is neither true nor is it an attainable ideal.

Although there is no complete cross-section of the oil industry in any part of these Islands, we owe to the acumen of the late Lord Cadman and Professor Watts the inception some 30 years ago of two schools for instruction in petroleum technology, one at Birmingham University and the other at the Royal School of Mines. The author has been associated with the latter practically from its inauguration, and has shaped its courses to fit the changing needs of the industry. As a geologist in a geological school it was necessary to keep in touch with the work of geologists in the oil industry, and the only way to do so effectively was to become one of them as far as that was possible. It has been a fascinating experience to grow up with the oil industry, to see its problems alter in the last three decades, to face the changing conditions in the industry, and to watch the growth of a British school of oil geologists who have won for themselves an accepted position in the world. At an early stage it became obvious that geologists would find an outlet for their science not only in the direction of exploration, but also in the exploitation of oil-pools, and the problem was to develop a curriculum which would train students to be capable of dealing with either branch of this work. Fortunately most of the subjects required either for exploration or exploitation are in general of a similar nature, and all students would need to be familiar with them. The bias lies primarily in the aptitude of the student either for orthodox geological field methods or for the more physical and mathematical sides of the subject which are associated with the development of an oil-pool.

In any case the course designed for an oil geologist must necessarily include a large number of subjects not normally taken in a University course in geology. Topographical surveying, principles of drilling, the characteristics of drilling muds and oil-field waters, geophysical methods of attack and a number of ancillary subjects, which an oil geologist must study to a considerable extent, even though he need not necessarily master them in detail, are quite foreign to ordinary geological training. On the other hand, a large amount of the stratigraphy of the British Isles which would normally be taught in great detail in any British school of geology has had in the past no direct bearing on the work which an oil geologist has to do. It was obviously better to replace this stratigraphical study of the British Isles by a corresponding study of the stratigraphy and structure of the world's oil-fields. The essential features of such a course are therefore the following :—

(*a*) A thorough groundwork in mathematics, physics, and chemistry.

(*b*) A general course covering the whole field of geology.

(*c*) A more detailed course of physical geology (the philosophy of the subject) and structural geology.

(*d*) Petrology mainly devoted to sediments but including all rock types that a student may have to deal with, and a special palæontological course, in which micropalæontology figures largely.

(*e*) A study of the world's oil-fields.

(*f*) Physical and chemical testing of oils, oil-field waters, and muds.

(*g*) Surveying, the theory of drilling, and geophysics.

(*h*) Field studies and industrial training.

Whilst this synopsis is not exhaustive, it is sufficiently comprehensive to indicate the need for a four years' course if the ground is to be covered thoroughly. (In most of our Universities there is a tendency to demand this longer period, in order to enable a student to pursue his studies in one direction further towards completion.) The ideal to be aimed at is that one of the subjects should be chosen for advanced study which should lead to a period of research wherein the student can have time and leisure to trace a particular line of inquiry to some degree of finality.

Throughout the later part of the course the student should be encouraged to work from original references in all matters, in order to get a proper appreciation of the value of a library. Concurrently, and preferably as early as possible in the educational process, the student should obtain personal experience in the industry. He need not at this stage be sufficiently advanced to appreciate fully all that he sees, but on the other hand he will get a clear mental picture of the work which he may be required to do, and return to his training with a clear conception of its purpose and an added zest to achieve success. The oil companies as a whole have been exceedingly helpful to us in enabling our students to obtain this industrial experience, and the facilities they have provided have been of immense value to the students, particularly in giving an impetus to their studies.

Realizing fully the fact that it is not possible for a single department to cover the requirements of all sections of the industry, it has been our custom to mould our own students in such a way that their training would be complementary to that of the Birmingham school. In this way it was expected that the two establishments together would help to fill a gap which would otherwise be left in meeting the educational requirements of the Industry, and the author hopes that an authoritative statement will be added to his contribution to cover the Birmingham University courses in Oil Engineering and Refining.

Suggestions for the Development of our Educational System.

In dealing with the courses in Oil Technology at the Royal School of Mines which are designed to meet the needs of our exploration and exploitation geologists, it will have been noted that some of the subjects in the curriculum would not normally appear in a geologist's training. Yet these subjects are essential for an oil geologist, and without them, or at least without a considerable acquaintance with them, he is lost (exclusion must, of course, be made in the case of certain geologists who are specialists). Neither is it reasonable that a student should spend a very large part of his time in the detailed study of the stratigraphy of a particular area the knowledge of which is unlikely to help him in his future work, when the same time could be spent and the same general principles absorbed in the study of regions where oil is found.

Whilst, therefore, the basic foundations of geology are the same everywhere, there is everything to gain and little to lose in making a course for a student in oil geology definitely *ad hoc* to his subject at an early stage. This must not be done at the risk of weakening his general foundations in the science, but there need be no danger of that if it is done properly. Furthermore, oil literature has now become so extensive that a student who enters the industry without having had a long period in which to study it is severely handicapped, and his work afterwards suffers. The author believes that this fact will have to be recognized at an early date if we are to maintain the efficiency of our British oil geologists in relation to those who are being trained elsewhere. No young geologist now entering the oil industry should be weak in mathematics and the fundamental sciences, incapable of carrying out a topographic survey, uninformed on the subject of geophysics, or constitutionally antipathetic to physical and engineering problems. The only exception to this would be those who are entering for specialized work alone.

The features which apply to the training of oil geologists have their counterpart in each of the other sciences, and certainly from the author's observation the more we can teach our future technicians about the related work of the sciences with which they have to deal, the better will be the results of the common effort. In one direction in particular the industry can help each of the sciences, and thereby improve the education of its employees. Investigations which are carried out in the oil industry are in some cases of such a nature that they cannot be published for a period, but there still exists an unfortunate tendency to deny to technicians the privilege of publication even long after the general results are known within the industry. There is no advantage gained by this secrecy, whereas a timely publication would bring credit to the companies' technicians and to the companies themselves, and would also spread desirable information which would be good for the industry as a whole. The policy of withholding information is the very antithesis of the team spirit which spells general progress. On the whole it usually recoils on those who practise it in retaliatory measures which are not difficult to devise, and in any case the good sense of technicians usually results in the dispersion of the knowledge among their fellow members of the industry, so that it might with equal propriety be published and the full credit given to the right quarters. Of late years the industry as a whole has become more generous in its attitude in these matters, but whilst it cannot be denied that it has every right to safeguard its interests, the safeguard should be in the hands of those who can use it effectively and can use their judgment rather than in a general principle of prohibition. In this particular there is much that can be gained in copying the practice of American oil companies, who usually take a more generous view on the early and wide dissemination of information of general interest to the industry as a whole.

There exists among the general public a very distorted view of the economics of the oil industry and an almost complete ignorance of the work which it is doing. The tendency of the average man in the street is to associate oil companies with vast monopolies which kill competition, make enormous profits and in general have their fingers in all international affairs. He knows nothing of the immense risks that are run in the finding of new oil-fields unless he happens to be an unfortunate shareholder of a derelict company, nor does he realize the need to create large companies if the services which the oil industry carries out for the community are to be properly performed. He knows nothing of the good sense which has attempted to eliminate the evils of competitive drilling while preserving the efficiency of general competition, nor does he realize the smallness of the profit per gallon and the stringent overall efficiency which is necessary if a company is to survive. Yet these are the facts of the industry, and there is no reason why they should not be widely published. There are companies who through good fortune have made handsome profits; but they are counterbalanced by those who have fallen by the way, and the general overall interest on the capital invested is surprisingly low when due regard is taken of the risks involved. The only adequate safeguard against such risks lies in the spreading of a company's interests over a considerable area of potential production, *i.e.*, it lies in the growth of the individual companies into units which by their very size and the extent of their potential reserves are sure of a continuity of production.

The number of employees at work in the oil industry is exceedingly small in relationship to the total output of oil and to the capital involved. If, furthermore, we exclude the relatively large army of the rank and file in the distributing part of the industry, the figures are still more striking. Like all other industries, marketing appears to involve a greater inefficiency in the use of labour in relationship to the strict requirements, but this condition is more apparent than real, for it is a feature which affects all our industries, and until we have created readjustments throughout the community it is probably unavoidable.

The scientific and engineering staffs in all branches of the industry are highly trained technicians, many of them giving the best part of their lives to work in regions which, no matter how the companies may attempt to improve the environment, cannot be compared with the motherland. In one particular, *i.e.*, the education of the young children born in the tropics, far from the normal educational facilities available in this country, a considerable problem arises. Up to a certain age arrangements can usually be made locally with the co-operation of the companies, and this is generally done, but there comes a time when it is essential that the children should be given a broader education available only in more civilized areas. It seems rather curious that an industry which has taken such care to meet the smallest whims of its customers should not have developed a comprehensive scheme to give the children of its own employees, who should be the oil-men of the future, the best opportunities for a school and finishing education. Such children ought to be excellent material as candidates for future posts in the oil industry, and if taken in hand early enough would go some way towards satisfying the recruiting problem, for if we are to attract the right sort of youth to the industry we must go back to the schools. Would it not therefore be wise to encourage selected schools with bursaries and leaving scholarships as is done by several other industries.

Much good work is being done by many of the oil companies in other directions, and several of them have been exceedingly generous in the awarding of scholarships to Universities. It would be a welcome tribute to the value of the technical staffs of the oil companies if the industry would tackle this educational problem on broad lines, recognizing the fact that if we cannot be collected into one community in this country, we can at least place a general educational service at the disposal of those who give their services unstintingly to the industry they serve.

The most important years in the education of the average individual are those spent at school. There, in the main, habits are formed and the mind in its most plastic form gains its main impressions. Home influence and school life are largely responsible for what we are, though later environments, particularly if they are dominant ones, may affect us considerably. So far as the curricula of the schools are concerned it will usually be found that they are dominated by the public examinations, the School-leaving certificate, matriculation, Higher School certificate, and Intermediate. As the efficiency of the teaching is normally gauged by the examination results we cannot expect a large measure of attention to be paid to other yard-sticks, nor is the matter helped by the intense competition of scholarship examinations which creates still more concentrated effort along certain rigid and restricted lines.

There is no effective alternative to the general system of examinations, but there can be some safeguards to prevent too early a specialization, too narrow a restriction of the subjects to be studied. The standard reached by many boys at school is exceedingly high and is a tribute to the skill of the teachers and the aptitude and hard work of the serious pupils, but it is sometimes purchased at a price which is not good for the ultimate welfare of the pupils. Specialization can be controlled by the skilful setting of general knowledge papers and a greater emphasis on essays. Among many of our young science students there is a deplorable inability to express their thoughts in presentable English. This is certainly a growing evil. The remedy surely lies in the insistence on a broader basis of general study up to the standard of matriculation, and a departure from the present scramble to take this examination as early as possible in order to begin specialization immediately afterwards. Where scientific courses are ultimately followed they should not be limited to the basic sciences, but should include one science such as botany, zoology, biology, or geology, which are closely related to the world in which we live. No child should go through school without some training in the sciences, and this training should be introduced as a means of teaching observation and deduction. They are as essential in a liberal education as the subjects hallowed by custom.

The argument that the multiplicity of subjects would overburden the pupil's mind is no reply, for what is aimed at is not a more overburdened mind, but one properly adjusted with a sense of values and untrammelled by superfluous detail.

The same applies in general to our education in the Universities. The detailed knowledge of one particular branch of a subject is necessary in the present state of our advancement, but the student should be safe-guarded from the effects of such final concentration, firstly by emphasis on the thoroughness of his grounding in the basic sciences, and secondly by a more complete insistence on well chosen ancillary subjects, one or more of which should be included in his curriculum. This principle is subscribed to in most of our University courses, but often the ancillary subjects are poorly chosen and the student regards them as an unfortunate hurdle rather than as a help in his future work. Finally, all University education should make provision for some independent work in the later stages of training to encourage and develop the creative principles of self-reliance and research rather than the mere passive absorption of accumulated facts.

The writer has been careful to avoid indulging in any comments on methods of education because to do so would lead to a discussion which, however fruitful, would not help the present issue. We are not so much dealing with methods of training as with a general educational policy for the good of the industry. Occasionally during the body of the statement one cannot help airing personal views and there are certainly some general remarks which will probably receive a measure of support. Firstly, with regard to personnel, the condition of a sound mind in a sound body is essential for a recruit into our industry. Oil work, at least that part of it which is spent abroad, requires a robust constitution, and candidates for such work should have a healthy sports record. Secondly, with regard to the mental preparation, the writer has never been able to subscribe to the view that it does not matter what you teach a boy so long as he hates it thoroughly. This may have certain disciplinary significance, and all education should not be made so easy that it is effortless, otherwise the average mind does not become built on those robust lines which glory in the overcoming of difficulties. However, difficulties will arise without their artificial manufacture, and on the whole the more positive method of education wherein the student's interest is aroused so keenly that he pursues his studies through his own volition is definitely the better way. Furthermore, while there is no denying that the choice of curriculum is highly important, it is not "the" vital feature of a good education, which should be the inculcation of a right attitude to life. If we fail to instil this attitude, our educational policy is a failure as a whole, whatever skill we may have taught our students in certain directions. In this sense the actual courses are less important than the traits which they engender, accuracy, neatness, good time-keeping, continuous hard work until the result is achieved, a deep appreciation of the significance of knowledge, and a willingness to impart as well as to receive. Man finds his greatest satisfaction in work well done and in his secret heart would prefer to go down in defeat knowing his work was good rather than accept the plaudits of the uninformed for success which he knows is not merited. There is no royal road to success save by good honest toil, whether it be with the hands or with the head, nor has the manual worker any right to a monopoly of the term "labour," which is as applicable to the student and to the scientist as to any other worker.

All that has been said above about the aims of education can be summed up in the general statement that education is the moulding of behaviour. As such it involves the building of character and the implanting of knowledge. Whilst it is true that our most receptive phase is in youth, the process never ceases through life. It is one of our duties, and a privilege also, that we are all consciously or unconsciously engaged in the process of education. This is not a monopoly of the teacher, though it may be more constantly in his thoughts, but the duty of us all to those who will follow afterwards.

The Educational Work of the Institute.

When our Institute was originally formed, one of the main objects of the Founder Members was stated to be the provision of a better education among petroleum technologists and the accumulation of information on the occurrence, production, and refining of petroleum and oil shale. The stimulating Editorials of our first Editor, Mr. Dalton, returned to this point on several occasions, and in particular in the first volume of the *Journal* you will find he rightly lays emphasis not on the conveyance of information nor on the accumulation of facts, but on the stimulation of thought, the engendering of the right atmosphere in which ideas will flourish and bear fruit. It is from both these standpoints that the work of the Institute will ultimately be judged.

The *Journal* of the Institute should constitute the main medium for the dissemination of information, and the abstracts should be a valuable means of keeping its members abreast of current literature. The progress reports, taking, as they are meant to do, a bird's-eye view of the developments in particular directions, are possibly of even greater educational value, at least when they are written from this point of view. We do, however, need at longer intervals more comprehensive reviews of the trend of thought and development in the various branches.

The formation of the student sections, the various student awards, and the encouragement given to students in the publication of some of their contributions, many of which incidentally have been very welcome additions to our published knowledge, have all been indications of our great interest in our younger men. I am quite sure that all of us would desire that this side of our activities should increase, for it is in the hands of our younger men that the future growth of the industry lies. Our branch institutions, particularly those in the oil-producing areas, are pillars of strength. Papers from these branches have a great value, for they tend to preserve the balance of the Institute's interest. We must strengthen our ties with our branches and create a greater flow of literature from these potential sources of supply.

There are, however, other tendencies within the Institute, admittedly the result of the fact that our members resident in this country belong dominantly to the refining and marketing branches of the industry, which, if allowed to proceed unchecked, will completely destroy the balance of our representation. The *Journal* is rapidly becoming so dominantly chemical that it is beginning to convey the impression abroad that the membership of the Institute conforms to this tendency. This is actually not the case, for an analysis of existing technical members shows that they are evenly divided between chemical technology on the one hand and exploration and production on the other. If we do not take heed of this warning signal, far from broadening the basis of our membership we are most likely to narrow it ultimately to a section of the industry which, however important and indispensable, does not represent the whole of oil technology. No members desire this to happen, least of all, I believe, those chemist members who would be the residual portion.

A survey of the publications of the *Journal* during three practically equal periods indicates that the proportion of chemical papers has risen from 52 per cent. in the first period to 59 per cent. in the second and 71 per cent. in the last period. This increase of chemical contributions to a dominant position has indeed become still more marked in the last five years, for, apart from 1942, the tendency has been to average about 80 per cent.

That chemical papers should, in fact, tend to predominate is very natural, for it is the experience of all societies that a large number of their contributions arise not spontaneously, but as a result of canvassing by members who are actively interested in the work of the Society, and members living in this country can obviously be more readily approached than those abroad.

Of more ominous significance is the tendency of many geologists and engineers to publish their papers in other journals, indicating that in their considered opinion the *Journal* is not the ideal medium for their thoughts, because it is unlikely to be read by their brother scientists in other branches of their own science. While this continues the *Journal* cannot be regarded as giving an average cross-section either of the industry or its own membership. These are the facts, the results of a set of circumstances which are admittedly difficult because they inevitably give a bias in the very direction which the Institute has taken. They are a natural result of the conditions, and must either be accepted and allowed to take their course, with the consequences already indicated, or they must be resisted and safeguards introduced if we are to preserve our broad basis and keep a more evenly balanced representation of all sections of the industry's activities. It would not be proper to attempt to suggest the necessary safeguards here, but the author would be failing in his duty in a discussion of this type if he failed to direct attention to a feature of this nature which will tend to endanger the educative work of the Institute.

INSTITUTE OF PETROLEUM

A MEETING of the Institute was held at the Royal Society of Arts, John Adam Street, London, W.C. 2, on Thursday, 29th April, 1943, at 5 p.m. MR. C. DALLEY, President, occupied the Chair.

The following paper was read :—

"Education and the Petroleum Industry." By Professor V. C. Illing [Fellow] (see pp. 259–277).

DISCUSSION.

THE PRESIDENT, in opening the discussion, said he would like to confess at once that in his training as an engineer he had always been top of the form in chemistry.

He thought that the men, to whom Professor Illing had referred, who had to see that oil was found, whether by geophysicists or by geologists, so that the people who contributed the money should receive a return on their investment, were men for whom technicians should have every sympathy.

Professor Illing's remarks about the geologist and the geophysicist had made him think of the aptitude of petroleum technologists for adapting to their industry methods which were well known outside. In the last few years the geologist had had a number of useful tools given to him to help him in his task; for instance, the Electrical survey, which was of value in many parts of the oil world and was an application of well-known electrical principles. There were many other methods which he thought should be regarded as weapons for the geologist, who was the man to whom one had to look for finally obtaining oil.

There was a difficulty in connection with publications in the *Journal*. He often had the uncomfortable task of refereeing papers which were going to be read at Engineering Institutions, but which were peculiarly oil papers and should be read before the Institute. The writers were 90 per cent. engineers and only 10 per cent. petroleum technologists, however, so they read their papers to their Engineering Institution. The only way to get them into the *Journal* was for joint meetings to be held of the Institute and the particular Engineering Institution.

MR. T. DEWHURST commented on the interest and excellence of the address, and said that he was glad that Professor Illing had referred to the valuable pioneer work of the late Professor H. de Böckh. A survey of the Egbell (Gbley) area in the Vienna basin was carried out with the Eötvös torsion balance in 1915 and 1916, and indicated the presence of a dome. Oil was discovered in this dome in 1917, and de Böckh was struck with the coincidence and became most enthusiastic in regard to the value and possibilities of the torsion balance as a new weapon in the search for oil. After the first world war, Professor de Böckh visited this country to explain to him (the speaker) the construction and use of the balance, and from this and other early experiences he could confirm that the general adoption of the torsion balance to the search for oil was due very largely to the insight and enthusiasm of Professor de Böckh.

In regard to the subject of education, he had had the experience of interviewing many candidates from many universities, and he had been appalled at the curricula obtaining at some of those universities. It seemed incredible that university authorities should attempt to turn out specialists in one science after giving them a meagre and quite inadequate grounding in the more basic and fundamental sciences. Students had been ruined by their having been allowed to specialize on totally inadequate foundations.

He believed that the best form or method of scientific training ever devised was that organized by the great Professor Huxley at the old Royal College of Science, and it was much to be hoped that Huxley's principles would not tend to become neglected in the present institution and would be much more widely adopted elsewhere.

In regard to the teaching of geology in our universities, he agreed with Professor Illing that there was a tendency to emphasize unduly the importance of the study of igneous rocks and to pay inadequate attention to the very important subject of sediments and sedimentation.

In regard to junior school education, he would point out that in the old days there was a subject called physiography, which included much general elementary science and was a useful introduction to science in general. He regretted that that subject seemed to have disappeared, and suggested that its reintroduction into junior schools would be beneficial.

With reference to the publication of geological papers, the *Bulletin of the American Association of Petroleum Geologists* showed what could be achieved in this respect. However, the American was not so reserved as the Englishman, was more addicted to the method of trial and error, and was keener on new ideas and their ventilation. This attitude of keenness rather than caution was favourable to publication, and consequently when one American geologist got on the scent of a new idea or a new device he was followed immediately by hundreds of others, with the result that there was an enormous output of papers on one and the same subject. That could not occur in connection with the *Journal* of the Institute, as British geologists and engineers were relatively very few in number, and were scattered in all parts of the world. With few specialists and a wide dispersal of interests, it was impossible to secure the degree of intensification that obtained in the United States, where enormous numbers of specialists concentrated their attention on the prospecting and oilfield problems of their own country. Nevertheless, much more could and should be done to encourage publication of geological and engineering papers in the *Journal* of the Institute.

He had been impressed by Professor Illing's remarks as to the importance of obtaining and maintaining a proper balance between the various interests in the Institute. In this connection it should be borne in mind that there were many petroleum chemists in this country, while most of the engineers and geologists were stationed abroad. Some ten years ago he had been impressed with a similar but less striking lack of proportional representation of interests, and he could claim that he had attempted to correct the position by the initiation of a series of Summer Meetings of the Institute. These meetings were designedly held during the season of the year when petroleum technologists who were engaged on oilfields and in refineries in many parts of the world spent their home leave in this country. His view had been that it would be advantageous for home and overseas members to meet and discuss all kinds of technical subjects, and also to meet socially at an Institute dinner. His expectations were amply fulfilled, for the Summer Meetings of 1934 and 1935 were most successful, and were much appreciated by all participants from home and overseas. They also stimulated the Branches of the Institute, and indeed led to the formation of the Burma Branch. He did not know why the practice of holding Summer Meetings of the Institute had been abandoned, but he would urge those who were interested in the subject to look up the old numbers of the *Journal* in which those meetings were reported, when they would realize how beneficial and even inspiring they had been, and would accept the proposition that their resumption after the war would help to smooth out some of the difficulties set out by Professor Illing, and would add to the usefulness, welfare, and success of the Institute.

Colonel L. V. W. Clark thought that what Professor Illing had said in his address was absolutely fundamental, but there were a few other points which ought to be considered.

He had had the pleasure recently of dealing with university bursaries for engineers, physicists, mathematicians, and so on, which had been started by a Committee on which he sat and which it was hoped to continue after the war, but it would be very difficult to place the holders of those bursaries in industry after the war. Very large numbers of engineers were being trained, but very few oil engineers, owing to the war situation. It would be very difficult to place those engineers in any sort of industry, and the oil industry would not be able to take large numbers. It would not be possible to increase the educational facilities for oil, because of the small numbers coming forward. He thought he was right in saying that outside Birmingham there was no university in the Empire which dealt with the engineering side of the industry as a full subject. At Birmingham if the number reached five in the final year they thought themselves fortunate, but it was difficult to place even five coming from one university.

Another point which Professor Illing had made was that teaching was a question of giving. He thought there was one point which ought to be stressed in that connection. If a university lecturer was paid £300 a year to start with and the students he trained were offered positions abroad at £400 or £500 a year, it would be difficult to get any first-class oil engineer to go into the teaching profession. As Birmingham was the only school of its kind in the Empire, any teacher who went into that school had only one opportunity of getting into the top rank, yet he was turning out young men of 21 and 22 years of age who could go out into industry and earn very much more than he did.

Professor Illing had made a distinction between the scientist and the engineer. He wondered why Professor Illing did that.

Mr. J. S. Jackson said he was sorry that Professor Illing had felt constrained to curtail his address in order to keep it within the usual hour, as he would certainly have liked to have heard more of this very interesting paper.

In connection with the broad problem of education, he would like to see a clear distinction made between general education and specialized technical training. He felt that much of the discussion on the present occasion had dealt with specialized training and not with general education. The specialized training of an educated man was a relatively simple matter, but the general education, which was the foundation upon which specialized training was built, presented many difficulties.

He would particularly like to say a word about the teachers, an aspect of the education problem to which reference is seldom made. Colonel Clark had pointed a very obvious moral when he reminded the meeting that the teacher usually earned a pittance while he prepared his students for posts in which they would immediately obtain adequate remuneration. It was indeed not at all surprising that many able teachers decided to follow the example of their students and seek the more remunerative posts, to the lasting detriment of education in general. The teaching profession was after all the basic essential of any educational system. There could not possibly be a satisfactory and effective educational system as we know it, no matter how grand the buildings and equipment of schools and universities might be, unless there was a proficient, enthusiastic, and satisfied teaching profession. He would suggest that the attitude of the authorities concerned towards the teaching profession as a whole epitomized their attitude towards education. If they thought little of the teaching profession they really thought little of education. He submitted that the general attitude towards teachers was rather poor. The " captain of industry," and even the humblest clerk in industry, both seemed to despise the teacher, looking upon him almost as a lower form of life. In fact the teacher was frequently regarded by such people as one of nature's mistakes, something half man and half woman. He felt that such a state of affairs would have to be completely and radically altered, and until the general status and remuneration of the teaching profession were substantially raised and until the teaching profession could attract and retain its fair share of first-class men, all attempts to remodel and improve our educational system were foredoomed to failure.

It was to be hoped that in the not too distant future all children would remain at school until the age of 16, when all who would benefit by further education could, if they wished, proceed to a technical college or a university. If a scholar proceeded to a university, he should then specialize to a certain extent, and the education, while still being quite broad and generous, would lead to some recognized qualification. This could be done by the age of 20. If the student completed his degree at this age, that would be the right time for him to begin to specialize for some particular industry. For instance, the specialized training for the petroleum industry could start then, and occupy two or three years, during which time he could do research or study the technique of the specialized processes involved.

Such a scheme would, however, only cater for the requirements of highly specialized technical experts, and there would still have to be available the means of training the various other staff grades. He said that a good deal of staff training had been carried out in the past by individual companies, but usually in difficult circumstances, since any one company would usually experience some difficulty in collecting the necessary teaching staff and suitable specialized equipment. Perhaps the universities, and even the Institute of Petroleum, might do something to help by co-operating with the individual companies, and more might be done to provide suitable courses of lectures at convenient centres. Here mention should be made of the excellent work done by the Sir John Cass Institute.

In the past the educational efforts of the Institute had been very spasmodic. The educational value of the *Journal* had been referred to in very complimentary terms, but he thought that the educational value of the *Journal* in its present form was distinctly limited. Normally, the *Journal* was only of interest to specialists, and he thought that something much more systematic could be attempted by way of general education. As a beginning perhaps part of the *Journal* could be set aside regularly to provide matter of real educational value to the normal person engaged in the petroleum industry.

Mr. C. D. Butler said that, speaking as one of those beings just referred to, half man and half woman, who spent most of their lives trying to teach, he thought the teaching profession was, rightly to some extent, looked down upon as being a collection of the good boys of the school.

As a matter of fact, the trouble which he and his colleagues experienced was in trying to find out what the industrialists really wanted. When he buttonholed them one at a time, he found that they did not know whether or not they wanted a brilliant honours student from a university. Very often he was told that it was a disadvantage when one went into a job to be too brilliant an honours student, because the practical man on the job did not like it. Some industrialists wanted students to go through their own laboratories or shops, and said that they could pick up their technical training and their cultural education on the way. Anyone who had had experience of trying to study either technical or cultural subjects at night after a long day's work knew that it was a very great strain to reach a satisfactory technical or cultural standard in that way. A man who obtained a degree or other qualification by night-school work ought to have three stars after his name. It seemed to him that the petroleum industry should make up its mind how it wanted to recruit people. Probably most of those present that evening had got into the industry almost by accident. He thought the industry should arrange some kind of bursary scheme. There were many men who could not possibly stand the financial strain of going to the university without a job in view, but bursaries were an enormous assistance. When boys of 16 to 18, having had a good secondary education, came to consider what profession they should adopt, it should be possible to say to them : " Well, there is the oil industry. If you get into touch with such and such a firm or institution they may offer you a job now, with certain facilities for final qualification, or they will keep an eye on you until you get your degree, and then they will try you out." At present there was little or nothing of that kind at all. The only way in which teachers could keep in contact with the industry was very spasmodic, through old students or personal friends who were actually in the industry. He thought that, to use an oil metaphor, the petroleum industry at present was drawing its recruits entirely from surface seepages, and most of those were probably rather viscous, and very often contaminated. Those who passed through the filtering sands of a university department such as Professor Illing's might emerge crystal clear, but such desirable surface seepages were rare. The industry must explore deeper horizons. For every man who went into the industry now by chance there were at least half a dozen potentially first-class executives or technicians who never got within striking distance of it, because the way was not reasonably clear to them.

Mr. E. A. Evans said that Professor Illing had stressed one aspect which had not been mentioned in the discussion. In brief, it could be described simply as "personality." Obviously knowledge was an essential acquisition, but if it existed without personality the possessor of it was under a great disadvantage. Doubtless we all realized this very simple fact, but it was so often overlooked that its importance was worth emphasizing. Many a brilliant student had failed to obtain a job, or to make worldly progress, merely because his personality had not been sufficiently developed.

It was well to look to some of the other professions where personality must count. In medicine much had been achieved by the doctor creating an atmosphere around the patient, and in law the ability to convince by sheer personality was a great acquisition. Why not in science? The scientist could continue to make his discoveries, but if they were to become great discoveries it was becoming more and more important that he should be able to convince those around him and the world of their importance.

Personality was not a thing which could be taught; it could only be developed. The art of good description and choice of words could be taught, and should form a very definite part of one's training. It might be useful to quote the old Latin proverb, "He who knows and can't express is just as if he didn't know."

Professor Illing referred to the status of academic men. Generally speaking, most of them were retiring, perhaps somewhat disinterested in everyday worldly affairs. Probably they would claim a much greater market value if they were differently constructed. The absent-minded professor was an unfortunate piece of humour, and was often a pose. The professorial class would probably confer greater benefits on humanity if they pushed the veil aside and exposed the value of their work, and took a more paternal interest in their students, both during and after the training period. There was insufficient intercourse between these learned gentlemen and the rank and file at technical meetings, and finally there could be, and should be, better bonding between industry and science by an increased sympathy on the one side and personality on the other.

Professor Illing, in replying to the discussion, said he was very glad that Mr. Dewhurst had referred to Professor de Böckh's work. He was sure all the geologists of the Institute appreciated that work and its significance.

In his paper there were references to two other outstanding men in the industry. One was Lord Cadman, the founder of the Birmingham School, and the other was his own revered leader, Professor Watts, who had been a member of the Council of the Institute, and who, as early as the time of the foundation of the Birmingham School, realized the importance of geology to the oil industry. In 1912 Professor Watts visited him at Cambridge and asked him to come to the Royal School of Mines and start an oil course there. That was before the Institute was founded, and he did not think there had been a proper appreciation of Professor Watts' work in the *Journal*.

He could assure Mr. Dewhurst that Huxley's method would be continued at the Imperial College of Science and Technology; the authorities there valued highly the system developed by Huxley, and were building on it to meet modern needs.

With regard to physiography, unfortunately that subject had been merged in geography, and had not gained by being so merged. As in the case of physical geology, the geographers had absorbed, but they were not competent to teach physical geography or physical geology. He hoped that the subject of physiography would be resuscitated and put back into the school curriculum with a proper geological course.

With reference to the American Association of Petroleum Geologists and their papers, he agreed that numerous papers were published as a result of a large number of geologists following up a new idea, but, in the main the type of papers printed in journals owed much to the activities of members of the Council of an organization and of members who were keen on particular subjects.

Mr. Jackson had put his finger unerringly on one of the fundamental problems of education. As a nation, if we are to rise to greater heights we must adopt a more generous attitude towards the teaching profession. All attempts to improve our education by Act of Parliament would fail unless steps were taken to raise the status of the teacher, and thereby attract the right types into the profession. It was regrettable that the proportion of male teachers in the elementary schools was so low, for boys needed the guiding hand of men once they had reached a certain age.

Oil companies were maintaining contact with Universities and were attempting to guide students into the industry by giving scholarships and opportunities for practical experience. This, however, was not enough; it was essential that some of the staff of the Universities should maintain continuous contact with the changing needs of the industry. The speaker had felt it his duty to his own post in the University of London to keep one foot in his College and the other in the oil industry.

The speaker felt that Mr. Evans had misunderstood him. His emphasis was on character rather than on personality. The concern of the teacher was to see that the student adopted the right attitude to his work and to his fellows. Mr. Evans seemed to have been unfortunate in his contacts with the professorial class, and he would like to assure him that there were many who did not conform to his description.

On the motion of the President, a vote of thanks was accorded to Professor Illing, and the meeting then terminated.

THE INSTITUTE OF PETROLEUM.

LUNCHEON.

WEDNESDAY, 23RD JUNE, 1943.

A Luncheon of the Institute of Petroleum was held on Wednesday, 23rd June, 1943, at the Connaught Rooms, Great Queen Street, London, W.C.2. The PRESIDENT (MR. C. DALLEY) presided, and those present included :—

The Rt. Hon. Geoffrey Lloyd (Chairman of the Oil Control Board), Brigadier Sir Donald Banks, K.C.B., Hon. M. R. Bridgeman, Sir William B. Brown, K.C.B., Mr. R. A. Carder, Mr. H. B. Heath Eves, Professor C. L. Fortescue, Sir Frederick Godber, Mr. F. A. Greene, Mr. S. Harlow, Sir Harold Hartley, C.B.E., Mr. A. C. Hearn, Mr. J. Allan Howe, Mr. A. L. McColl, Col. H. E. Medlicott, D.S.O., Rear-Admiral F. H. Pegram, C.B., Mr. W. M. Selvey, The Right Hon. Lord Sempill, Mr. D. A. Shepard, Sir Frank E. Smith, K.C.B., Mr. E. E. Soubry, Mr. F. C. Starling, C.B.E., Lt.-Col. R. A. Thomas, C.B.E., Engr. Vice-Admiral Sir F. R. G. Turner, K.C.B., Mr. E. S. Wood, Paymaster Captain L. A. Boutwood, R.N., Lt.-Col. S. J. M. Auld, O.B.E., and Mr. T. Dewhurst.

After the loyal Toast had been honoured, SIR FREDERICK GODBER proposed the Toast of

"HIS MAJESTY'S MINISTERS."

SIR FREDERICK GODBER said :

I have been given a pleasant and, in some respects, an easy task in proposing this Toast. There is one name that stands out above all others, and the man who bears that name typifies all that is good in our people. His fighting qualities sustained us during the dark days of 1940 and 1941, and his statesmanlike review of the war, when he refused to give us optimistic promises as to the early outcome of the war, was a summing up of the tempo of the people and was almost uncanny. He knew without a shadow of doubt, at a moment when others had very grave doubts, that there could be only one outcome to this conflict. He knew, and saw very clearly, that the people were behind him, and that come what may and whatever be the cost, they would stand solidly with him. He saw this very clearly, and perhaps very much more clearly than many others did. He also saw that the freedom which was obtained at Runnymede had passed beyond the confines of the Empire, and that sooner or later, regardless of what the people and the Empire could do, others would have to stand, and would naturally stand, with us and come into the conflict on our side. He proved to be abundantly right in that. He himself has told us how much we owed to the few—and how very right he was. But never let us forget the duty that we owe to him for what he has done and for what he is doing (loud applause). Let us give him our gratitude and our heartfelt thanks. God grant that he may be with us for many years not only to lead us in war, but also to lead us in peace (hear, hear).

In welcoming the Rt. Hon. Geoffrey Lloyd, Chairman of the Oil Control Board, I should like first sincerely to congratulate him on his appointment by His Majesty to the Privy Council. It is an honour unique and well deserved, and I feel that in honouring Mr. Geoffrey Lloyd, His Majesty has also honoured the industry which we all serve. It has been my lot to see a great deal of Mr. Geoffrey Lloyd during the war, and much of the success with which petroleum problems have been faced and met have been in no small measure due to him. It is also in no small measure due to his very wise action in securing the co-operation of the industry and in making the industry work with him and for the Government. In the early days of the war, when plans for supplying this country and the Empire with petroleum products were under discussion, he made only one condition, and that was that policy was necessarily a Government matter, but the carrying out of the policy should be left very largely to the industry, and in fact the industry is carrying out policy. Indeed, who could better carry out that policy than those who had spent a lifetime in developing what was an involved and very delicate machine. As an industry we should register satisfaction that on the whole our relations with His Majesty's Government and the Ministry have been in happy accord. I hope that this augurs well for the future. I believe that deep down in their hearts Britons want to be left alone and to leave others alone. All of them long for the day when control will be eased and freedom regained (hear, hear), but it will necessarily be freedom tempered with discipline.

It has been my pleasure recently to form one of a small Mission to Washington. Mr. Lloyd was Chairman of that Mission, and there was an incident in connection with that Mission which I think is interesting because it impressed me tremendously at the time. Among other functions, the Mission were invited to meet the American Petroleum War Council, which was a Council consisting of all the heads of the American industry—some 100 or 120. They represented the senior executive of the whole American oil industry, and Mr. Geoffrey Lloyd was invited to address the gathering. It was not an easy task. He was facing 100 or 120 of America's leading oil men, and after making his speech he, rather incautiously it was felt by some people, invited questions. These past-masters in the art plied him with questions, and he very successfully answered them all. After the Conference it was asked, " Where did that young man learn his oil? " (laughter). That was no mean compliment from these hard-headed oil men to pay to the Chairman of the British Oil Control Board.

I am sure I am speaking for everybody present, as I do for myself, when I wish Mr. Geoffrey Lloyd every success and assure him that all the practical knowledge and experience of the industry and especially scientific knowledge, are at his disposal and express the hope that the industry will be enabled to place at his disposal the experience and knowledge in peace as well as in war.

THE RT. HON. GEOFFREY LLOYD (Chairman of the Oil Control Board), in replying to the Toast, said :

It is a great pleasure to be here once again at the annual luncheon of the Institute of Petroleum because, after all, I have had the good fortune, not entirely common among Ministers, of having done the same job since the beginning of the war. Although I was very much of a neophyte and a beginner the first time I came to this luncheon, now, after nearly four years, I can see many people with whom I have not only worked closely during the war, but for whom I have a great respect and whom I regard as my personal friends. I can see a great many in this hall to-day. The fact that not only have I done that part of the job that has fallen to me here, but have also, as Sir Frederick said, been through my baptism of fire in the American oil industry, leads me to hope that, although I make no claim to be an oil man in the full sense, if I am granted the privilege of going on for a few more years I may even graduate to the rank of being regarded, perhaps, as an honorary oil man (laughter).

I only want to say, in reply to the Toast that Sir Frederick has given in such nice terms, a few general words about the oil position and the oil organization in this country during the war, because not very much has been said about it, for reasons which I shall come to a little later on. A great Allied war leader has said that this is a war of engines and octanes, and that is, in my view, a very highly specialized application of the wider truth that the present war is fundamentally based on oil and oil-driven engines operating by land, sea, and air. Thus it is that the quantity and quality of petroleum products available for the fighting forces and for the supply systems that support them are of vital importance to war potential and war strategy. Of course, for that reason, oil being so close to the fundamental strategy of the war, it has, during war-time, to be shrouded in a proper secrecy. Therefore, we cannot talk about most of the things which most of you in this room are engaged on at the present time, and have been engaged on during most of the war. In fact, I doubt whether there could be gathered together in a room of this size a number of people who, when you consider the ramifications of oil in war, know more of the inner secrets of this war than some of you people here.

But there is one subject on which it is possible to say certain broad things, and that is that the production of high-grade aviation spirit does constitute a triumph of research and development for the men who have done the jobs in the secrecy of the laboratories of England and America. Without going into technicalities, which you know far better than I do, it is the fact that better aviation petrol enables the fighter aircraft to make those sudden bursts at the highest speed. It also enables bombers to take off with the heaviest loads, as well as, of course, increasing the range of both types of aircraft. That is just as important in the battle of the Ruhr as it was in the Battle of Britain and the Battle of Malta.

Having said just a word about quality and the effect of quality of petroleum products on war operations on the Allied side, perhaps I might say one word about the effect of a deficiency in quantity as it has manifested itself and has shown itself on the side of our enemies. It was indicated in a recent broadcast by a German officer of the Afrika Korps when he said, "The question of petrol harries our nerves . . . we have to remain on the roads because a diversionary route through the desert would use up too much petrol . . . a large number of petrol containers washed up from a sunk ship helps the retreating forces for another short spell . . . the supply situation becomes more and more difficult . . . there is no petrol with which to transfer troops."

I do not need to add any comment to what that German officer said, except that on our side it is the fact that throughout the war sufficient bulk supplies of petroleum products have been available for the operations of British forces in all theatres of war throughout the world (loud applause). That achievement would never have been possible without the wonderful work that has been done by the Petroleum Board and the oil industry generally, both in this country and in the United States, because never forget that in addition to our own resources we had great assistance from the great oil companies of America long before America even came into the war on our side. On my own account I would like to agree with what Sir Frederick said about the co-operation of the industry with the Government during the war. As he said, it is for the Government, who know all the strategical factors and have official information with regard to the war, to lay down policy, and I think we were right to bring the industry in and ask them to do the actual executive work, which they know so well how to do. I think it is of interest to draw your attention to the pronouncement made recently on the subject by the Select Committee on National Expenditure. If I may say so, that is not a body that distributes bouquets in all directions, but they have said that the arrangements between the Government and the industry were to be commended as being clear-cut and simple and functioning satisfactorily. I think that is a tribute that we can all feel very pleased to have.

You know better than I—although I am now beginning to know a certain amount —the tremendous ramifications of the work that is being done by those who are engaged in all aspects of petroleum supply and production, but inevitably, as I have said, there is a common secrecy shrouding all this work during the war, but I would like to take this opportunity of giving a message from the British Government to all those who are working in this great field to-day. That message is that the British Government realize that all of them are doing a vital war job which is for the most part highly secret, and we ask you to continue your great effort in the knowledge that your contribution will be able to be made known when it is possible to tell the full story when the victory is won (loud applause).

"The Institute of Petroleum."

Mr. A. C. Hearn :—

I endeavoured to persuade one of the eminent naval officers present to propose this Toast, as seemed fitting in the fourth year of a war in which the petroleum expert had played so valuable a part in and behind the fighting line. I was baffled, however, by reference to the Silence of the Senior Service and to the limitations of the (so-called) Simple Sailor. I feel bound to say that, in a long experience, I have noticed no incapacity amongst naval officers to express their feelings, with both vigour and fluency, when the need arose. As had once been very pertinently asked, how otherwise did the sailors' parrots manage to get their stuff? As regards their alleged simplicity, it is only to be hoped that our diplomats are blessed with a similar form of guilelessness!

I must apologize for this digression, but I number so many friends amongst its members that although the Toast is strictly proposed to the Institute—a corporate body—I feel that it is really addressed to the individuals composing it; that is, to its molecular constituents. The mention of molecules reminds me of a sentimentalist who, reading of many forms of violence and maltreatment applied by modern chemists and engineers to the hydrocarbon molecule, came to the conclusion that they must be a singularly brutal lot of people. He supported his novel thesis by claiming that they, in conspiracy with the engine designers, had made modern warfare the catastrophic affair it had become. Unfortunately, and quite unavoidably, in so many ways and in so many lands, war and peace make complementary demands on the science and ingenuity of you all. Far from worrying about the criminal charge, you can pride yourselves on having contributed so much to the victory that is now inevitable.

Although I have retired from active participation in the industry, I still see the Institute's *Journal* and various other technical publications. I am greatly impressed by the scientific approach that is being made in all quarters and to all types of technical oil problems. I can remember, years ago, listening with amusement to informal discussions between geologists and chemists in which the main question at issue was who represented pure science and who that impure thing known as empiricism? The impression then left on my mind was that few of them were scientists and none of them was pure? Those days are now happily past, and it seems to me that nowadays we are all scientists and all pure! I am incompetent to say in which direction most progress has been made, but personally I have been particularly impressed by what is being done in the chemical world. This, however, is largely due to the imposing and complex nature of the formulæ in which the chemists indulged, reinforced as it is by the sesquipedalian abracadabra of their written and spoken language. It is awe-inspiring, and, I feel, slightly infectious.

I should like to emphasize the fact that the many exacting demands made during the war period on the members of the Institute, and on the members of their confraternity in the U.S.A., will be followed by almost equally exacting, though less sanguinary, demands when you again face the tasks of peace. I have no doubt that you will be equal to it.

In conclusion, I should like to say that Mr. Dalley, the President—an old friend of mine and a bulwark of the Institute—is known to you all not only as a technologist who had made valuable contributions to the field and other engineering technique, but also as a very kindly and genial personality.

I now have great pleasure in proposing the Toast of "The Institute of Petroleum," coupled with the name of the President—Mr. Dalley.

Mr. C. Dalley (President), in replying to the Toast, said:

I thank Mr. Hearn for the kind things he has said about the Institute, and also for the personal references to myself, which I value very highly.

It is the custom on these occasions to give a review of the activities of the Institute during the intervening period between these meetings. The first point I should like to make is that it is about thirty years ago that I deserted my first love and joined the petroleum industry. During that period I have been privileged to gain experience in every branch of the petroleum industry and, what is more important, I have had contact with and knowledge of the personnel operating in these branches. Through other associations also I have broadened my contact with those whom I now number amongst my colleagues and friends, and in my present position I can say that the great majority of the members of the Institute are doing their utmost in the war effort for the United Nations. There are also very many others throughout the oil world generally who are 100 per cent. engaged in the war effort on the side of the Allies. There are a few who may feel they could do more, but they must rest content that what they are doing is probably relieving someone who would otherwise be very much overloaded. There would have been many more present at this meeting if they could have got away from their duties, but all those members are present in spirit.

Broadly speaking, for many engaged on production and refining, war-time work is merely intensified peace-time work, handicapped by shortage of materials, and with the loss of facilities which are readily available in peace-time.

A second point I should like to make—and it is one which has not been appreciated in the past, although it is just beginning to be appreciated—is the great collaboration and co-operation there has been for some time between American and British petroleum technologists. In the past, the average Briton spoke of his American cousin, as of someone distantly removed, yet at that time petroleum technologists in both countries were working closer than brothers in a co-operative effort to solve the problems constantly arising in the industry, and they did so with very great success. There are, of course, many things in common between the two countries—for example, their languages are very similar. There is a section of the Institute in the United States. By comparison it is not large in numbers, but what it lacks in quantity it makes up for in quality. For example, one of the principal members is Dr. Gustav Egloff, who has spent a lifetime in research and is well known for his work in producing high-octane spirit. The Institute has many Branches, and it is usual to exchange greetings with them on occasions like this, but in the case of one Branch we have an advantage on the present occasion and, without encroaching on Col. Auld's prerogative, in proposing the Toast of the Guests, I should like to welcome Mr. Ruthven Murray from Trinidad. He is a worthy representative of one of the most virile Branches in the Institute. It can be still said that Trinidad is the largest actual producer of oil in the British Empire.

The Past-Presidents may be considered as the House of Lords of the Institute and I must speak in an appropriate manner with regard to them as, incidentally, they recommend the appointment of the President! In their wisdom they decided that the Institute should end its period of hibernation at Birmingham and return to London. That has been done, and the Institute is now lodged in the Imperial College of Science. We look forward with hope and ambition to having a building of our own. The last time this matter was discussed, there were no sites in London, but now there are plenty of sites and fewer buildings!

Another recommendation of the Past-Presidents was the appointment of a Joint Honorary Secretary, and they suggested Mr. Ashley Carter (a very popular choice), who, although he was getting older in years perhaps, was getting younger in energy and spirit. He is now busily employed in bringing the activities of the Institute back out of the period of hibernation. The Institute is now holding its monthly meetings again, and there has recently been published a new Edition of its *Standard Methods of Test.* That this is useful is shown by the fact that 1000 copies were sold in less than as many hours, and that should be so when it is realized that the Committees which produced this book consisted of 140 members, all of whom were experts in their particular subject. They were controlled by Dr.—now Professor—Garner, and if ever he needed a monument there is one in this book.

Another important development is the establishment in South America of the South American Institute of Petroleum, embracing representatives of all the Republics in South America. This Institute has been invited, and had freely offered its co-operation. There is a nucleus of British, American, and Allied oil men in all the South American States who can assist in the formation of this Institution and this new body will be of great value to all when properly organized.

One other activity to which I would like to refer is that, model regulations for the installation of electricity in fields, refineries, bunkering stations, and depots, readily adaptable to tropical, temperate, and Arctic conditions, are in course of completion. These new regulations incorporate, where possible, established rules of recognized authorities, and they have been prepared by and on the experience of electrical engineers of the major oil companies on both sides of the Atlantic. Before the new regulations are issued they will have the approval of the relative authorities. I have played some small part in its development, and therefore may be excused for saying that when this book is published it will be unique.

Some years ago the Council changed the name from the Institution of Petroleum Technology to the Institute of Petroleum. The reason given was that it would broaden the scope of the Institute and would bring more people in the industry within its orbit. Personally I do not think that was the real reason; it was rather that the members had a feeling that the petroleum technologist was considered by those outside the industry to be a kind of scientific polygamist! This is merely an incorrect interpretation of his versatility in the immediate adaptation to his own problems of any new scientific discovery, and one or two examples might be mentioned. Firstly, there is the search for petroleum in which great progress has been made in the past few years. The sub-soil can be electrically analysed to locate gases peculiar to petroleum. A bore-hole 10,000–12,000 feet in depth can be surveyed electrically and a graphic record produced showing where there are oil-sands, where there are water-sands, and whether these are salt or fresh. Their depth can be measured to an inch. There is also the electrical inclinometer which graphically records and correctly orientates the deviation of the hole from the desired direction. Thus the risk of failure to find oil is greatly reduced.

Secondly, in refining plants theoretically all heat used in splitting up the oil is recoverable by interchange, and the oil refiner has nearly succeeded in doing this. Only the other evening, at one of their monthly meetings, a designer of plant complained that the oil refiner wanted all the products and left him nothing with which to fuel the plant !

Thirdly, with regard to products, many will remember that some years ago the coal industry issued a very interesting map showing an oak tree, the trunk representing coal, and the leaves and branches the various products obtainable from coal. The petroleum tree at that time was a mere sapling. That oak tree must have grown considerably since then to represent the additional products from coal. There are still more to come, in the form of oil products.

As to the position to-day, in the April *Journal* of the Institute a paper was published by Dr. Egloff in which he concluded by referring to the solvents, plastics, high explosives, acetylene, synthetic rubber, lubricating oils, aviation gasoline, and edible fats which could be produced from natural gas. As a matter of fact, he states that " if one starts with natural gas alone all the known synthetic products that man has produced in organic chemistry can be derived, and there are over 500,000 different ones. Any synthetic product desired can be produced at a price. The hydrocarbons are all potentially available to be converted into the manifold products that man required in a modern world." Thus, the petroleum sapling has now grown into a forest. But perhaps I had better not pursue this further, or we might be asked by the British or American Governments to submit forms in quintuplicate giving particulars of those different products—*i.e.*, those which they had not had already !

Reverting to my previous reference to the fact that the petroleum technologist is always ready to adapt to his own problems any new discovery, the petroleum technologist is also not averse to looking back into history. Therefore, as it is not permissible now to talk much about what is being done to-day, we might look into history for a moment. When the many products I have mentioned, and the development work that has been done during the last few years, are borne in mind, there may be a tendency to forget that petroleum was used as a munition of war by the ancients. In the Book of Judges it was described how one, General Gideon, went out to smite the Midianites. He started with an Army of about 30,000, but a great number of them went " all-Italian like," and he had seriously to think out some method of carrying out his plan with much depleted forces. He formed a band of Commandos, and armed the men with a trumpet in one hand and a long-necked earthenware bottle containing a lighted lamp in the other. At the proper time the signal was given and the Commandos blew their trumpets and made such a raucous noise that they frightened the Midianites into a state of paralysed immobility. Then they threw the bottles, breaking the necks, and the lamps in the bottles ignited a " secret fire." The noise of the exploding bottles and splinters flying about scared those of the enemy still left alive and they took to flight. Those bottles were used to-day, and were known as Molotoff cocktails (laughter). Whether there is any connection between the cocktail as a drink and the selection of the Commandos, it is clear that the Commandos were selected not for their drinking habits, but for their habit of drinking. Those who are interested and would like to check up this story, should refer to Chapter 7 of the Book of Judges, verses 16 onwards.

I said at the beginning of my remarks that many of those engaged in the oil industry are, in war-time, carrying on their peace-time work of petroleum production on an intensified scale, but under many handicaps. They are an unseen service supplying the other services with their petroleum requirements—a mighty weapon—and they are proud of the part they are playing in the provision of one of, if not the greatest, munitions of war. Petroleum is a powerful weapon of war, but it could also be a greater instrument for peace. It has entered into the national life and certainly into the national Budget of all nations, whether producers or consumers. Although some people—they could not be oil men because oil men are always optimistic !—seem to think that the petroleum era is to be short, I myself disagree and believe that for a very long time it will continue a controlling factor in national life. When hostilities cease, the oil industry will take a greater pride in the part it can then play in the utilization of this, one of Nature's greatest gifts to mankind, not only in the establishment of peace but in the maintenance of a permanent peace.

"The Guests."

Lt.-Col. S. J. M. Auld (Past-President) said :

It is a practice to be commended that in addition to the more formal speeches at these functions, opportunity is taken to say " hullo " to those friends of the Institute who come to support the Members on their annual festal occasion. It is, of course, impossible to mention all of them by name, but there are a few who will have to be prepared for special attention. First and foremost are our American friends, whom we are so glad to see present in fair numbers—and when I say " friends " I do not mean merely Allies, I mean friends whom no one would ever forget for the manner in which, in our blackest hours, they rallied to our aid and supported us with their sympathy and supplies, money and munitions, and, not the least, with oil. We shall always remember these things. I had hoped to refer this personally to one whose faith in us has never faltered and who worked unceasingly to help us with the supply of the oil which has been our life-blood. I refer to Mr. Orville Harden, who unfortunately at the last moment has not been able to attend, but I ask Mr. Emile Soubry, on his behalf, to accept our gratitude and take back the thanks of the rank and file of the British Petroleum Industry to their own associates in the great American Petroleum Industry, which, throughout the war, has vitalized us by its continuous transfusion of oil. After what I have said I could not suspect Mr. Harden of being an " Indian giver," though the retention of Mr. Soubry in the States might point that way. However, if Mr. Soubry were as often in England when stationed in America as he is in America when stationed in England, we need not grumble.

There is another American to whom I feel sure all would like me to make reference. Mr. Dave Shepard has so endeared himself to everybody who has to work with him here that public acknowledgment of the fact seems unnecessary. I always think of Mr. Shepard as a concentrate of all the enviable traits, but " concentrate " is perhaps hardly the word to apply to one of his broad-mindedness and great-heartedness—to say nothing of his stature.

Of our own oil men present as Guests little perhaps need be said, because we know so much about them. Many are already Members of the Institute, and those who are not should be. It is a good opportunity, however, with Members of the Trade Control present in Sir Frederick Godber, Mr. McColl, Mr. Heath Eves, Mr. Soubry and Mr. Carder, and Mr. Vos of the Petroleum Board, to congratulate them on the great showing the industry has made in its war effort, and on the encomiums of the Minister and the Select Committee. They in their turn must, I feel sure, be proud of their " boys in the back room." Sir William Brown and Mr. Starling, I know, would endorse these views. Mr. Starling in particular, since he is now seeing in its great wartime structure that organization which he was so largely responsible for founding in peace-time. There are other friends outside the petroleum world. We have present legislators and officials, others who have mutual purposes in professional science, and those who use the products of the industry both in the Services and commerce.

On the general principle that the customer should come first, I should like to start by welcoming the Fourth Sea Lord and the Engineer-in-Chief of the Admiralty. I imagine, by the number of repeat orders coming in, that there is no question of a reversion to coal in prospect. I might add that this could not be said of the German Navy.

In the Presidents of the Institution of Chemical Engineers and the Institute of Fuel we are strongly supported by particularly kindred societies. And the presence of Professor Fortescue of the Institution of Electrical Engineers is a graceful reminder that their own worthy President, in having so completely immersed himself in oil, has not thereby been insulated from his parent professional body.

I wish to join this Toast with another friend of old standing—Lord Sempill. Here is one whose ability and versatility are well known. At one and the same time he is an elected Peer of Scotland in the House of Lords and President of the Junior Institution of Engineers. He has been a pioneer and record-breaker in long-distance flying in light aeroplanes, and now he specializes in economics. He has served in the Royal Naval Air Force both in this and the last war and has held the rank of both Colonel and Commander. Lord Sempill has interested himself in the question of oil and fuel throughout his career. Judging by his recent address to the Institution of Civil Engineers, he has, in addition, good schemes for post-war engineering development and, what is more, for paying for it. It is perhaps of interest to know that although he has been sent in past days by the Government to teach the Japanese how to fly, he has since set that right by introducing aviation to the Greeks.

I now have the greatest pleasure in proposing the "Health of the Guests," and coupling it with the name of that great fellow-Scotsman—Lord Sempill.

The Rt. Hon. Lord Sempill, replying to the Toast, said :

I am glad that the Toast has been proposed in a most thoughtful and generous vein by a fellow Scot. I am proud that the Council of the Institute has given me the privilege of replying on behalf of the Guests. I am particularly glad to speak for them all, and especially those from the United States of America.

A great deal has been said, and rightly said, about co-operation between the United States and Great Britain in research and development of petroleum technology and the use of the products thereof. Such sentiments cannot be repeated too often, and it is appropriate to pay a tribute to the tremendous activity in that field that those from the United States had shown, both prior to and since coming into the war.

The Minister, in an interesting and informative speech, referred to the efficiency and effectiveness of the air forces of the United Nations, and to what was owed by them to petroleum technologists. I myself, as one of the pilots at the luncheon, support that tribute to the full. The debt that the air forces owe to petroleum technologists as a whole is a very real one. The Minister might perhaps have stressed the fact that not more than 30 per cent. of the aviation fuel is made up of straight-run products, and that the remaining 70% is produced by synthetic processes. In this way petroleum technologists have made it possible for the efficiency of the combustion engine to be continuously stepped-up with the practical results that we can see to-day.

In the field of aeronautics there has always been a close co-operation between the United States and this country. The 31st Memorial Lecture of the late Wilbur Wright has just been given by Dr. Warner, Vice-Chairman of the Civil Aeronautics Board, who came over especially for this purpose. He delivered one of the most brilliant addresses on air transport that it had ever been the privilege of the Royal Aeronautical Society to hear. The field of air transport is a vital one. As the war progresses we see how dependent we are on air transports, and if the post-war world is to bring those benefits to mankind that we desire, then air transport must play a dominant part. The United States and ourselves, seeing as we do these problems from the same angle, must seek to apply the vast technical and operational experience which exists to this end.

It is impossible to mention the names of all the Guests, but I am particularly proud to mention the Fourth Sea Lord, under whom I had the privilege of serving, and I am only sorry that it was not possible for the Fifth Sea Lord, the Director of the Naval Air Service, to be present. I should also mention the Engineer-in-Chief of the Navy, the supreme technical authority of that vast and intricate machine powered with many millions of horse-power.

In the name of all the Guests I thank the President and Members of the Institute for inviting us to the luncheon, and I am sure that the feelings of the Guests for whom I speak, and my own feelings can best be summed up in the words of the sixteenth-century writer who laid down that there were five good reasons for drinking—to wit, the visit of a friend; present thirst; future thirst; the goodness of the wine; or any other reason. I feel that all these reasons have been fully satisfied on the present occasion, and I thank the President and the Members of the Institute for their hospitality.

The proceedings then terminated.

TRINIDAD BRANCH.

REPORT OF THE COMMITTEE ON THE WORKING OF THE BRANCH DURING THE SESSION 1941–42.

Five meetings were held during the Session, at which the following papers were read :—

26th November, 1941. *14th Annual General Meeting.* "Notes on the Decay and Destruction of Lumber, and Methods of Prevention," by R. L. Brooks.

30th January, 1942. *68th General Meeting.* "Naval Aircraft and Aircraft Carriers," by Lieut.-Commander H. Gardner, R.N.

27th February, 1942. *69th General Meeting.* "The Value and Accuracy of Field Measurements," by C. J. May and R. Pike.

27th March, 1942. *70th General Meeting.* "Gamma-Ray Well Logging in Trinidad," by Glenn M. Conklin.

17th April, 1942. *71st General Meeting.* "Air-Raid Precautions," by Brigadier J. G. Gilman (S.A.).

Mr. L. K. White was elected Chairman, and Mr. A. F. Castle Hon. Secretary and Treasurer.

The average attendance of members and guests at meetings was 47, but it was brought up to this figure by the attendance of ladies at the meetings when non-technical papers were read.

There were 83 members on the roll at the end of the year, compared with 78 for the previous year.

The Annual Dinner was not held on account of the War.

The sum of $99.90 was contributed to the Benevolent Fund by members of the Branch and forwarded to the parent body. The sum contributed the previous year was $103.00.

An extract from a letter from the Secretary of the parent body states :—

> "Please convey to the members of the Branch the sincere thanks of the Chairman of the Fund."

Great difficulty was experienced by the Committee in securing papers by members to be read before the Branch, and the thanks of the Committee are due to those members who gave much time and effort towards keeping the Branch in a live and useful state.

(*Signed*) A. F. Castle,
Honorary Secretary.

At the 79th Committee Meeting held on 12th January, 1943, the following officers were elected for 1943 :—

Mr. H. C. H. Thomas, *Chairman.*
Dr. F. Morton, *Hon. Sec. and Treasurer.*

TRINIDAD BRANCH.

Balance Sheet as at 31st October, 1942.

Liabilities.			Assets.	
Subscriptions to Benevolent Fund :—			Cash at Bank	$595.27
As per last Balance Sheet	$14.90		Cash in Hand	4.00
Received during the year	99.90			
	114.80			
Remitted to London during year	94.90			
To be remitted to London		$19.90		
Income and Expenditure Account :—				
As at 31st October, 1941	419.28			
Excess Income over Expenditure for year ended 31st October, 1942	160.09			
		579.37		
		$599.27		$599.27

Income and Expenditure Account for Year Ended 31st October, 1942.

Expenditure.			Income.	
Car Hire—A.R.P. Lecture	$7.50		Grants from Institute of Petroleum, London	$191.28
Stationery, etc.	5.31			
Postages	13.97			
Telephone	4.41			
		$31.19		
Excess Income over Expenditure		160.09		
		$191.28		$191.28

(*Signed*) L. A. Bushe, *Chairman*. A. F. Castle, *Hon. Sec. and Treasurer*.

F. E. Hunter, H. A. Harris } *Auditors*.

Minutes of the 15th Annual General Meeting, held at Apex Club House at 8.30 p.m. on 25th November, 1942.

Mr. L. A. Bushe, on the invitation of the Hon. Sec., occupied the Chair, the Chairman of the Branch being out of the Island.

1. The Minutes of the 14th Annual General Meeting were read by the Hon. Sec., and their adoption, being proposed by Mr. A. J. Ruthven-Murray, seconded by Mr. F. Penny, was agreed to unanimously.

2. The Accounts for the year 1941–42 having been circulated, Mr. Ruthven-Murray enquired what was the grant at present being received from the parent body. Mr. L. A. Bushe explained that it was formerly £40 p.a. and was now £20 p.a. £20 of the £40 shown on the Balance Sheet was due from the previous year. In reply to Mr. Ruthven-Murray's enquiry as to local revenue, Mr. Bushe stated that there was none whatever at present, the former Branch contribution of $1.00 per annum having been discontinued for some years.

Mr. A. F. Castle, replying to Mr. Ruthven-Murray, said there was a slight decrease in contribution to the Benevolent Fund over the previous year, but the amount was considerably higher than it had been three or four years previously, and remained round about $100. Mr. Bushe remarked that the Branch was in a very satisfactory financial condition.

The adoption of the Accounts was proposed by Mr. H. D. Fletcher and seconded by Mr. H. MacLea and carried unanimously.

3. The Report of the Committee on the working of the Branch during the Session 1941–42 was read by the Hon. Sec. The adoption of the Report having been proposed by Mr. F. E. Hunter, seconded by Dr. F. Morton, was carried unanimously.

4. *Election of Officers.*—Mr. Bushe informed the meeting that it was not necessary to have a ballot. There were three new members of Committee, Mr. G. F. Hazzard, Dr. F. Morton, and Dr. J. E. Smith taking the place of Mr. G. S. Taitt, Mr. H. W. Reid, and Mr. A. F. Castle.

The new Committee comprised: Dr. F. Morton, Dr. J. E. Smith, Mr. G. F. Hazzard, Mr. H. C. H. Thomas, Mr. L. A. Bushe, Mr. L. K. White, and Mr. F. W. Penny.

5. *Auditors.*—A vote of thanks to the retiring Auditors, Messrs. F. E. Hunter and H. A. Harris, was proposed by Mr. L. A. Bushe and seconded by Mr. A. F. Castle, and carried unanimously.

6. *General.*—The Chairman remarked that the Branch was in a fairly healthy state, but it was obviously going to be more difficult for people to attend meetings. The Committee did not want the Branch to die, and the only way to keep it alive was to have papers to read at the meetings.

Dr. J. E. Smith proposed a vote of thanks to the retiring Hon. Sec. (Mr. A. F. Castle). This was seconded by Mr. Bushe and carried unanimously.

There being no other business, the meeting terminated at 9 p.m., after which a paper, "The Analysis of Trinidad Crude Oils," was read by Dr. F. Morton.

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.

928.* More Wildcats Drilled in May, but Results Poor. L. J. Logan. *Oil Wkly*, 21.6.43, **110** (3), 11.—Wildcatting expanded materially in May, and discoveries increased above those for several preceding months, but the overall results were disappointing because the new producing areas were predominantly rated mediocre or poor. 65 wildcats or semi-wildcats succeeded against 46 and 43 in April and March respectively, but less new oil was found in May than in April or March. Only two of the

May discoveries (new deep Ordovician pay field of Winkler County, West Texas, and the new pay (Rodessa) of the New Hope field, Franklin County, East Texas, which was recently opened in the deeper Travis Peak sand) seem likely to have reserves of 20,000,000 brl. or more.

345 wildcats and semi-wildcats were completed in May, against 250 in April and 248 in March. The May discoveries may add 40,000,000–100,000,000 brl. to the U.S. reserves, whereas 60,000,000–150,000,000 brl. are ascribed to the discoveries in each of the months March and April.

The current oil production is about 127,000,000 brl./month. There appears to be little chance of 4500 wildcats being drilled in 1943.

During May Illinois had one small new field, seven substantial extensions, and four new pays; Kansas had seven new fields and one new pay; Oklahoma had one new pay, two gas-fields, and one gas-field extension.

The Winkler County Ordovician strike is on a narrow north–south Ellenburger structure outlined by geophysics. The first Lower Permian production of the eastern side of the Permian basin has been found at Vincent, West Texas.

Tables give data about the wildcat completions by States for May and for the first five months of 1943, with some 1942 figures for comparison; and a list of the successful wildcats in May 1943, with name, location, completion date, depth, completion horizon, producing formation, initial production, structure, and method of discovery.

G. D. H.

929.* Canadian Oil Production Down in First Quarter. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—During the first three months of 1943 Canada produced 2,501,867 brl. of crude and natural gasoline against 2,644,684 brl. in the same period of 1942. Alberta gave 2,427,455 brl. in the first quarter of 1943, of which 2,269,578 brl. came from Turner Valley. In the same quarter of 1942 Alberta produced 2,604,299 brl., and Turner Valley 2,473,928 brl. The Northwest Territories yielded 38,037 brl. of oil in the first quarter of 1943, and Ontario 29,749 brl., the corresponding figures for the first quarter of 1942 being 129 brl. and 35,108 brl. G. D. H.

930.* Mexican Crude Production Running Below Last Year. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—The crude-oil output of Petroleos Mexicanos, the Mexican Government oil company, is below the 1942 level. The March production for the southern zone is slightly above that for February. In the thirty days ending 19th April the northern area gave 2,203,122 brl., the bulk of it from Poza Rica. G. D. H.

931.* New Oil-Field Opened in Southern Alberta. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—Oil production has been obtained in the Vauxhall field, Alberta, 50 ml. north-east of Lethbridge.

Imperial-Armelgra No. 1 well is giving 35 brl./day by pumping. G. D. H.

932.* Oil Supply Near Arctic Circle Made Available by Army. Anon. *Oil Wkly*, 5.7.43, **110** (5), 50.—In 1920 a single well found oil on the Mackenzie River, near Fort Norman, and the oil was refined and used locally. In 1942 it was realized that military installations in Canada and Alaska could be supplied with oil from this area, if the products could be made and transported to them. Wells have been drilled, a pipe-line is being laid, and a refinery will be built in spite of great difficulties. Sufficient oil is understood to have been obtained to meet the original specified requirements.

G. D. H.

933.* Whence Cometh Our Future Oil? Anon. *Oil Wkly*, 12.7.43, **110** (6), 22.—Recent sharp rises in U.S. oil production indicate that in less than a year the surplus production capacity will have been fully absorbed.

There has been a sharp decline in the quantity of new oil found annually during the past four years. Various surveys have shown that the rate of finding oil has fallen in spite of an increase in wildcat footage and a continuation of a high rate of drilling wildcat wells. The new fields found have been smaller in size than those discovered in preceding years.

Denison believes that deeper drilling on known producing structural traps offers the quickest method of maintaining daily productive capacity. In many areas 5000 ft. or more remain to be tested below recent producing traps, and while a great many of these structures will require wells over 10,000 ft. deep, none need exceed 15,000 ft. In such drilling, materials may be conserved, the location of the structure is known, and geophysical work and much geological work are unnecessary.

Levorsen maintains that many layers of geology, each with its own wedge-belts of porosity, facies and lithological changes, structural history, and oil and gas geology, remain to be explored. He notes that some thousands of miles of wedge-belts of porosity remain to be explored. Krynine and Levorsen believe that more detailed geological studies and re-examination of existing data will prove valuable in locating stratigraphic traps at reasonable cost. Geologists have become buried in routine service work, which prevents the paying of adequate attention to the discovery of new fields. The oil industry's economic framework does not encourage the geologist to fulfil this most important function.

Pratt states that mental outlook is a greater obstacle to oil-finding than the physical conditions within the earth's crust. Too much attention is paid to re-working limited unknown oil-bearing areas, too little to expanding the search.

Knowlton advocates improved secondary recovery work as a means of increasing production, apart from exploratory drilling. Torrey estimates that the U.S. oil reserves could be increased by more than 4,000,000,000 brl. by wide application of suitable secondary recovery technique. Low oil prices seem to be a retarding factor in secondary recovery work. G. D. H.

934.* Well Completion Rate Up in June ; Total Down 21·7% for Year. Anon. *Oil Wkly*, 12.7.43, **110** (6), 69.—During the four weeks ended 26th June the completions averaged 367 per week, the highest rate in 1943, but 6% below the June 1942 figure. In the first half of 1943 the completions (8732) were 21% below the total for the same period of 1942. So far this year Californian completions are nearly double those for the first half of 1942, those of Colorado and Kentucky double, and those of Wyoming, Montana, and Arkansas have increased by 59%, 28%, and 13%, respectively.

This year Texas completions are 41% below the figures for the first half of 1942. Other decreases are: Illinois 7%, Indiana 40%, Louisiana 42%, Michigan 30%, Mississippi 72%, New Mexico 39%, Ohio 23%, Oklahoma 15%, Pennsylvania 33%, and West Virginia 18%.

Tables give data on completions by States and districts for June 1943, and for the first half of 1943, with comparative figures for other months and for 1942. G. D. H.

935.* More Rumanian Oil for Germany Sought ; but Concern Felt for Declining Output. Anon. *Oil Wkly*, 12.7.43, **110** (6), 70.—The Germans have been collaborating in expanding oil-transporting facilities in Rumania, both pipe-line and rail, and a canal from Constanta to Bucharest is planned.

Rumanian oil constitutes about one-third of the oil available to the Axis in Europe, and the exports to Germany form about a fifth of the total oil consumption of Axis-controlled Europe. The Rumanian output in 1942 is estimated at 34,000,000 brl., a decline of 10% on the 1941 output, and little more than half of the 1936 output. The decline in Rumanian oil production was begun by governmental policy which discouraged development, and in recent years it has been accelerated by excessive production rates in developed fields.

In 1941 the Buzau and Bacau districts gave about 250,000 brl. The Dambovitsa district was at its peak in 1936, but by 1941 had declined to about a third of the peak figure. The Prahova district's peak production was in 1939, but it suffered a much smaller decline to 1941. G. D. H.

936.* Crude Production Rising in North-Western Canada. Anon. *Oil Wkly*, 12.7.43, **110** (6), 71.—In April 1943 the North-west Territories produced 19,692 brl. of oil, compared with 2 brl. in April 1942, and the total for the first four months of 1943 is 57,729 brl.

During April 1943 Canada produced 837,072 brl., and for the first four months of 1943 the total is 3,338,939 brl. of 35 gal. Of this last total Turner Valley yielded 3,022,566 brl. G. D. H.

937.* Rate of Wildcatting Slows Down During June. L. J. Logan. *Oil Wkly*, 19.7.43, **110** (7), 13–16.—Although fewer wildcats were completed and fewer discoveries made in June than in May, the total oil discovered may have been as much as in May, and some of the discoveries may develop into major reserves. 50–100 million barrels of reserves may have been found in June, but March and April each had 60–150 million barrels of possible reserves. Even the more optimistic figure for June is 20 million barrels below the month's production.

Only 1602 exploratory tests were completed in the first half of 1943, and 99 of these were semi-wildcats. 224 of the 1503 wildcats found oil, gas, or distillate, compared with 281 out of 1519 in the first half of 1942.

During June 1943 53 new oil, distillate, or gas-fields, new pays or extensions were opened. There were 26 new oil-fields, and 11 new pays. A major discovery may have been made in California, where there may be a ½-ml. extension to the Republic pool, which has already given 11,000,000 brl. The drilling is to about 3100 ft.

On a seismograph-outlined anticline in Winkler County, West Texas, a discovery well has flowed 1370 brl./day from the Ellenburger at 10,647–10,697 ft. The Keystone field of the same County, another probable major discovery, has had a discovery well which flowed at 6788 brl./day from the Ellenburger at 9655 ft. There may also be production in the Clear Fork (Permian) and Silurian. There was 307 ft. of highly productive gas-distillate section in the upper Ellenburger, followed by 131 ft. of oil-zone.

Illinois had two new oil-fields and three new pays in June, while Kansas had six new fields; Oklahoma has two new oil-fields, two new gas areas, and a new pay discovery.

Tables give by States details of the June, and January–June completions for 1943, and comparative totals for May 1943 and the first half of 1942. Data presented for the June 1943 discovery wells include location, depth, producing formation, structure, initial production, oil gravity, etc. G. D. H.

938.* Preliminary Explorations Give Promise Ecuador Will Grow in Oil Importance. Anon. *Oil Wkly*, 19.7.43, **110** (7), 54.—The Ecuador oil production recovered in 1942, and preliminary work indicates a growth in importance of the country's output when equipment becomes more freely available.

Geophysical work is being continued in the coastal region, and extensive preliminary work is understood to have been carried out in the interior region.

The country's output is about 2·25 million brl./year, and crude and refined products are exported. 1·5 million brl. were exported in 1942, against 840,000 brl. in 1941.

Ancon, on the Santa Elena, is the chief field, and yields oil from Eocene sands at 1200–6000 ft. The oil is in lenticular sands and trapped against faults, and an area of about 12,000 acres has been proved. North and west of Ancon are several small fields giving oil from shallow wells and pits.

Tables give oil-production and consumption data for Ecuador in recent years.
G. D. H.

939.* Testing Oil-Sand at Athabasca, Canada. Anon. *Oil Wkly*, 19.7.43, **110** (7), 56. —Deca 2, a well in the Athabasca fields, has struck oil at 1655 ft., an 8-ft. oil-saturated core having been obtained in the Grandrapids sandstone. Atadone 2, a mile to the west, found a 50-ft. oil-sand at 1651 ft. Another well is to be drilled 6 ml. to the east.
G. D. H.

940.* Crude Production Higher in New Brunswick County. Anon. *Oil Wkly*, 19.7.43, **110** (7), 56.—During 1942, 27,270 brl. of crude were produced in Albert County, New Brunswick, an increase of 3464 brl. over the 1941 output. G. D. H.

941. Oil-Zones of the United States : Triassic–Jurassic. Anon. *Oil Gas J.*, 22.7.43, 42 (11), 40B.—Following the Appalachian revolution there was widespread erosion of the land surface with the deposition of salt and then red beds in the Permian. This continued into the Triassic, but in the Jurassic the sea invaded from the Gulf of Mexico and the North Pacific. In the Gulf area, red beds were deposited, followed by salt, then the Smackover limestone, which is the main producing horizon of a belt of fields running roughly along the Louisiana–Arkansas border. Red beds rest on the Smackover, followed by the marine Cotton Valley, which produces over a more restricted area.

In the Rocky Mountain area the Sundance (Jurassic) rests on Chugwater Triassic red beds, and produces in the Wind River, Green River, and Powder River basins. There is Morrison production in Western Colorado and Utah. In Montana the Ellis (Sundance equivalent) rests unconformably on the Mississippian and is productive at Kevin-Sunburst.

There is little likelihood of finding oil in the Triassic anywhere in U.S.A. Attempts to extend Jurassic production west from Arkansas into Texas have failed, probably due to lack of porosity. The porosity may have been caused in places by erosion when the sea retreated. The formation wedges out northwards. The extension of the Jurassic south and west from Arkansas is unknown.

The Ellis and Sundance were deposited in Upper Jurassic times by sea as it spread over an old land surface, with the consequent possibility of numerous stratigraphic traps. The Morrison is largely fresh-water, and is not expected to yield much oil.

Since much of U.S.A. was land in Triassic and Jurassic times, the formations below the Lower Cretaceous are potential stratigraphic traps. From Northern Canada to Montana only the Madison has proved important, although there are limestones from Pennsylvanian to Devonian age.

A map is appended showing the Triassic and Jurassic fields, outcrops, and possibilities. G. D. H.

942. June Completions Are Up 10 per cent. Anon. *Oil Gas J.*, 22.7.43, **42** (11), 61.—1309 wells were completed in June, 10% more than in May, and 13·8% more than in June 1942; 726 were oil-wells and 157 gas-wells. Gains in completions occurred in the Appalachian area, Kentucky, Michigan, Illinois, Oklahoma, and California.

A table summarizes by States and districts the operations in June 1943, giving the numbers of each type of completion, the total footage, and the numbers of wells in different depth ranges. G. D. H.

943.* Question of Adequate Producing Ability Becomes Foremost Oil Problem. W. L. Baker. *Oil Wkly*, 26.7.43, **110** (8), 12.—The main oil-industry problem has changed from shortage of transport to shortage of production during the first half of 1943. The rising rate of manufacture of war weapons suggests that the war-time use of oil has not yet reached its peak level. Developments so far in 1943 do not indicate that a record-breaking oil output could be attained and maintained for any length of time. During July the production was about 4,100,000 brl./day, 300,000 brl./day more than in January, and only 38,000 brl./day below the all-time peak of December 1941 and January 1942. 706,881,000 brl. of oil were produced during the first half of 1943, and it seems likely that the year's total may be 1,525,000,000 brl. In 1941 it was 1,404,000,000 brl.

Above-ground stocks have fallen during the past six months.

It has been indicated that the U.S. production is not necessarily capable of being maintained at more than 4,200,000–4,300,000 brl./day during 1944 and 1945 without waste, and the rising demand is already approaching 4,200,000 brl./day.

21,412 wells were drilled in 1942, a third less than in 1941; in the first half of 1943, 8695 wells have been completed.

It is generally accepted that the current discovery rate is inadequate, and most believe that more materials and a rise in crude prices are necessary. Political circles are greatly interested in these matters, and higher crude prices seem likely to materialize. Spacing regulations have been relaxed in almost all the shallow areas, and with the completion of pipe-line, aviation spirit, and synthetic-rubber plant projects, steel allocations for drilling may become more generous. G. D. H.

944.* An Optimistic Angle on Reserves. D. Hager. *Oil Wkly*, 26.7.43, **110** (8), 18.—In the Elk Basin field of Northern Wyoming and Southern Montana prolific wells have been obtained in the Palæozoic, as might have been expected from developments at Byron farther south. All Wyoming structures not yet drilled to the deeper Permian and Pennsylvanian horizons are likely to have wells deepened rapidly. There are, however, not many structures of any size in Northern Wyoming and Southern Montana which remain untested. In Northern and Central Montana there are numerous domes and faulted structures awaiting testing, and these may produce at depths of 3000–8000 ft.

Madison and Devonian tests are being made in Northern Montana, where there are sharp folds and fault-block structures. Nearly all these structures can be determined by surface geology, but in the Dakotas geophysical investigations will be needed in some areas. The Dakota sandstone and the Lower Palæozoic beds have oil possibilities in the Dakotas. The area of Nebraska west of the Nemaha ridge and south-east of the Black Hills uplift is merely a continuation of the Kansas producing area, and here geophysical prospecting should prove fruitful.

Arizona and Utah have favourable areas, and large sectors of West Texas and New Mexico are only partly tested. Western Kansas should provide numerous new fields. Prospecting in the Forest City basin has been unsatisfactory, and the few wells drilled scarcely scratched the area. Pennsylvanian, Devonian, and Ordovician horizons there may well provide oil- and gas-fields. It is difficult to locate structures in Michigan except by subsurface work, and this State possesses much untested acreage. Western Illinois should provide numerous limestone fields in the Devonian, Silurian, and Ordovician. Indiana has not been so intensively prospected as many assume, and Kentucky's best chances of deep production are in the Coal Basin of the central and south-west parts of the State. Mississippi has not been thoroughly prospected. Deeper production and new fields may be expected in Louisiana and Arkansas.

Geophysical investigations will be needed in Alabama, Southern Georgia, and Florida before oil in commercial quantities is likely to be found. California's best prospects lie in deepening wells in present fields and drilling old folds only slightly tested.

There are not many areas which will justify extensive prospecting campaigns, but new activities are now justified in all the outlying areas passed over lightly when the prolific East Texas and West Texas fields were found. Due consideration must be given to the choice of the best method for investigating each area. G. D. H.

945.* Results of Intensive Wildcatting Not Enough To Meet Needs. Anon. *Oil Wkly*, 26.7.43, **110** (8), 21.—The wildcatting carried out in U.S. this year is almost an all-time record, but it has not fulfilled the P.A.W. programme. 3264 wildcats were drilled in 1941, and 3166 in 1942. 4500 were demanded for 1943 in an effort to find sufficient flush fields to assure the maintenance of a producing capacity adequate to war needs.

1602 exploratory tests were completed in the first half of 1943, and while numerically at about the 1942 level, the proportion of successful wildcats is considerably below the 1942 figure. Only 14·9% of the 1943 wildcats have found oil, gas, or distillate, whereas the figure was 18·4% for the first half of 1942. In 1943 there have been found 133 new oil-fields and 51 new oil horizons, against 161 new oil-fields and 86 new oil horizons in the first half of 1942. A liberal estimate of the volume of oil found in the first half of 1943 is 700,000,000 to 750,000,000 brl.—about the same as the production in the same period—but conservative estimates reduce the discoveries to about 350,000,000 brl.

Nearly a dozen fields with reserves estimated at about 20,000,000 brl. have been found in the first half of 1943. Guijarral Hills, California, is an Eocene shore-line field which may have a reserve of 25,000,000 to 50,000,000 brl. A north-west extension or a new pool adjacent to the small but prolific Republic pool has been found, and a reserve of 15,000,000 brl. is allotted to it. On the Texas Gulf Coast there is a two-mile extension to the Stowell field. East Texas has a major discovery (New Hope), and West Texas probably has four.

No discoveries of first-class importance were made in Michigan during the first half of 1943, but Illinois had a substantial addition to its reserves.

The chief features of the wildcatting in other States and areas are noted, and a table classifies the tests by States, with some 1942 figures for comparison. G. D. H.

946.* Footage Off More Than Completions as Wells Are Shallower. Anon. *Oil Wkly*, 26.7.43, **110** (8), 32.—During the first six months of 1943, 8695 wells were completed, with an average depth of 3043 ft. The corresponding figures for the first half of 1942 were 11,157 wells and 3122 ft. This reduction in average depth is due to heavy drilling in the Atlantic coast area, where the depths involved are relatively small. The demand for heavy crudes has led to a concentration of drilling in shallow, heavy-crude fields, and so California has drilled nearly twice as many wells as in the first half of 1942, but has increased its footage by only about one-fifth. The average well depth on the Louisiana Gulf Coast was 9087 ft., on the Upper Gulf Coast of Texas 7721 ft., and on the Lower Texas Gulf Coast 5939 ft. The average in Arkansas and Mississippi exceeds 5280 ft.

Tables give the total footage, average footage, and number of completions annually since 1925, and similar details by States and districts for the first halves of 1941, 1942, and 1943. G. D. H.

947.* Well Completions Drop in 1943 ; Some Areas More Active. Anon. *Oil Wkly*, 26.7.43, **110** (8), 34.—Due to man-power and supply difficulties, drilling this year has been at the lowest level since 1933. This year drilling has been at the rate of about 17,500 wells/yr., some 22% below the rate for the same period of 1942. Since wildcatting was at about the same level as in 1942, the decrease in 1943 completions is in proven fields.

Relaxation of well-spacing regulations has led to a sharp increase in drilling in California, where completions have been at nearly twice the 1942 rate. There has been great activity in shallow heavy-oil fields, the average drilling depth in the first half of 1943 being 3266 ft., against 5157 ft. in 1942 and 5759 ft. in 1941. In spite of this great increase in drilling, the producing capacity has not risen.

In the East and the Middle West and Mid-Continent also there has been some relaxation of spacing regulations. Here wildcatting results have been mediocre, and relatively few fields of major importance have been opened. Illinois has had no spectacular discoveries, but has had a substantial number of discoveries of small new fields, new pay horizons, and extensions to established fields.

Indiana's completions are down by 28%, Ohio's by 23%, Pennsylvania's by 33%, and West Virginia's by 18%. In Kansas the completion rate is almost unchanged, but there were 15%, 13%, 43%, and 41% declines in the first half of 1943 in Oklahoma, Arkansas, North Louisiana, and Texas, respectively. Montana and Wyoming had increases in drilling amounting to 28% and 59%, respectively.

A table gives by States details of the completions in the first half of 1943, with some 1942 data for comparison. G. D. H.

948.* Rigging Up Rotary for Test West of Calgary. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—40 ml. west of Calgary rotary equipment is being installed at a well now 1490 ft. deep, and it is expected to drill to the Madison at about 3000 ft. G. D. H.

949.* Dry Gas Discovered in Fort Norman Area. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—While drilling for water in the Fort Norman area, United States Army engineers have discovered dry gas. G. D. H.

950.* Wartime Exploration in Canada Extensive. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—A 12,000-ft. well is to be drilled off Prince Edward Island.

In the Athabasca area wells have met the oil-saturated sands at 1655 ft., and there seem to be possibilities of a new field. So far drilling in the Taber and Ram River areas of Alberta has not shown great commercial promise. There has been some drilling at Vermilion. G. D. H.

951.* Royalite Oil Is Active in Alberta Mountains. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—Drilling by Royalite has begun 65 ml. west of Rocky Mountain House, Alberta, and 6 ml. west of Nordegg. Home Oil drilled some wells in this general region, and Ram River Oils has also drilled in several places, the latter company being reported to have found definite prospects at one point. Gas is stated to have been found 70 ml. south-west of Rocky. Thirty years ago a well 20 ml. west of Rocky encountered oil. G. D. H.

952.* Petroleum Exploration and Development in Wartime. E. de Golyer. *Petrol. Engr*, Reference Number, **14** (10), 37.—A third of the world's total oil output formerly started on its way to market over the waters of the Gulf and Caribbean, and much of it went to U.S. North Atlantic ports. Loss of tankers through various war causes has necessitated the provision of other means of transport—tank-car, barge, and pipe-line —on a far greater scale than previously. The refining industry has been revolutionized by great changes in the types and amounts of products required.

Before the U.S. entry into the war it was believed that the rate of production could readily be substantially increased, but such a belief has proved unduly optimistic. The rate of oil discovery in the past four years has failed to maintain the reserves, and at the same time has prevented the easy attainment of an increased rate of production, which is most quickly obtained by the discovery of new fields.

There has been, and still is, an excess producing capacity, but part of this is not accessible because of transportation restrictions. Moreover, war demands are likely to increase.

In the past few years wildcatting and geophysical work have been carried out on a greater scale than ever before, but the results are below hopes and needs. Since 1938 the number of fields discovered each year has decreased. During the period 1926–1938, omitting 1932 and 1933, over 1,000,000,000 brl. of crude was discovered yearly. The average for the entire period exceeded 2,000,000,000 brl./year. The decreasing annual reserve discoveries of recent years may indicate the approach of the end of the phase of search for structural traps. Stratigraphic traps may provide the much-needed increase in producing capacity.

Exploitation also has its problems, and, due to shortage of equipment, drilling in 1942 was reduced to 60% of that in 1941. G. D. H.

Drilling.

953.* Lubrication and Inspection of Drill-Pipe-Handling Equipment. G. E. Mullinix. *Oil Wkly*, 31.5.43, **109** (13), 11–12.—Because the rotation of the sheaves in the travelling block is readily apparent, the few lubricating points on this unit are usually serviced much as specified by its manufacturer, while the hook, immediately below, is less likely to receive either regular or correct lubrication at all the dozen or more bearing or working surfaces. For the hook there may be required two types of grease, each of these again being changed for the proper weight to fit summer or winter operating temperatures. Since the types of bearing surfaces in various makes of hooks change with the individual design, it is not possible to provide a general specification which will cover all uses. The recommendation of the hook manufacturer should be followed closely, if maximum service with minimum wear is to be attained. For the bearing points equipped with grease-gun fittings, the proper seasonal grade of grease should be used, the gun being relied upon to furnish the force for expelling the old and worn grease and distributing the new lubricant around the wearing surfaces. This same type of grease, applied to those areas designated as grease-brush lubricated, may fall short of attaining its full protective purpose. Generally, a grease brushed on must have more adhesive properties than a gun grease, more body to resist being scraped from the surfaces it is intended to protect, and a higher resistance to dilution, cutting, or emulsion when in contact with water. Some companies use the same lubricant specified by the manufacturers of their wire drilling line for coating surfaces such as the hook-elevator link contact, finding that although basic conditions vary greatly, the ultimate effect of the lubricant is close to that demanded by the service.

Oil for such points as demand this type of lubricant must be of the proper consistency, non-gumming under heat, with low pour point, and fresh stock. The practice sometimes resorted to of using reclaimed oil from engine crank-cases, even if the material be strained, filtered, or even centrifuged, is one which effects a minor economy so inconsiderable when compared to the probable damaging of several hundred dollars worth of irreplaceable equipment that it should not be tolerated under any conditions. Even if the lubricating qualities of such reclaimed oil seem unimpaired, its liability to flushing from the bearing by even a small amount of water makes it a distinct hazard to effective equipment operation.

Other details are given. A. H. N.

954.* Hillside Blow-Out Necessitates Ingenious Repair Method. C. R. Dale. *Petrol. Engr*, June 1943, **14** (9), 33–36.—The topography of the Ventura field is rugged, consisting mainly of steep hills separated by canyons. The surface elevations of the wells vary over several hundred feet. One morning in early February water began flowing from the side of a hill above one of Shell's lease roads that had been built through one of the canyons. The water was followed by mud, gas, and muddy, salty water with considerable sand and a trace of oil. A crater formed, and in less than 24 hours it was approximately 10 ft. in diameter. By the time the flow of fluid was shut off this crater had reached a diameter of 50 ft. The exposure at the crater definitely had the appearance of a fault-zone. The flow gradually increased until it reached a maximum of about 10,000 brl./day, and varied between this rate and 5000 brl./day until shut off. Virtually all the flow was a frothy fluid of medium brown colour. The temperature at the mouth of the crater averaged 100° F. The flow was by surges coming at about 5-minute intervals.

Tests to find the offending well by using a detector in mud and water pumped in the surrounding wells and by chemical analysis of the crater fluid proved unsuccessful. Pressure observations were made at the various wells both with the wells shut in and while pumping in mud or water. These pressure measurements gave some interesting information on Well 116, located more than 1000 ft. from the crater, which eventually proved to be the offending well. The static pressure taken 4 hours after this well was shut in showed a formation pressure of 1700 lb./sq. in. at 7515 ft.—a pressure much lower than expected. On the following day (after being shut in for 22 hours) the pressure at 7515 ft. was 1685 lb./sq. in., or nearly the same as for the day before. A third pressure survey was made after the well had been shut in 46 hours, and the pressure at 7515 ft. was found to be 1670 lb./sq. in., or 15 lb. per sq. in. lower than the pressure measured 24 hours previously. Two readings were taken below the bottom of the tubing, and failed to indicate a static fluid gradient.

To determine definitely the source of the trouble, Shell took thermal logs of the wells surrounding the crater, beginning with Well 116, in which the pressures had been found lower than expected. The thermal logs in all the wells except Well 116 showed no break in the thermal gradient. In Well 116, however, the survey showed the temperature at 1150 ft. to be 16° higher than the normal gradient, and indicated a flow of warm fluid on the outside of the water string from a depth of about 2500 ft. up to that point. Mercaptan in gas was used as a detector after that, and its odour was noticeable in the crater 24 hours after pumping the gas. The well was then repaired and flow stopped. A. H. N.

955.* Sodium Silicate Mud Used to Drill Deep Shale and Salt-Water Zone. C. C. Pryor. *Petrol. Engr*, June 1943, **14** (9), 108.—In a well where drilling was of an extremely hazardous nature, the drill-pipe had a great tendency to stick, and where great thickness of heaving salt-water shale zone was to be encountered, it was decided to use silicate mud. Silicate of soda muds prevent hydrous disintegration and swelling of heaving shales, and they are particularly suited to supply the high mud weights necessary to balance the abnormally high formation pressures associated with salt water. The sodium silicate liquid weighs 11·8 lb./gal., whereas ordinary water-base muds start with water at 8·33 lb./gal. This extra weight permits use of very heavy muds with greatly lowered content of suspended solids. Obviously, this feature permits easier control of the viscosity, gel strength, and other properties, simplifying control of both the salt water and the shale. Flocculation of drilling fluid due to the salt water is prevented by use of the sodium silicate, and the mud protects the open hole, preventing sloughing of the shale, stuck drill-pipe, bridging, and high-pressure gas blow-outs. Details of the well programme are given, together with properties of mud for two drillings.

The total mud cost for drilling the well to total depth of 10,336 ft. was approximately $14,000, as compared with a cost of about $25,000 for drilling other wells previous to No. 33 with water-base mud, thus resulting in a saving on mud alone of about $11,000. Down time because of stuck drill-pipe, fishing jobs for tools lost in the hole, etc., was entirely eliminated ; also, the hazards of drilling the high-pressure zone were minimized because of the close control of the mud possible.

It is concluded that during the two drillings, especially in the second hole, the accomplishment of carrying a directionally drilled hole would have been virtually impossible with almost perfect hole conditions. Cuttings obtained showed perfect bit-marks. If a water-base mud had been used the Oligocene shale would have gone completely into the mud, and the wall would subsequently have swelled or heaved into the hole, requiring reaming and washing, such as has resulted in other wells. Whipstock setting or running of knuckle-joints would have been extremely hazardous had the hole not been well conditioned. Use of silicate mud resulted in each whipstock being set and retrieved and knuckle-joints run without incident.

It was possible to land a short string of 5-in. casing on bottom and cement to the test-sands drilled. Results of drilling the two holes show the necessity of using a sodium silicate mud in operations involving extended controlled drilling in the shale in the East Hackberry Dome section. A. H. N.

956.* Electrical Logging in Oil-Base Drilling Fluid. W. A. Sawdon. *Petrol. Engr*, June 1943, **14** (9), 124.—Oil is a dielectric and, offering infinitely high resistance, carries no electric current. Oil-base drilling fluids, whether consisting entirely of oil or being compounded of oil with other substances, therefore interfere with electrical logging of a hole unless some means is provided to transmit the current from the formation to the electrode. Oil-base drilling fluids have come into rather extensive use to meet certain conditions, particularly in drilling through low-pressure sands where loss of water into the productive formation is detrimental. Equipment has therefore been developed to procure a reliable electric log of a hole when it is full of oil or an oil-base fluid. Such equipment also permits obtaining an accurate log of a hole full of fluid composed partly or completely of oil from a formation passed through or entered during drilling operations.

Drilling fluids made of native clays, with or without admixtures, or composed entirely of prepared bentonite and water, provide adequate conductivity for electrical logging operations. Even distilled water could be used for drilling and an electrical log obtained with a standard type instrument, because of the readiness of water to dissolve various substances from the formation and thus become an electrolite. When using oil, however, it is a different matter. Most oil–water emulsions offer such high electrical resistance that no electrical formation logging can be done in such a medium without employing an instrument that will cut through the oil-mud film on the wall of the open hole and make a firm contact with the formations to be traversed. By means of this contact, maintained during the passage of the instrument through the formations being logged, the electrical properties of the formations are transmitted to the instrument.

The instrument is described in detail. Typical logs are given as illustrations.

A. H. N.

957.* How to Inspect Wire Rope. A. J. Morgan. *Oil Wkly*, 7.6.43, **110** (1), 16.—Methods of inspecting wire rope can be fairly well standardized, although inspection practices must necessarily vary to allow for the peculiarities of the individual installation. Evidences of deterioration in wire rope will, within fairly wide limits, be the same whether the rope is working on a draw-works hoist or a small electric hoist. Frequency of inspection, however, can vary from daily to yearly, depending on the installation.

Deterioration of wire rope will be evidenced by : (1) Broken wires ; (2) worn wires ; (3) pitted or corroded wires : (4) drastic reduction in rope diameter and excessive lengthening of lay ; (5) marks of mechanical abuse, such as flattening and distortion. To inspect wire rope properly is to discover its worst spot. Thus, an inspection must include the entire length of the rope. If the rope is covered throughout its length with a heavy lubricant on the outside which obscures a view of the broken wires and of the abrasion-worn surfaces of the wire, provision must be made for the inspection to ascertain where the wire breaks are occurring and the degree of the abrasion abuse the rope has suffered. In the majority of instances, however, it will be possible to ascertain the section of rope showing the most deterioration simply by looking at it.

Inspection procedure is detailed under six separate headings. A table gives diagnosis of trouble by listing characteristics and courses of different types of breaks.

A. H. N,

958.* Procedure for Reclaiming Worn Slush-Pump Rods by Metallizing. E. J. Calk. *Oil Wkly*, 7.6.43, **110** (1), 24.—The rods are first annealed, and are then mounted in a lathe between centres. Due either to service or the annealing, the rods are always found to be bent, so the first operation is to straighten them. This is done by applying heat with an acetylene torch at the point of greatest deflection or bend, and bringing a set of rollers which are mounted in the tool-holder of the lathe against the heated portion, thus forcing the rod to run true, or, in other words, straightening it. A tool is then mounted in the tool-post of the lathe and the rod machined, a very coarse feed being used so as to give a very rough machined surface, almost the same as a threading effect. At each end of this machined portion the rod is under-cut or dove-tailed, so as to lock the metallizing metal on to the rod.

Metal is then sprayed on to the rod to a sufficient depth to give an oversize of approximately $\frac{1}{32}$ in. greater than the finished size. The rods are then ground and polished to bring them back to the original size. A. H. N.

959.* How to Inspect Sheaves Used With Wire Rope. A. J. Morgan. *Oil Wkly*, 14.6.43, **110** (2), 42.—Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used. In the majority of instances the cause of abnormal deterioration of wire rope is to be found in the machinery on which it is operating. The principal items to be checked are: (1) Sheaves. (2) Drums. (3) Reeving. (4) General operating conditions.

Sheaves are discussed and the necessity for the inspection of their size, grooves, materials, operation, and general conditions is stressed. A sheave that is out-of-round or has a flat spot on its bearing surface will also cause whipping of the rope, and must be repaired immediately. Sheave-grooves should be either machined or ground to a smooth and true surface and contour. When a sheave-flange is broken off, the wire rope may jump this flange and cause serious damage both to the rope itself and to the machinery. If the rope does not jump the flange, it is at least likely to come in contact with the sharp edges of the broken flange, which may gouge it badly. Such sheaves should be replaced without delay. A. H. N.

960.* When to Replace Wire Rope. A. J. Morgan. *Oil Wkly*, 28.6.43, **110** (4), 36.—Important though it is, the question of when a wire rope should be replaced is very difficult to answer in general terms. There are no hard-and-fast rules that tell just when to remove rope from all installations. Safe, economical, and practical rope-removal practice can be established only by close study of each installation. Two considerations apply in every case: (1) safety; (2) economy. Thus, the question to be answered really is, " How early should a rope be removed for safety's sake; and how late can it be removed for economy ? "

It is common practice to allow a factor of safety in wire-rope installations. This factor of safety is the ratio between the maximum calculated load and the ultimate strength of the rope. These factors of safety vary considerably according to the installation. They are large where rope failure might cause loss of life or serious property damage. Such safety factors, however, do not afford a really accurate measure of the safety of an installation. The true gauge of safety is not the original factor of safety when the rope was new, but rather the amount of usable life left when it is removed. Economy demands that, in so far as possible, the maximum life of a wire rope be obtained. Good rope practice attempts to establish the greatest length of service commensurate with safety.

Where corrosion is a factor there is no safe guide for judging the proper time of removal of the rope. Even ultimate strength tests on corroded ropes can be misleading, because they cannot indicate the rapid rate of deterioration that might occur were the rope continued in service. Corrosion in a wire rope can be controlled by proper and suitable lubrication. When corrosion has started in a rope it can be retarded by lubrication, but the lubricant cannot restore the rope to its original condition; therefore, this rope must be regarded as a corroded rope. A. H. N.

961. Patents on Drilling. J. D. Isaacks and R. Jones. U.S.P. 2,319,236, 18.5.43. Appl. 22.8.40. Deflecting tool with bit assembly.

H. S. T. Eyck and C. A. Fulton. U.S.P. 2,319,395, 18.5.43. Appl. 17.6.51. Aqueous drilling mud containing mineral phosphate.

C. S. Penfield. U.S.P. 2,319,514, 18.5.43. Appl. 8.9.41. Apparatus for controlling fluid flow through drill-strings.

E. E. Post and C. F. Bonnet. U.S.P. 2,319,705, 18.5.43. Appl. 27.8.41. Drilling mud having clay and pectate pulp.

J. D. Chesnut. U.S.P. 2,319,720, 18.5.43. Appl. 30.6.40. Process for cementing oil-wells and the like.

S. Speckert. U.S.P. 2,320,107, 25.5.43. Appl. 14.7.41. Alligning connection for drill-collars.

A. W. Kammerer. U.S.P. 2,320,136, 25.5.43. Appl. 30.9.40. Well drill-bit for rotary systems.

A. W. Kammerer. U.S.P. 2,320,137, 25.8.43. Appl. 12.8.41. Rotary drill-bit.

R. A. Doughty. U.S.P. 2,320,543, 1.6.43. Appl. 31.10.41. Wire-rope clamp and socket.

C. L. Allen. U.S.P. 2,320,550, 1.6.43. Appl. 24.6.40. Well drilling-bit which is self-feeding.

B. H. Barnes and B. S. Minor. U.S.P. 2,320,553, 1.6.43. Appl. 25.6.39. Means for proportioning expansible collars on pipe or the like.

B. S. Lindsey. U.S.P. 2,320,622, 1.6.43. Appl. 13.5.40. Conditioning of drilling muds.

J. Neufeld. U.S.P. 2,320,643, 1.6.43. Appl. 4.5.41. Well-surveying method and apparatus.

D. Scaramucci. U.S.P. 2,320,670, 1.6.43. Appl. 12.7.39. Well-casing attachment with a ball-valve.

W. G. Green. U.S.P. 2,320,863, 1.6.43. Appl. 21.6.40. Well-surveying method and apparatus.

W. L. Russell. U.S.P. 2,320,890, 1.6.43. Appl. 2.8.41. Method of geophysical prospecting in wells.

S. A. Scherbatskoy and R. E. Fearon. U.S.P. 2,320,892, 1.6.43. Appl. 31.1.42. Method of geophysical prospecting in wells.

S. W. Webster. U.S.P. 2,320,901, 1.6.43. Appl. 8.6.40. Water-cooled cathead.

J. W. MacClatchie. U.S.P. 2,320,974, 1.6.43. Appl. 18.8.41. Blow-out preventer.

J. W. MacClatchie. U.S.P. 2,320,975, 1.6.43. Appl. 30.12.41. Piston for high-pressure operations, fitted with packings.

J. M. Range. U.S.P. 2,321,243, 8.6.43. Appl. 19.2.40. Shab-shaker.

J. E. Reed. U.S.P. 2,321,245, 8.6.43. Appl. 14.4.41. Rat-hole swivel wrench for a unitary, well-rig, string-joint making and breaking apparatus.

L. G. Howell. U.S.P. 2,321,295, 8.6.43. Appl. 23.6.41. Apparatus for logging bore-holes using Geiger–Muller counter.

G. F. Fermier. U.S.P. 2,321,474, 8.6.43. Appl. 8.1.40. Core-orientating device.

G. G. Harrington, T. H. Stancliff, and C. H. Black. U.S.P. 2,321,484, 8.6.43. Appl. 4.3.40. Drill-bit for rotary system.

B. W. Sewell. U.S.P. 2,322,064, 15.6.43. Appl. 22.12.41. Coring device having pressure-retaining elements.

T. B. Lewis. U.S.P. 2,322,150, 15.6.43. Appl. 18.5.40. Derrick and method of its erection.

H. Allen. U.S.P. 2,322,269, 22.6.43. Appl. 14.10.40. Blow-out preventer of the ram type.

R. M. Dempsey. U.S.P. 2,322,425, 22.6.43. Appl. 12.8.40. Dumping bailer with a collar and a number of spring arms on the sides.

R. W. Stuart. U.S.P. 2,322,484, 22.6.43. Appl. 20.9.40. Method for removing mud-sheaths for completion of wells by using a solution of a phosphate.

L. G. Howell and L. W. Blau. U.S.P. 2,322,634, 22.6.43. Appl. 23.6.41. Method and apparatus for logging bore-holes.

A. B. Williamson. U.S.P. 2,322,679, 22.6.43. Appl. 4.2.41. Rotating blow-out preventer.

R. B. Kinzbach. U.S.P. 2,322,694, 22.6.43. Appl. 11.10.41. Pipe-cutter and reamer with a knife moving radially outward.

R. B. Kinzbach. U.S.P. 2,322,695, 22.6.43. Appl. 11.5.42. Pipe-milling device to be used in milling pipes in wells.

W. Gerstenkorn. U.S.P. 2,323,027, 29.6.43. Appl. 25.9.41. Drilling implement used with rotary drilling bits and comprising a one-way clutch.

A. R. Maier. U.S.P. 2,323,095, 29.6.43. Appl. 13.5.41. Catline apparatus for hoists on well-drilling units. A. H. N.

Production.

962. Viscosity of Natural Gases. L. B. Bicher and D. L. Katz. *Petrol Tech.*, July 1943, 6 (4), A.I.M.M.E. Tech. Pub. No. 1599, 1–7.—The viscosity of natural gas is required for computing the pressure drop in pipes or porous media.

The viscosities of methane, propane, and four of their binary mixtures have been determined at pressures from 400 to 5000 lb./in.^{2} and temperatures of 77–437° F., with an experimental accuracy of 3·2%. The viscosity data have been plotted as a function of molecular weight with lines of constant pressure, and extrapolated to pressures above 5000 lb./in.^{2} and temperatures below 77° F. A further graph shows the viscosity of normal paraffins at atmospheric pressure as a function of molecular weight.

Comparison of the viscosities of light hydrocarbon mixtures under pressure (up to 2500 lb./in.^{2}) as predicted from the molecular weight with observed values shows an average deviation of 5·8%. Prediction should not be made near the critical region or in the two-phase region, for in the former case the properties vary rapidly, in the latter they are a function of the concentration of the constituents as well as of the molecular weight.

Under atmospheric pressure the molal average viscosity of nitrogen and the nitrogen-free hydrocarbon gas reproduces the experimental value satisfactorily, and under high pressure a similar procedure should be the best approximation now available.

A series of graphs gives the relationship between viscosity and molecular weight for methane–propane mixtures at pressures up to 10,000 lb./in.^{2} and temperatures of 0°, 60°, 100°, 200°, 300°, and 400° F.

Another graph relates viscosity at atmospheric pressure and the molecular weight of paraffins for various temperatures from −40° C. to 480° C. G. D. H.

963. Selective Acidizing and Permeability Determination by an Electrical Method. D. G. Hefley and P. E. Fitzgerald. *Petrol Tech.*, July 1943, 6 (4); A.I.M.M.E. Tech. Pub. No. 1604, 1–9.—An apparatus has been developed which permits selective acidization of producing formations and determination of the relative permeability of a formation by fluid injection. This apparatus, known as the "Electric Pilot," is an electrical fluid-interface locator, the electrical circuit of which is completed when the electrodes in the well are in contact with a conductive fluid, but is not completed when immersed in a non-conductive fluid.

In acidizing the lower pay of a multiple zone well the electrode-seating nipple is installed on the lower end of the tubing, and sufficient tubing is run into the well to place the nipple 2 ft. above the top level to which acid should rise during the treatment. The electrode unit is run down to the nipple seating, and when in this position the electrodes project down below the bottom of the tubing. Acid is pumped down the tubing and discharged into the well below the electrodes, while oil is simultaneously pumped into the annulus between the casing and the tubing. Separate injection of oil and acid reduces turbulence at the interface and emulsion formation. Readings, taken at the surface, of the current passing between the submerged electrodes indicate whether the oil–acid interface is too high or too low, and the pumping rates are adjusted accordingly, so as to maintain the interface at the desired level.

In the permeability survey sufficient salt water is introduced into the bottom of the well in order to cover all the section to be surveyed, and this water is forced into the formation by introducing oil into the well. The rate of fall of the salt water–oil interface is determined by means of the interface locator. From these data the relative permeability of various sections of the formation can be calculated.

The results are given for a number of typical acidizing applications in which the interface locator was used to control the acid. G. D. H.

964. Engineering Features of the Shuler Field and Unit Operation. H. H. Kaveler. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1605, 1–28.—The Cotton Valley formation and the Reynolds oolite are oil productive formations in the Shuler field, but the Jones sand pool, at a depth of 7500 ft., developed with 146 wells on 20-acre spacing, is the reservoir of principal interest.

The Jones sand sandstone reservoir is an anticlinal trap, typically gas-drive or depletion type in performance. The core analyses from 88% of the wells drilled, together with drilling time and electric-log data, yield an accurate estimate of the "productive" sand thickness and its areal distribution over the pool. Accurate production statistics, monthly reservoir-pressure surveys, and bottom-hole sample analyses when correlated by the "material-balance equation" show unusually good agreement with that principle. Estimates of oil initially in place made by the material-balance method and the sand-volume method are in good agreement at 116,000,000–120,000,000 brl. The reservoir-pressure history of the pool reflects the reaction of a reservoir to production, proration, and secondary-recovery practices.

The cost of the extensive programme of reservoir study in the Jones sand pool has been estimated, in order to emphasize the value derived from such an investment through better understanding of a reservoir's reaction to production practices.

Unit operation of 140 of the 146 Jones sand wells made possible an effective unitized gas-injection pressure-maintenance programme. Reservoir-pressure decline was arrested, natural flow was maintained, and pumping and lease equipment were conserved. An increased ultimate recovery of 20,000,000 brl. beyond the estimated 34,000,000 brl. primary recovery is indicated at present.

Extension of the Jones sand unit to include the undeveloped Cotton Valley formation will permit additional recovery of otherwise uneconomic reserves of oil through wells no longer required in the Jones sand operations. G. D. H.

965. Role of Connate Water in Secondary Recovery of Oil. P. A. Dickey and R. B. Bossler. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1608, 1–9.—The presence of connate water in oil-sands is of far greater practical significance in secondary recovery operations than in primary production. The percentage saturations of oil, water, and gas in a depleted field determine whether it will be possible economically to recover oil by secondary methods, and whether water-flooding or gas-drive will be successful. It appears likely that economic recovery of oil by secondary water-flooding can occur only when a rich bank of oil is formed by the encroaching water. If the sand has a greater effective permeability to water than to oil before flooding, a bank will not be formed, and water-flooding will not be successful, although gas-drive may be. Published laboratory data indicate that the effective permeability of a sand to oil and water depends primarily on the degree of saturation of the sand by each of these phases, and that a small difference in relative saturation produces a large difference in effective permeability to the phase in question. Thus, there exists a critical range of saturations wherein a small change in oil or water content of a sand will make water-flooding possible or impossible. In gas-drive operations the degree of water saturation is important but less critical. The presence of connate water in a sand increases the proportion of the residual oil that may be recovered by gas-drive. Sands with oil-saturations too low and water-saturations too high to make water-flooding possible can often be subjected to gas-drive with economic recovery of oil.

The results of laboratory work on test samples which do not contain water cannot be applied to normal field operations. More tests on cores containing water as well as oil are desirable, and the improvement of coring technique is necessary, but sufficient data are already available to enable an operator to use core data intelligently in assessing the possibilities of a secondary recovery programme. G. D. H.

966. Completion Records Aid Conservation of Strategic Materials in Wells. V. E. Baum. *Oil Gas J.*, 1.7.43, **42** (8), 46.—The use of correct and accurate records is advocated and explained, together with advantages accruing therefrom. A. H. N.

967.* Gas-Lift Unit Driven by Wire Extension from Another Well. C. A. McGill. *Oil Wkly*, 5.7.43, **110** (5), 16.—The short paper described how a gas-lift well was regulated from another. Deciding that it was feasible to drive the surface jack from the unit on an adjoining well, the horseheads on both jacks were extended by welding channel iron to the lower portions, thus bringing a guide for the wire line only a few inches above the foundation frame of the units. The wire line operating the subsurface valve on the driving unit was extended around the horsehead pulley, brought back down the head-guide, and thence across the intervening territory on wooden hold-ups to the reins of the driven surface unit. Two small holes were drilled into the lower portion of the driven head to permit the wire from the driving unit to be " reined in."

Operation requires that the driven unit be stripped of some of its counterweight, and the driving unit requires additional weight to the beam. Both units produce in a similar manner, and have given efficient service. A. H. N.

968. Combination Gas-Lift and Repressuring Plant Used in Payton, Texas, Pool. H. F. Simons. *Oil Gas J.*, 1.7.43, **42** (8), 32–34.—The principal requirement for both repressuring and gas-lifting of the production is a source of high-pressure gas. When it became necessary to install lifting equipment in the field, gas-lift was considered as a method. Shortly after the field's discovery and development in 1938, efforts were made to unitize and repressure the entire pool, but complete agreement among the operators could not be reached, and the plan was dropped. However, the operators of two of the leases decided to repressure these properties and to build a plant which could be used for both repressuring and gas-lift. The plant was built in 1939, and has operated continuously since. At the present time it is supplying 1,250,000 cu. ft. of gas for injection into the formation through three wells and for the lifting of the production from sixteen wells by gas-lift. There are two flowing wells on the properties and one pumping well; only recently, a third well which had been flowing was converted to a gas-lift well.

The leases being repressured are in one corner of the field, and consequently it is possible to maintain the pressure in the formation under a portion of the property without driving the oil to other parts of the structure. The producing formation is the Yates sand, which is rather clean in some sections of the lease, and contains considerable cementing material in others. The sand averages approximately 60 ft. of gas and oil sand which in the best wells is a fairly solid sand body, but which in poorer wells is quite streaked with lime and shale.

As far as the gas-lift portion of the operation is concerned, it is a closed system, the gas used to produce the oil being returned to the plant for compression and use again. The only time any gas is lost is when several wells happen to produce simultaneously and the separator capacity is not sufficient to handle the gas. A small amount is then vented instead of being delivered to the compressors. This does not happen very often, and the curing of this small operating deficiency would require a greater investment than the saving obtained would warrant. Details of the operation are given. A. H. N.

969. Oil-Well Pumping Practices. Part 1. J. Zaba. *Oil Gas J.*, 1.7.43, **42** (8), 29–31.—Nearly 90% of all the wells operating in the U.S.A. on January 1, 1943, produced oil to tanks by application of different methods of mechanical lift. Among the methods used, oil-well pumping is applied in such an overwhelming majority of cases that it has to be considered as the most important of all the oil-field production practices. It is the purpose of this series of articles to present a concise treatise on the subject of modern pumping operations, taking into consideration their present status, along these three lines of evolution. To accomplish this, the articles will discuss modern pumping equipment, both surface and subsurface, and will present the practical application of the results of research to oil-well pumping problems. No attempt will be made to include theoretical investigations which are still controversial, or which, because of their nature, belong in the realm of pure research. The practical side of the subject will be emphasized, even though this may necessitate discussion of subjects which may appear quite fundamental.

This first part deals with the elements of reservoir behaviour, discussing the types of drive and definitions of common terms, and thus forms an introductory portion of the series. A. H. N.

970.* Simplification Makes Dehydration System More Efficient, Economical. F. Briggs. *Oil Wkly*, 28.6.43, **110** (4), 33.—After eliminating the use of two steam-boilers, four medium-size steam-driven pumps, and four 1000-brl. tanks from a dehydrating system, the characteristics of the processed crude were improved to the extent of increasing the gravity by one degree, the basic sediment and water content was lowered by ¾ of 1%, and the saving in electrical energy exceeded 10%. The salvage value of the items removed from the system constituted an important windfall, to which was added the invaluable time of one man formerly required. The plant is described. A. H. N.

971.* Secondary Recovery in Terms of the Engineering Problem. G. H. Fancher. *Oil Wkly*, 28.6.43. **110** (4), 24.—Prof. Fancher discusses at some length the formulæ and principles involved in problems of flow of fluids through formations followed by economic considerations. It is the author's firm belief that secondary-recovery operations must be considered seriously by operators and technologists in order to increase the recovery of oil in the U.S.A., prolong the life of producing properties, and prevent an irretrievable loss to the nation of its most valuable single natural resource. Too frequently secondary methods of recovery are regarded as methods of last resort and are looked upon as something only for the stripper operator. This attitude may be due to the far too prevalent custom in cost accounting, particularly in the case of the larger operator, of assessing a stripper property with a share of all costs of a district, including the overhead for complex executive and exploration staffs, where such services are no longer useful to the stripper property. It is felt that comparison only of actual expense on a secondary-recovery project to income should be made. If this were done, a certain profit/barrel of oil recovered might be found. No quarrel with accounting methods for various purposes is intended. The important fact, after all, in secondary recovery, is the recovery of a barrel of oil which otherwise would be lost to man's use for ever. Perhaps sometime it will not be necessary to use the adjective "secondary," but it will be realized that oil recovery implies not only wise utilization of nature's energy in an oil-field, but also the augmentation of her energy whenever necessary. The time to water-flood or inject gas is at the time the field is discovered, if maximum recovery at a desirable rate cannot be achieved otherwise.

The development of secondary-recovery projects is more dependent on the obtainment of an increase in the price of crude oil than any other factor. The operators and geologists know where the oil is, the petroleum engineers know how to get it out of the ground, in large measure the wells and equipment are available, and the nation needs the oil. All that is lacking is profit incentive. A price increase is fully justified and necessary to insure the maximum recovery from oil-sands of every barrel of oil which can be obtained. The war situation introduces further considerations for such conclusions. A. H. N.

972.* The Temperature Bomb. F. Briggs. *Oil Wkly*, 28.6.43, **110** (4), 15–17.—Two types of well thermometers are employed : those that use the principle of the temperature-caused variation in resistance of a conductor of electricity, and those that depend on the temperature-caused expansion of a fluid. In the resistance-type thermometer, the electrical conductor is calibrated so that for a certain resistance to the current flowing, a corresponding temperature of the medium surrounding the thermometer is indicated. The fluid-expansion type, commonly referred to as "temperature bomb," likewise is calibrated to denote a certain temperature for a corresponding expansion of the fluid.

Similar to the pressure-determining devices used in subsurface work, the temperature bomb is limited in cross-sectional area so that it may work in conventional size pipe. The principle of operation is also the same for these two types of instruments—namely, the transmittal of a pressure change through some recording mechanism. The temperature bomb contains a gas-filled bulb, connected to a Bourdon tube, to which is attached a recording pen. The pen traces on a chart placed in a clock-driven drum. As the temperature of the medium around the bulb changes, the gas in the bulb and tube expands or contracts, causing the recording pen to move. This movement is then traced on the chart as a curve of displacement against time. The sealed bulb acting as the expansion chamber may contain methyl chloride. This gas, CH_3Cl, is very responsive to temperature changes, and expands very nearly in proportion to temperature increases. If the expansion of methyl chloride when plotted against temperature is a straight line, this means that the stylus movement will be the same for certain temperature changes over the range of the instrument.

Dimensional and other details of the Amerada temperature bomb are given, together with method of its operation. Interpretation of temperature charts—*e.g.*, in cementing operations or in determining points of fluid entrance into the well—are given with magnified illustrations. A. H. N.

973.* Synchronized Gas-Lift System Levels Compressor-Plant Load. T. H. Rodgers. *Oil Wkly*, 14.6.43, **110** (2), 26.—By pairing wells so that input gas goes to only two units at any one instant, and grouping these pairs so as to keep gas demand as even as possible from pair to pair, it is possible to plan the layout of a gas-lift installation which will have uniform gas demand, and from which will result a uniform main-line pressure. Distribution of gas to the individual well is then determined through an intermitter-time scale which will produce best results, well data being correlated with that of other wells so as to adhere as closely as possible to the predetermined optimum condition in which but two wells are on input simultaneously. The use of synchronous motor-drives for the intermitters permits maintenance of such a closely regulated time-flow cycle, once it is established.

The gas-lift system employed in one field is discussed. On an individual well basis, experience in this field shows that the best results are obtained from gas-lift when three physical conditions are met: first, the static pressure should be high and exhibit a fairly flat decline curve; second, the formation gas–oil ratio should be around 1000 cu. ft./brl. or more; and third, water cuts should not exceed 20%. Some water shut-off programmes depend on good cement contact with thin shale bodies to protect producing sands below. When producing a well in such circumstances it is often thought desirable to hold a back pressure against the formation to prevent excessive sand movement into the liner such as occurs with large pressure differentials across the sand face and high fluid velocities, and so prevent the thin shale from caving. This is easily done in gas-lift work by placing a choke in the surface tree to hold any amount of tubing pressure.

A detailed description of the field's layout, and systems used, is given in this long paper. A. H. N.

974.* The Dynamometer. F. Briggs. *Oil Wkly*, 14.6.43, **110** (2), 34.—There are three principal types of polished-rod dynamometers: those of a strictly mechanical nature that indicate the load by measuring stretch (over a short length) of the polished rod; the hydraulic type that compresses a liquid proportionate to the applied load; and the electrical strain-gauge type that, by suitable intricate devices, measures a self-generated current that flows in amounts proportionate to the load on the polished rod. Each type is described. "Harmonics" are explained in simple brief sentences. A diagram gives the shape of dynamometer cards where harmonics of second, third, fourth, and sixth orders obtain.

In a well with a fluid pound the load curve shows sudden reductions on the down-stroke. This is what should be expected; the pump plunger, striking the fluid level in the partly filled working barrel, momentarily receives an upward push, thus relieving some of the load for an instant. Such a condition changes the usual shape of the trouble-free load curve; additional vibrations are introduced which are responsible. Sucker rods operating in this type of well are subject to severe damage if the loads are great, and usually give poor service. Slowing the well down, shortening the length of stroke, introducing a smaller pump, are remedies that relieve a pound due to a pump-off condition. A pound due to a gas condition is another problem, and only experimentation with various speeds and strokes, as well as subsurface equipment, will determine the best operation.

Excessive loads due to the friction between rods and cork-screwed tubing, or between a tight-fitting plunger and the working barrel, are indicated by a continual increase in the load curve for the complete up-stroke; the general shape of the curve slopes up in the direction of the up-stroke. Only facts or experiments will determine which of the frictional conditions is responsible; the pump should be pulled and examined for wear. If pump changes have no effect the tubing can be raised 1 or 2 feet and a further trial made. If the hole is crooked, there is little to be done other than to try rod-guides.

Detection of other causes of trouble—*e.g.*, leaks around plunger cups, effectiveness of counterbalance, etc.—are discussed. A. H. N.

975.* Industry Must Adopt Co-operative Gas-Injection Programmes. H. W. Harts. *Oil Wkly*, 14.6.43, **110** (2), 18.—The problem is briefly discussed from the engineering, conservation, and legal viewpoints. Pooling systems are similarly described and recommended. It is pointed out that many men interested in the production of oil, and even some petroleum engineers, undoubtedly think that some of this procedure may show socialistic tendencies; but the recent trend of oil production and the conservation of gas leads in this direction, and the first indication of an actual shortage of petroleum in the U.S.A. will undoubtedly precipitate legislation somewhat on these lines, and this, in turn, will have more than a minor bearing on the future producing practices in the U.S.A. If a sufficient number of operators in new producing areas take steps to conserve their resources and prevent waste and loss of production, they will undoubtedly be permitted to produce their properties as they have in the past; however, if the wasteful practices are continued, in all probability either State or federal agencies will step into the picture and tell the companies or individuals interested in oil production how and when they will be permitted to operate their various producing properties. A. H. N.

976.* Wasson Operators Propose New Production Schedule. Anon. *Oil Wkly*, 7.6.43, **110** (1), 22.—Bottom-hole energy, man-power, and automotive equipment could be conserved and load-capacities imposed on pipe-lines and gasoline plants could be smoothed out, if wells in the Wasson field, Gains and Yoakum Counties, West Texas, were permitted to produce several days' allowable at one flow-period instead of producing their allotment each day. This is the opinion of a majority of operators in the field after conducting flow tests. Flow tests were made on sixteen representative wells in the field. The results of these gas–oil ratio flow tests taken on ten wells by one operator indicate that the lowest ratio is obtained when the well is permitted to produce a quantity of oil at least comparable to 5 days' allowable in one flow-period. The average gas–oil ratio decreases with the quantity of fluid produced at one flow, a ratio of 643 being obtained when the quantity of oil produced was equivalent to 1 day's allowable, 601 for 2 days' allowable, 557 for 3 days' allowable, and 551 for 4 days' allowable.

Test results of another operator working independently substantiate those previously outlined—namely, that the majority of wells in the Wasson field could produce in excess of five times the present daily allowable with an accompanying reduction in gas–oil ratios. Briefly, the proposal is that any operator may elect to depart from the present regulations for the field, or he may continue to abide by them. If an operator decides to adopt the new production schedule, he must follow these terms: (1) Send written notice to the Texas Railroad Commission and submit a producing schedule for a month's period ; (2) this revised schedule must provide for each well being produced at least six times in any 30- or 31-day month ; (3) the amount produced from any well in any one day shall not exceed 110% of the allowable as calculated by dividing the monthly allowable, as determined from the commission proration schedule, by the number of times a well is scheduled to produce that month. A. H. N.

977.* **Calculating Production Decline Curves for Natural Gas Wells. Part 2.** A. R. Greer. *Petrol. Engr*, June 1943, **14** (9), 90.—A short discussion involves the mathematics of calculating the production curves, and must be read in full to be understood and appreciated. The paper deals particularly with calculations where deviations from the simple gas laws are large and known for different conditions. A. H. N.

978.* **A New Conception of Acidizing. Part 2.** C. E. Clason. *Petrol. Engr*, June 1943, **14** (9), 76.—An example of the increase in flowing capacity by enlargement of crevices is worked out. It is realized that the limestone has a certain permeability and effective porosity apart from those of the crevices considered. Enlargement of the crevices therefore enlarges the channels or conduits of the system as a whole towards the well-bore. The net result can be an increase in production of 200 or 300 times that of the original. More efficiency will result from enlarging the drainage area, because oil and gas will be drawn from a greater distance around the well-bore by virtue of less potential energy being required to move the oil and gas through the formation to the bore of the well. Such a well could be treated with a greater volume of acid than another well the pay formation of which is the same thickness but of uniform permeability and porosity, before the economic limit was reached. That limit is reached when a further treatment would produce only a slight increase in radius of penetration compared with the enlargement of the crevices, and result in no greater volume of production. In areas where formations respond favourably to acid treatment such as just discussed, wells could be spaced farther apart than usual after it was proved that production could be increased by this method.

Different fields require different methods of acidizing, so the author gives descriptions of typical methods which may be used, with appropriate modifications, as standards. Acidizing gas-wells is first discussed. The practices discussed, with the exception of water-washes, are also applicable to oil-wells. Certain procedures are common to specific gas-fields or areas. These procedures have been worked out, and are based upon calculations and reasoning, plus experience. The main procedure in the Hugoton and Panhandle areas is to give one or more small mud-clean-out shots with a weak acid solution preliminary to initial treatments with larger volumes of acid. Water is injected between stages to aid in washing-out insolubles and for diluting spent acid so as to accomplish its quicker and better removal.

A compressor and measuring line float, or Echometer, is used to displace and measure the acid injection when using gas as a pressuring medium. A water load with the well tubed and the gas-lift principle of unloading is also used. Both penetrating acid and gypsum retention are applicable to this work, as well as water for washing purposes, treated with one-half the amount used to make penetrating acid. In other areas, such as the chalk-gas production fields near Monroe, Louisiana, gas pressuring alone is used, as water seems to have a plugging effect on the formation. Other types of formation producing gas in Louisiana and elsewhere can undoubtedly benefit from the washing process, especially if the rock pressure is less than 500 lb. but great enough to unload the well. Details of gas-well washing and acidizing are then given. The following schedule is given in full, as it appears of interest : check open flow of well ; then place 500 gal. or the proper amount of 5% acid in the open hole and blow out into the air for 3–4 hours ; this flocculates and removes mud. In some cases two treatments may be made. Check again for open flow and then displace 1000 gal. of 15% acid from the well-bore. The well can be blown until the gas is fairly dry. Check increase in open flow. In the next stage treat with 4000 gal. of 15% acid, followed by 4000 gal. of water used in the same manner as a wash, separately, allowing a longer time for blowing out. Check again, and if a 50–100% increase is obtained over that which the well showed after the last weak acid wash, it appears favourable for a larger and additional treatment. A volume of 8000 gal. would penetrate the formation 40% farther than 4000 gal., and approximately 8000 gal. of water should be used in washing. Again check open flow. If the flow is 25–100% or more than the preceding treatment, it would certainly indicate that crevice conditions exist, and a still larger stage treatment could then be applied. A treatment of 12,000 gal. would penetrate at least 40% farther than the previous 8000 gal. for the same conditions in the pay, and should be washed with 12,000 gal. water. It is problematical where such a procedure would end, as this would make a total of 25,000 gal., yet it is conceivable that a total treatment of 50,000 gal. would be feasible in some wells if the method is used as described. A. H. N.

979.* Inspection and Analysis of Formation Samples. L. C. Uren. *Petrol. Engr*, June 1943, **14** (9), 51.—Porosity is defined and explained. Measurement of bulk volume of a rock specimen may be done : (1) By immersion in a liquid, such as mercury, which does not enter the pore-spaces of the specimen, and measuring the increase in volume of the liquid ; (2) by saturating the pore-space with a liquid, such as acetylene tetrachloride, then immersing the specimen in a measured volume of a fluid and noting the increase in apparent volume of the fluid ; (3) by coating the specimen with a water-impervious substance that does not enter the pore-spaces of the specimen, then weighing the coated specimen, first in air and then in water, and computing the volume from the known density of the water and the loss of weight when immersed in water ; (4) if the specimen is dressed to some regular geometrical form, such as a cube, its bulk volume can be computed directly from its measured dimensions ; and (5) if the volume of the pores and specific gravity of the mineral substance of which the specimen is composed are known, the bulk volume can be computed from the dry weight of the specimen. Each method is then detailed.

The volume of pore-space within a rock specimen can be determined indirectly by measuring the bulk volume and mineral substance volume. Subtracting the volume of the mineral substance from the bulk volume gives the volume of the pores. The volume of the mineral substance can be determined in several ways : (1) By gas displacement ; (2) by comparison of the dry weight of the specimen with the weight when saturated with a liquid of known density, and (4) by crushing the sample to separate the individual grains and then determining their volume by weighing them in a pyknometer of known volume. These several methods are described separately.

The long paper ends with an examination of the methods of studying grain size and distribution. A. H. N.

980.* Gas Repressuring at Glenn Pool. K. B. Barnes and J. F. Sage. *Oil Wkly*, 31.5.43, **109** (13), 19. *Paper Presented before American Petroleum Institute.*—Glenn Pool was the first major oil-pool in Oklahoma. Original development took place mainly during 1906–1909. Peak production has been reported as 117,400 brl. daily in June 1907. The southern portion of the pool, covering 8100 acres, is the most prolific sector. The North Extension area covers 8400 acres. Oil-production and well-completion records for early years are very incomplete. However, it is believed the southern sector has recovered at least 25,000 brl./acre to date, while recovery from North Extension has been about 4000, with total for entire reservoir in order of 222,000,000 to 236,000,000 brl. The reservoir is of gas-expansion type, and the southern sector contains an unusually thick section of oil-sand.

Systematic gas repressuring or " gas-drive " operations were started in May 1940, and very successful results obtained. By 1st April, 1943, the repressure effort had been expanded to cover work done by 7 companies on 18 leases, with a total of 2000 acres partly under repressure operation. A total of 308 old oil-wells are being affected, while 51 new oil-wells and 65 new input wells have been drilled. The production of these projects was 714 brl. daily before repressuring. During March 1943 the average production was 1983 brl./day, or an increase of 1269 brl. An average of 1·42 tons of steel, the majority consisting of second-hand light-weight casing, was used/brl./day of increased oil rate.

An accurate method of estimating the increased oil recovery that may be obtained at Glenn Pool by repressuring has not yet been developed. In some work reliance has been made on comparisons with similar projects elsewhere, accounting for differences in past oil production, sand character, thickness, per cent. oil and water saturation, and other pertinent factors. The most similar operations in the Mid-Continent are probably the pattern-type air-gas drives in the northern portion of the Nowata, Oklahoma, field, and some comparisons with these have indicated that repressure yields, for the better Glenn Pool properties, may be between 5000 and 10,000 brl./acre. Other investigators have examined recovery data for a large number of gas-repressuring projects in the Mid-Continent which have had substantial operating history, and found that on the average the successful operations will obtain about 25% more oil than would have been recovered ultimately without repressuring. On this basis, with the average recovery expectancy at Glenn Pool without repressuring on the order of 28,000 brl./acre, the repressuring might effect an additional yield of about 7000 brl./acre.

Neither of the foregoing methods of recovery estimation is precise in character. They depend specifically on the exact sand conditions and the existing oil and water saturation values under a particular lease, which are factors judged by broad experience. Possibly the best method that might be used should be based on the average percentage of oil and water saturation existing under a given lease. The recovery expectancy of the repressuring should be the difference between the existing per cent. oil and water saturation at the start of the work and a lower per cent. oil and water saturation that would be obtained when the produced gas–oil ratio reached a limiting economic point. Such a method, however, required reliable relative permeability–saturation curves for the sand and oil and water saturation core data which are representative of conditions in place in the formation. A. H. N.

981.* Utilizing Well Energy in Cleaning Flow-Lines of Paraffin. F. Briggs. *Oil Wkly*, 31.5.43, **109** (13), 13–14.—To clean flow-lines without using steam power, one company uses cleaning tool pushed by gas pressure from the well. The first go-devil was fashioned in the shape of a bullet, from a short piece of hardwood. A washer made from rubberized fabric belting was rounded and bolted to the cap (or back) by means of a long carriage bolt run through a longitudinally drilled hole in the centre of the bullet-shaped body. The overall length of this was approximately 5 in., with a diameter of 2 in. designed for operation in 2½-in. flow-lines. The diameter of the leather cap or scraper was such that small clearance was allowed between it and the pipe-walls. Experience proved this type susceptible to failure of the wooden body through cracking; also it was very light.

Eliminating the detriments of being too light and the possibility of cracking, one of the present type of go-devils used on this lease is constructed from 2-in. pipe; the nose made by slitting, bending, welding, and machining the pipe back to a finish. The leather wash-pipe is attached to the cap by means of a projecting bolt welded in the exact centre of the inside bullet shell. Aside from the metal construction, this has the same appearance as the wooden type.

A later design in use consists principally of three washers, spaced apart along a centre bolt, and held in position by a nut on the end. This type has weight, but not too much of it, has three concentric scrapers of increasing diameter such that the "bite" of paraffin load is distributed over each. Similar to the action of multiple piston rings on a cylinder, this increased number of washers should also provide greater resistance to leakage of the motivating gas past the go-devil. A. H. N.

982.* Factors Necessary for Consideration in Planning a Secondary-Recovery Development. R. C. Earlougher. *Oil Wkly*, 5.7.43, **110** (5), 19.—Before any secondary-recovery project is started, a thorough investigation should be made to determine the feasibility of such operations and also to decide on which type of operation—that is, gas injection or water-flooding—is to be used. Such a study is roughly divided into two parts. First, the preliminary investigation which has to do with the assembling of all available records and information concerning the property under consideration, and a thorough analysis and breakdown of such information. Second, if the preliminary study proves favourable, a detailed investigation should follow. This latter normally consists of obtaining new information—namely, the drilling of new wells and acquisition of cores of the producing formation and the subsequent detailed analyses and interpretations of results secured therefrom. If, from this detailed study, it is decided that secondary-recovery operations merit a test in the field, the operating plan should be set up, and preparations made for close and careful operating control during the life of the project.

Briefly, the preliminary investigation should cover the following points: (1) Past production records and history. (a) Initial production. (b) Sustained production. (c) Total primary recovery. (2) Water production from old wells. (3) Sand thickness and areal extent from old logs. (4) Condition of old wells. (5) Number and location of abandoned holes. (6) Gravity and viscosity of oil. (7) Water supply for flooding or gas supply for injection. (8) Market and selling price of oil. Each of these items is discussed.

In making a detailed study of a prospective area, the first step necessary is to secure a sufficient number of cores so as to obtain as nearly as possible an average picture of the producing formation. The chief factors to be determined from cores, and the resulting analyses are: (1) Net sand thickness. (2) Oil content in place in the sand as expressed as barrels/acre-foot, as well as total barrels/acre-foot. (3) Per cent. porosity. (4) Per cent. oil saturation expressed as percentage of the total pore volume. (5) Per cent. connate water expressed as percentage of the total pore volume. (6) Permeability. (7) Laboratory flooding tests. (a) Residual oil saturation after flooding. (b) Differentiation between floodable and non-floodable sand. (8) Net floodable sand thickness. Separate discussion is given for each of the eight items. Graphs and other details illustrate the important points. It is concluded that secondary recovery definitely is a speciality in itself, and in many ways entirely different from all other operations in the oil industry. If secondary recovery is to be applied, and to be successful, detailed and careful investigation should be made of any property before a project is commenced. Likewise, no one factor is sufficient to ensure the success of such an operation. As the best example, it has often been said that any property with a good past production history not in a water-drive field was adaptable for water-flooding; however, this is entirely too broad a statement. There are already several cases in which such properties have been subjected to flooding solely on that basis, and the result has been a failure. On the other hand, this factor of past production history is important, and should be considered. Likewise, a secondary-recovery project is not something to be turned over to some orphan department for a plaything. More often than not when such has been the case, the result has been a failure. Any water-flooding project should be a full-time job, and should be given every possible consideration. There are undoubtedly large oil reserves available which can be secured by secondary recovery methods; however, great expense and study will be required to obtain them, and at present this work is limited by the existing price of crude oil. A. H. N.

983. Construction and Operation of a Water-Treatment and Disposal Plant. Anon. *Oil Gas J.*, 8.7.43, **42** (9), 29–32.—In one well-known field from which oil has been produced in quantities for many years, the emulsion cut has gradually increased, until recently the pressure necessary to ship the oil required an average of 350 lb./sq. in. on the shipping pumps. The transfer line had been in service for many years, and had become thin because of wear and external corrosion, and the 350 lb. at the field end was about as high as could be maintained with any degree of safety. Two solutions of this problem were offered the executives of the company by the engineers. The first included laying a new pipe-line from the field receiving tanks to the distant treating-plant, and the installation of a battery of new shipping pumps. The solution, however, in reality solved nothing, except to remove the pipe-line leaking hazard from the system which, if put into operation, would still deliver wet, emulsified oil to the old treating plant. The second solution included re-vamping the entire gathering and flow-line system of the producing properties, the construction of an unattended flow-line treating plant on the property, and disposing of the separated water so that only clean pipe-line oil would be shipped to the pipe-line receiving station. The second suggestion is described in detail, with a flow diagram and photographic illustrations.

One of the most valuable auxiliaries of this oil-treating plant is represented by a complete, detailed flow diagram showing accurately—but not to scale—the location of each operating pipe-line, the tanks, dehydrators, heaters, separators, and each individual gate or block-valve and instrument, numbered on the print and described in a box at one side, so that an inexperienced operator can readily understand what is to be done. The valves, instruments, and regulators are shown on the diagram and numbered in operating sequence with tags on each wheel, or stem, in the order in which they are most frequently used, following through from the wet-oil gathering line to the shipping pumps. The remainder of the valves are of somewhat minor importance to the operator, as the treating engineers usually put the plant into operation and make any necessary adjustment to overcome problems which the average pumper has not the time or training to handle. A. H. N.

984. Basic Principles of Reservoir Behaviour. Part 2. J. Zaba. *Oil Gas J.*, 8.7.43, **42** (9), 34.—Gas–oil and water–oil ratios are discussed. In measuring the gas–oil ratios, close attention to details is essential. Conditions of equilibrium must be assured and the rate of production at which the measurement was taken must be stated. Precautions must be taken that all gas produced is being measured. To avoid the confusion which frequently results from free use of term " gas–oil ratio," the term should be definitely qualified. Nomenclature has been suggested the use of which would eliminate the possibility of wrong interpretation. The following terms, which are self-explanatory, have been suggested : formation gas–oil ratio, formation gas–liquid ratio, circulated gas–oil ratio, gross gas–oil ratio, gross gas–liquid ratio, tubing gas–liquid ratio. The last two terms apply to pumping wells, and should be used when no gas from the annulus is included in the measurement.

Productivity index is defined and explained. The basic concept of the productivity index is simple, but the factors involved make it highly complex. For a homogeneous fluid flowing through the reservoir in a viscous radial flow under steady state conditions, the rate of flow would be proportional to the differential pressure. This may be expressed by the following equation : $Y = C(X - X_1)$, where Y = rate of flow, $X - X_1$ = differential pressure, C = constant of proportionality.

The constant C, the slope of the line, would be the productivity index, which would be constant for different rates of production. The reservoir fluid, however, is not homogeneous. It is an oil–gas mixture, the characteristics of which change as the liberation of gas takes place. The characteristics of the reservoir itself change as a result of changes in saturation. The flow in the proximity of the well may change from viscous to turbulent. The productivity index is therefore a function not only of reservoir and fluid characteristics, but also of oil–gas ratio, pressure differential, absolute reservoir pressure. From a purely theoretical standpoint, therefore, the productivity index would not be expected to be constant for different rates of production, which would limit its practical usefulness. Actual measurements, however, of the productivity index of a great number of wells showed that for moderate rates of production, and for conditions of equilibrium such as can be attained under practical field conditions, linear relation does exist in a large number of cases, between rate of production and pressure differential. In many other cases, deviation from this straight relation is well within the probable limits of error of measurements. Because of this fact, the productivity index found wide practical application as a measure of the productivity of wells. Different definitions used for productivity index and the specific productivity index are given, followed by general description of the methods used to measure them, and by a bibliography. A. H. N.

985. Repair of Corroded Casing Strings in Old Kansas Wells. N. Williams. *Oil Gas J.*, 8.7.43, **42** (9), 46–47.—Some of the methods being followed by Kansas producers in repairing corroded casing in old wells are presented in this article. Protection of pipe being run in new wells against corrosive waters is another important phase of operations now receiving attention.

Sources of the most corrosive water are the Arbuckle lime, the principal and deepest oil-producing horizon in the majority of fields of Western Kansas, and the Dakota sand, a shallow horizon which has been unproductive of oil to date. Arbuckle water, produced with the oil, attacks the casing from within the well. Corrosion from water in the Dakota sand and other shallow formations results when this water acts on the casing from behind, causing leaks that permit the water to get into the well. Corrosion by Arbuckle water inside the well can be controlled to a large extent by production methods. Casing failures due to Arbuckle water corrosion have been chiefly in wells that have been pumped up the hole with tubing and pumps set high enough to permit " skimming " the oil. By setting the tubing and pumps near bottom, and pumping from the bottom of the hole, the amount of casing with which water comes in contact is usually small, since ordinarily oil fills the annular space behind the tubing above the pump intake. Few casing failures from Arbuckle water corrosion have occurred in wells that have been pumped from the bottom, and this is now general practice.

Squeeze cementing jobs have been undertaken in quite a few wells with a fairly high percentage of success. Through perforations above and below leaking sections sufficient cement is squeezed behind the pipe to fill the annular space through the section and for some distance above and below, providing not only a water shut-out, but also a protective encasement behind the pipe. Squeeze jobs also have been resorted to frequently to get cement behind the pipe through the Dakota sand in wells in which surface casing was not set and cemented through that formation. Other methods are given, such as using new casings or using liners. A. H. N.

986. Patents on Production. D. Brookshire. U.S.P. 2,319,295, 18.5.43. Appl. 12.8.41. Well-packer with a working barrel section.

G. W. McCullough. U.S.P. 2,319,336, 18.5.43. Appl. 22.8.41. Regulating mechanism for valves.

W. W. Drinkard. U.S.P. 2,319,493, 18.5.43. Appl. 20.5.40. Retractable formation sealing tool with a valve.

C. A. Moon. U.S.P. 2,319,702, 18.5.43. Appl. 4.4.41. Method and apparatus for producing oil-wells.

I. S. Salnikov. U.S.P. 2,319,749, 18.5.43. Appl. 22.7.41. Bore-hole pump by hydraulic means.

C. H. M. Roberts. U.S.P. 2,319,885, 25.5.43. Appl. 8.10.40. Process and composition for treatment of emulsions of oil in water.

J. P. Walker. U.S.P. 2,319,962, 25.5.43. Appl. 24.6.40. Method of and means for treating and/or dehydrating oil, gas, and water mixtures, such as flow from oil-wells.

G. Raymond. U.S.P. 2,320,447, 1.6.43. Appl. 3.10.40. Device for determining flow volume of treating liquids flowing into a well.

C. P. Walker. U.S.P. 2,320,492, 1.6.43. Appl. 11.8.38. Method of determining fluid pressure and production capacity of oil-wells.

F. A. Guetjen. U.S.P. 2,320,589, 1.6.43. Appl. 28.4.41. Packing assembly to surround a reciprocating rod.

D. L. Mitchell, H Marks, and H. C. Beene. U.S.P. 2,320,633, 1.6.43. Appl. 16.11.40. Water-sealing composition for oil-wells.

C. M. O'Leary. U.S.P. 2,320,646, 1.6.43. Appl. 13.12.40. Rod-catcher.

T. J. Steward. U.S.P. 2,320,673, 1.6.43. Appl. 3.8.40. Well-treating fluid comprising an acid of the formula $HSO_3–A–R–A–SO_3H$, where A is a bivalent aromatic radical and R is a bivalent aliphatic radical.

L. Yost. U.S.P. 2,320,708, 1.6.43. Appl. 22.11.40. Submersible electrically driven pump.

A. Boynton. U.S.P. 2,321,002, 8.6.43. Appl. 8.12.39. Stage lift-flow device comprising a side-valve.

A. Boynton. U.S.P. 2,321,003, 8.6.43. Appl. 8.12.39. Differential stage lift-flow device.

T. B. Wayne. U.S.P. 2,321,056, 8.6.43. Appl. 29.7.38. Process and reagent for resolving emulsions.

J. H. Wiggins. U.S.P. 2,321,058, 8.6.43. Appl. 1.11.40. Floating roof for liquid storage tanks.

J. J. Grebe and L. C. Chamberlain. U.S.P. 2,321,138, 8.6.43. Appl. 2.5.38. Treatment of fluid pervious formations.

H. B. Lee. U.S.P. 2,321,215, 8.6.43. Appl. 5.10.40. Safety coupling for sucker-rods.

C. H. Mathis and C. Rampacek. U.S.P. 2,321,761, 15.6.43. Appl. 5.8.40. Process for plugging formations.

O. Barstow. U.S.P. 2,321,970, 15.6.43. Appl. 28.8.40. Method and apparatus for treating wells for injecting fluid simultaneously into at least two zones.

A. H. Brandon. U.S.P. 2,322,343, 22.6.43. Appl. 14.10.40. Tubing wear detector using feelers.

L. L. O. Cranford. U.S.P. 2,322,419, 22.6.43. Appl. 18.9.40. Paraffin scraping tool for wells.

H. H. Kaveler. U.S.P. 2,322,453, 22.6.43. Appl. 23.9.40. Apparatus for controlling oil-wells.

Q. F. Wirtel and C. M. Blair. U.S.P. 2,322,494, 22.6.43. Appl. 27.4.42. Process for breaking petroleum emulsions.

B. M. Davis. U.S.P. 2,323,085, 29.6.43. Appl. 7.11.40. Retrievable combination bridge plug and packer. A. H. N.

Transport and Storage.

987. Calibration of Horizontal Cylindrical Tanks. H. David. *Oil Gas J.*, 4.3.43, **41** (43), 49.—Given a tank of perfectly cylindrical form laid horizontally, it is obviously possible to calculate the volume of liquid which it contains from a knowledge of the depth of oil and the radius and length of the tank. From calculated data a graph is presented which enables a volumetric coefficient to be read off after determination of the ratio of the measured depth of oil to the known diameter of the tank. This volumetric coefficient (C) is such that the quantity of oil (Q) in gallons (U.S.) can be determined directly by the formula $Q = C \times L \times R^2$, where L is the length of the tank in inches and R is the radius of the tank in inches.

The use of the graph reduces the amount of calculation required, but the accuracy will be affected by inclination of tank, presence of piping, baffles, etc., in the tank, accumulation of b.s. and w. and spherical ends of the tanks. R. A. E.

988. Transportation Problems of the Oil Industry. S. A. Swensrud. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1610, 1–11.—In peace-time the transportation of petroleum and its products attracts little attention among those not intimately concerned with it, but the war has brought to the fore the tremendous importance of this problem. The construction of the 24-in. war emergency pipe-line now raises new questions regarding the relative merits of large-diameter pipe-lines and tankers, and focuses attention on the reasons why tankers originally displaced pipe-line transportation, which was then much more costly.

In product transportation the change from tank-cars to trucks and product pipe-lines is merely a speeding up of a process which has been under way for many years, due largely to the railway companies' inflexible attitude regarding rates. The transportation of products by pipe-line was delayed by other factors long after it became a practicable proposition.

The effect of transportation changes on marketing operations is profound. The development of pipe-line and other means of transport has been greatly aided by the integration of the oil industry, which gave the advantage of low incremental costs to large companies controlling a sufficient volume of oil to utilize the new forms of transportation. The war-time shift from tanker to rail transportation has been done well, but could have been effected more rapidly had there been a better appreciation of the possibilities of tank-car substitution and an earlier concentration on the moving and unloading of tank-cars in trainload lots. In the joint use of facilities the rapid attainment of 70–80% of the theoretical possibilities is probably preferable to the delays involved in the formulation and administration of complicated plans which will give 100% efficiency from the start. The post-war use of the large pipe-lines will be a big problem, and the same is true of the extra barge facilities which have been created.

G. D. H.

Cracking.

989. Phillips Cycloversion Process. Anon. *Oil Gas J.*, 4.3.43, **41** (43), 41.—The main object of the process is to convert naphthas produced in thermal cracking operations into stocks rich in aromatics and suitable for incorporation in aviation gasoline.

Aviation gasoline fractions containing up to 90% of aromatics with very small amounts of olefins may be obtained, and the principal by-products include butylene and *iso*butane. After laboratory and pilot-plant investigations, a new unit has been installed at one of the company's refineries. In the course of studying variables the unit has been operated on stocks ranging from light gasolines to heavy gas oils. For aviation-stock preparation, excellent results have been obtained by processing selected naphthas derived from gas oil or topped crude thermal cracking, or from gas reversion operations. The operating conditions of temperature, pressure, concentration, contact time, and cycle length can be varied to suit the type and boiling range of the charge stock. A fixed catalyst bed is installed in the reactors, reactivation being accomplished by controlled burning of the accumulated carbonaceous matter. Steam is used in both process and reactivation stages without injury to the catalyst, which is said to be able to withstand high temperatures and to have a long life. The process is made continuous by alternate use of two or more catalyst chambers. The length of the process period ranges from 1 to 5 hrs. when producing aviation stocks, according to the characteristics of the charge stock and the desired depth of conversion. The unit is illustrated.

R. A. E.

990.* Fluid Catalyst Cracking of Petroleum. E. V. Murphree, C. L. Brown, H. G. M. Fischer, E. J. Gohr, and W. J. Sweeney. *Industr. Engng Chem.*, 1943, **35** (7), 768.—A simplified flow diagram of a fluid catalyst cracking plant is presented and a description of the process is given. Several different methods of operating this process are discussed, in which motor and aviation fuels are obtained as direct products. Other methods of operating this process to produce aviation grade products are to hydrogenate the crackate or to employ the catalytic cracker as a means of producing *iso*butane and butylenes for subsequent alkylation. Typical analyses of products produced by these various processes are given.

Applications of the fluid catalyst technique to processes other than cracking are discussed, and it is shown that this is a process which is particularly advantageous where close temperature control is required, since the solid suspension imparts heat capacity to the vapours.

J. W. H.

991.* Thermal and Catalytic Decomposition of *cyclo*Hexane at High Pressures. V. Haensel and V. N. Ipatieff. *Industr. Engng Chem.*, 1943, **35** (6), 632.—The thermal decomposition of *cyclo*hexane has been examined in a continuous-flow system over the temperature range 500–540° C. at 100 atmos. pressure. Catalytic cracking with an alumina catalyst has been examined over the temperature range 550–578° C. at pressures of 44–140 atmos. in the same system as was used for the thermal decomposition experiments. Detailed analyses of the gaseous and liquid products in terms of chemical types and compounds are given, and from these data a mechanism of the decomposition reaction has been put forward.

J. W. H.

Polymerization and Alkylation.

992. Facts About and Possibilities of Alkylation and Isomerization Processes. A. L. Foster. *Oil Gas J.*, 15.4.43, **41** (49), 77.—Commercial application of both these processes to the petroleum industry is a comparatively recent development, but the importance of both is expected to increase not only during war-time but also in the post-war period. It is not possible to forecast the specifications which will be required of the motor and aviation fuels of the future. The importance which has been attached to volatility, especially in the natural gasoline industry, may, for example, be minimized by changes in engine design, in particular the possibility of solid injection of the fuel. One factor which can be counted upon with certainty is that anti-knock value will become of even greater importance than it has been in the past. It is therefore considered that the fuels of the future will tend increasingly to become blends of selected products manufactured by a variety of processes designed to enhance the natural anti-knock value of gasolines, and including alkylation and isomerization.

After a brief review of some of the principal methods employed in alkylation and isomerization at the present time and discussion of the general properties of some of the products, consideration is given to the future application of the processes and the potential production of alkylates obtainable from the light hydrocarbons available from natural gasoline and liquefied petroleum gas sources. Application of the isomerization process to low-grade refinery naphtha and low-octane-number natural gasoline residues may be economic, and perhaps necessary in order to convert the raw materials into marketable components. A combination of the two processes may effect changes in the utilization of natural gasoline, which may well become the source of raw materials for the processes. For example, the following scheme is a possibility: (1) Separation of *iso*paraffins by fractionation; (2) isomerization of the remaining *n*-paraffins, in different fractions or all in a single charge, (3) disposal of the isomeric products, part as charge for alkylation plants and the heavier portions as finished blending stock for motor or aviation fuels. R. A. E.

993.* Separation of Individual Cresols and Xylenols from Their Mixtures. D. R. Stevens. *Industr. Engng Chem.*, 1943, **35** (6), 655.—Considerable difficulty is encountered in the separation of these compounds by distillation owing to the closeness of the boiling points. It is shown that if these compounds are alkylated with *iso*butylene, the tertiary butylated phenols may be easily separated, and the products debutylated to yield *iso*butylene and the individual phenol. J. W. H.

Refining and Refinery Plant.

994.* Portable Heater for Preventing Hydrate Formation. J. C. Albright. *Petrol. Engr*, November 1942, **14** (2), 52.—A short description is given of a heater designed to raise gas temperatures in high-pressure gas streams sufficiently to prevent hydrate formation. The installation resembles a small oil-field-type boiler, is portable, burns gas, and uses a reservoir of water to prevent excessive heating of the pipe-line, which would lead to deterioration and corrosion. J. C.

995. Pilot-Plant Study of the Gray Clay Treating Process. A. W. Cobb and L. Carlson. *Oil Gas J.*, 19.11.42, **41** (28), 33.—The widely used Gray vapour-phase clay-treating process for improving colour and gum stability of cracked gasoline gives more economical operation on a refinery scale than is obtained on small-scale laboratory apparatus. Consequently, conversion factors have been in use to project to the experimental plant results the laboratory results obtained with a small catalyst bed. To get a more exact method of evaluation a pilot plant has been developed.

The experimental unit described was installed close to a large plant-cracking equipment, took vapours direct from the line leading to the plant Gray units, and consisted of two complete clay-treating systems, each having its own after-fractionater, condensers, and receiver. The double system allowed observation of the effect of altering single variables such as catalyst, time of contact, etc. A flow diagram and detailed description of the pilot plant are given. Tabulated data indicate not only excellent correlation with large-scale plant and the usual improvements in gasoline quality associated with Gray treating, but also show that the process has no deleterious effects on octane number. J. C.

996. Trend Towards More Precise Fractionation Accelerated in Natural-Gasoline Plants. H. S. Norman. *Oil Gas J.*, 15.4.43, **41** (49), 109.—The annual survey of natural-gasoline plants given on p. 113 indicates clearly that there is an accelerating trend towards closer fractionation of the light hydrocarbons. It is considered that this is not merely a measure designed to meet war requirements, but that prospective post-war demands will increase the rate of installation of the necessary plant. In fact, shortage of critical materials and the retarded rate of new oil-field discoveries have probably delayed the rate of construction of plants during the war period. A table shows the distribution of natural gasoline plant capacities in 1943 among the various States; in total there are 567 plants with a daily natural gasoline capacity of over 11½ million gals. 154 of these plants were equipped to recover liquefied petroleum gases, an increase of fifteen plants over 1942. The daily capacity of the recovery plants was over 3½ million gals., an increase of about ¼ million gals. a day over 1942. Bureau of Mines statistics indicate production in 1942 of 118 million gals. of *iso*butane and 674 million gals. of liquefied petroleum gases at natural gasoline and cycling plants and 192 million gals. of liquefied refinery gases at refineries.

Increasing volumes of butane are moving to isomerization plants, and *iso*butane is being segregated for alkylation plants wherever practicable. Whilst the demand for butanes for special purposes continues, greater emphasis may be placed on the recovery of propane in natural-gasoline plant operations. The survey of natural gasoline plants shows the name of the operating company, the plant location, the daily capacity in gals., and the daily capacity for liquefied petroleum gases where such plant is also installed. Plants are grouped alphabetically under the state in which the plant is operated and the name of the operating company. R. A. E.

997. Practical Design and Economics of Cathodic Units Applied in a Refinery. D. Holsteyn. *Refiner*, June 1943, 22 (6), 179–182. *Paper Presented before Petroleum Industry Electrical Association* (*America*).—To give some idea to those not familiar with them, of an oil-refinery layout and its intricate pipe-line system, an area 1 mile square, half of which is taken up by storage tanks and the other half occupied by the refinery units and equipment, storehouses, workshops and offices, is studied. Steel approximately equivalent to 600 miles of 4-in. line is buried in this small area. These lines, varying in size from ½ in. to 36 in. in diameter, fan out in all directions at different elevations, crossing and paralleling each other at distances from several feet to less than ½ in. They carry crude oils, various petroleum products, water, air, gas, chemicals, at different temperatures. Except for a few cases, the lines are laid without a protective coating.

The soil conditions throughout a refinery vary a great deal. Chemical spills, leaks in acid lines, seepage from refinery sewers and sludge-pits, all affect soil characteristics. Measured with the Shephard canes, this soil may show a resistivity of 5000 ohms per c.c. at one point, and a few feet away may measure as low as 100–200 ohms per c.c. The p_H value of the soils may vary from 2·8 to 9·0. Moisture content may be as high as 45%. Thus, the corrosion engineer engaged in cathodic protection is confronted with many variables in approaching his problems. The consensus of opinion among corrosion engineers is that when the potential difference, measured in volts, between the pipe and a copper sulphate electrode in contact with the soil adjacent to the pipe measured 0·85 volt negative, complete protection is accomplished. Details of design are given.

It is assumed that: (*a*) The average life of an unprotected line under more than normal corrosive soil is seven years. (*b*) The life of a protected line under same conditions is 26 years. (*c*) The cathodic unit life is 10 years and the installation cost/unit is an average of $1000. (*d*) Average protection of 10,000 sq. ft. of pipe surface/unit at an operating cost of $175/year, including supervision, renewal of ground-bed, and power cost. (*e*) The average price/sq. ft. of pipe installed is $1·35. This figure may differ from the extreme, depending on working conditions in hazardous areas and areas congested with underground piping. The calculated savings per month with protection is $94·53/sq. ft., and payout period is 10·6 months. A. H. N.

998. Reclamation of Cracking Still Furnace Tubes. L. V. Hile. *Refiner*, June 1943, 22 (6), 183–187.—A detailed and practical exposition of the reclamation of some 200 used 4–6% chrome, 0·5% molybdenum, 4 × 5-in. furnace tubes by arc welding is given. A. H. N.

999.* War Developments in the Petroleum Industry. E. V. Murphree. *Industr. Engng Chem.*, 1943, 35 (6), 623.—Brief reviews are given of the following processes: Superfractionation, alkylation, isomerization, hydroforming, catalytic cracking, butadiene production, and the manufacture of special products. J. W. H.

1000. Isomerization—A Useful but as yet a Little Used Tool for the Refiner. A. L. Foster. *Oil Gas J.*, Part I, **41** (42), 66; Part II, **41** (43), 51.—Although patents dealing with isomerization of specific olefins and groups of hydrocarbons were issued in European countries as early as 1912, it is only within the last decade that the application of isomerization to the production of motor and aviation fuels and their components has been developed on a commercial scale. In the first instance, isomerization was utilized as a means of converting part of the large quantities of *n*-butane available in refineries and natural gasoline plants to *iso*butane as an adjunct to alkylation, since usually there is insufficient *iso*butane from other sources in any individual plant to meet the requirements for alkylation of the butenes available. Three of the catalysts used with success on the commercial scale for alkylation are sulphuric acid, anhydrous aluminium chloride, and anhydrous hydrofluoric acid. The last two mentioned are also effective isomerization catalysts, and it appears feasible to employ either in a combination of isomerization followed by alkylation, using the same catalyst under somewhat different conditions for each step in turn. One or other of the processes using these catalysts is now building or operating in a large number of refineries in the U.S.

In the last five years three commercially successful isomerization processes have been developed: (1) The Shell Development Co. Process, which utilizes $AlCl_3$ or a complex formed by $AlCl_3$ and aromatic or other hydrocarbons, and a hydrogen halide; (2) the Standard Oil Co. of Indiana, or "isomate" process, which employs anhydrous $AlCl_3$ and a promoter such as HCl; (3) the Universal Oil Products Co. process employing metallic oxides or $AlCl_3$ and HCl. References to some of the patents concerned are given. These processes use nominal pressures and temperatures up to 300° F., conditions mild enough to warrant the assumption of low costs and relatively inexpensive equipment. Other companies—*e.g.*, Texas Co. and Standard Oil Development Co.—have also been active.

The patents reveal two fields of application of the isomerization process: (1) The improvement in quality of low-grade distillates by increasing *iso*paraffin content; (2) changing the configuration of individual hydrocarbons. The former has a definite and potentially important place in motor and aviation fuel technology. Low-grade distillates have been raised to 65–70 octane rating according to claims made, and it appears reasonable to believe that specially selected stocks may yield products suitable for blending into aviation gasolines and special military fuels of 80 octane or over, under suitable conditions of treatment. Such a method may have advantages over thermal refining or catalytic cracking or re-forming in respect of lower costs and product loss. Since the higher-molecular-weight hydrocarbons tend to split during the isomerization process into hydrocarbons of lower molecular weight, an increase in vapour pressure and volatility accompanies the octane rating increase. A table indicates octane ratings of several *iso*paraffins compared with their normal isomers.

As regards the second field of application, details are given of the isomerization of *n*-pentane, *n*-heptane, *n*-octane, and *n*-hexane, and of the effects of conditions on the yield of products from these hydrocarbons. Synthesis of the heavier *iso*paraffins, such as triptane and 2 : 2–3 : 3-tetramethylpentane, both desirable on account of high anti-knock properties, may prove to be simpler by a combination of isomerization and alkylation rather than isomerization alone. Recently the preparation of neo-hexane catalytically by a special adaptation of the "isomate" process has been announced. Theories of the mechanism of the isomerization reaction are briefly outlined, and future possibilities in respect of products other than engine fuels are discussed. R. A. E.

1001. Hydrogen Fluoride—The Catalyst. Part 1. J. H. Simons. *Refiner*, June 1943, 22 (6), 155–161.—This part deals with the physical and chemical properties of hydrogen fluoride. The history of preparing this compound is discussed. The industrial method of preparing the compound consists of a carefully controlled reaction between calcium fluoride (fluorite or fluorspar) at an elevated temperature, followed by a distillation of the gaseous products. In this process steel equipment is used throughout. The liquefied gas is stored in steel storage tanks. Pipes, fittings, and valves are all made of steel (ordinary, not stainless). The commercial material contains less than 0·5% water, the average being 0·1–0·2%. Silicon fluoride is less than 0·1% and often as low as 0·01%. It contains a small amount of sulphur dioxide which can be removed if required.

A general study of the properties of hydrogen fluoride shows it to be more akin to water and ammonia than to the other halides. Its physical properties give it considerable technical advantages over many other substances for similar large-scale industrial use. Its low formula weight, 20, gives it more effective chemical/pound than any other catalytic agent for use in the same reactions. This, of course, results in smaller and lighter equipment. As it freezes below solid carbon dioxide temperature, there can be little need for handling it as a solid. Its boiling point is conveniently near room temperature, and it can thus be handled as either a liquid or a gas without the need of using either high temperature or pressure. At 100° F. the vapour pressure of the liquid will give a gauge pressure of only about 15 lb./sq. in. The density of the liquid is close to that of water at the same temperature, and it is thus more dense than most hydrocarbon material. It has a very low surface tension. This, plus the high density, enables the liquid to mix readily with hydrocarbons by agitation, but at the same time allows the mixture to separate readily and easily by settling. It shows little tendency to foam. Pipe and tubing of small diameter can be used, as the viscosity of the liquid is low. The author has measurements of the viscosity in progress at the present time, and these will be published in the near future. The use of the fluoride as a solvent is discussed in detail, followed by a study of its electrical properties and its possible molecular structure.

Hydrogen fluoride is an extremely powerful acid, even more powerful than nitric acid. Despite this it is an apparently weak acid in aqueous solutions, where its apparent acidity is comparable with acetic acid. An explanation of this is given in an article in *Chemical Reviews*, 1931, **8**, p. 213. It is also an extremely powerful dehydrating agent. There is, in fact, no drying agent which either does not react with it or which will remove water from it. It must be made dry. It removes water from sulphuric acid and reacts with phosphorous pentoxide to form water. Despite this it does not dehydrate primary alcohols at ordinary temperatures, nor does it dehydrate acetone anything like so rapidly as sulphuric acid does at the same temperature. It shows a great tendency to form molecular complexes, as shown by the study of the potassium fluoride–hydrogen fluoride complexes by Cady. He lists KF·HF, KF·2HF, 2KF·5HF, KF·3HF, and KF·4HF. With water the complexes $H_2O{\cdot}HF$, $H_2O{\cdot}2HF$, and $H_2O{\cdot}4HF$ have been found. The stability of some of these complexes is very great. A large amount of heat is evolved on mixing hydrogen fluoride and water. The same is true on mixing hydrogen fluoride and sodium or potassium fluoride. The strength of the potassium fluoride–hydrogen fluoride complex is shown by the fact that it will produce by decomposition 1 atmosphere pressure of hydrogen fluoride only at 504° C. It should be pointed out that the existence of the salts KF·HF and NaF·HF does not mean that the acid is dibasic. It is not, and the "so-called" bifluorides are merely salts with hydrogen fluoride of crystallization. Hydrogen fluoride forms highly coloured molecular complexes with many organic chemical compounds such as phenols. It has a strong adhesion to many substances such as metals, oxides, minerals, etc., even those with which it does not readily react. A. H. N.

Chemistry and Physics of Hydrocarbon.

1002. Determination of High-Pressure Vapour-Liquid Equilibrium. J. Griswold, D. Andres, and V. A. Klein. *Refiner*, June 1943, **22** (6), 171–178.—Previous methods of measuring equilibria at high pressures are indicated. A description, with illustration, of the apparatus used by the authors then follows. The chief points of interest are: (1) A circulation-pipe and collar in the heater section, to insure adequate mixing of condensate and still liquid before the vapour is released from the boiling liquid. (2) Ample vapour space above the boiling liquid, so that entrainment is negligible. (3) A condenser constructed in several sections, so that condensing surface as well as type of cooling fluid may be altered to suit the system and the temperature level. (4) A ball-check valve in the condensate return line to prevent back-surges during momentary fluctuations of heat input or removal, or while withdrawing samples. The back pressure caused by this valve maintains a higher liquid level in the condensate chamber than in the still, hence the valve design fixes the vertical position of the condensate chamber with respect to the still.

Many of the parts may be made from extra-heavy and double-extra-heavy pipe. All pressure outlets, small connecting lines, and the two thermo-wells are made from ¼-in. extra-heavy-pipe. All direct pipe connections on the apparatus are welded in place. The operating procedure in obtaining liquid and vapour samples under equilibrium conditions is described. The equilibria of benzene–toluene systems at different temperatures and pressures are given in full. A. H. N.

1003.* Heat Capacities of Hydrocarbon Gases. D. R. Stull and F. D. Mayfield. *Industr. Engng Chem.*, 1943, **35** (6), 639.—The Bennewitz and Rossner method of calculating gaseous heat capacities from spectroscopic data has been extended to a wider temperature range. Tables of solutions to the Einstein function for one degree of freedom and bonding frequency contributions to the molar heat capacities are presented. By the new method the heat capacities of 29 hydrocarbons over the temperature range 250–1500° F. have been evaluated and compared with previously published data. The results show an average difference of ±4%. J. W. H.

1004.* Equilibrium Still for Miscible Liquids. C. A. Jones, E. M. Schoenborn, and A. P. Colburn. *Industr. Engng Chem.*, 1943, **35** (6), 666.—A detailed description is given of an all-glass simple apparatus for the determination of the vapour–liquid equilibria for miscible liquids. Experimental data are given for the systems ethylene dichloride–toluene and ethanol–water. From the results obtained it is shown that the former system closely obeys Raoult's Law. J. W. H.

1005.* Correlating Fluid Viscosity. A. S. Smith and G. G. Brown. *Industr. Engng Chem.*, 1943, **35** (6), 705.—An attempt to apply the theorem of corresponding states to the determination of gaseous and fluid viscosities has shown that it cannot be generally applied, but the correlation is of value in the case of closely related groups of compounds. Experimental determinations of the viscosity of ethane and propane in the range 100–5000 p.s.i. and 15–200° C. have been made, and a plot is presented for the normal paraffin hydrocarbons and their mixtures which enables the viscosity data in this series to be extended for reduced pressures up to 10 and reduced temperatures from 0·65 to 1·5 with the accuracy of the experimental data used in the correlation. J. W. H.

1006. Breakdown of Thixotropic Structure as Function of Time. R. N. Weltmann. *J. Appl. Phys.*, July 1943, **14** (7), 343–350.—Measurements of the thixotropic breakdown of structure, with time of agitation, were performed at different rates of shear on a number of pigment suspensions and on various oils in a rotational viscometer. The product of rate of breakdown in thixotropic structure and time of agitation at any rate of shear was found to be a constant for each material. It is called " the time coefficient of thixotropic breakdown," and is independent of the rate of shear, which is applied to agitate the sample. The time coefficient of thixotropic breakdown is measured in absolute units, having the dimensions of viscosity (dynes sec./cm.^{2}). The equilibrium time—the time necessary to break the thixotropic structure down to its minimum at a specified rate of shear—was also found to be independent of the rate of shear applied while agitating.

Briefly, the following has been found experimentally. In a Couette-type viscometer, the viscosity as calculated by Reiner's formulæ, where yield values are found, gives a straight line when plotted against log time of rotation at constant values of rate of rotation. Further, such lines plotted for different rates of rotation are parallel, and all end in asymptotic but different values of equilibrium viscosities, independent of time, each being a function of rate of shear. Combining these facts, the difference between the value of the viscosity μ at any time t and the equilibrium viscosity μ_E for any rate of shear, fall on a unique straight line for the substance when plotted against log time of rotation—*i.e.*,

$$\log_e \left(\frac{t_1}{t_2}\right) = \frac{(\mu_1 - \mu_E) - (\mu_2 - \mu_E)}{B} = \frac{\mu_1 - \mu_2}{B}$$

where B is " the time coefficient of thixotropic breakdown " and is found independent of rate of shear or time of shearing. Of course, after equilibrium time is attained the viscosity is constant and this formula breaks down—apparently discontinuously.

A. H. N.

1007.* Viscosities of the Methane-Propane System. L. B. Bicher and D. L. Katz. *Industr. Engng Chem.*, 1943, **35** (7), 754.—Experimental data are given for the viscosities of mixtures of methane and propane over the pressure range 400–5000 p.s.i. and at temperatures between 77° and 437° F. A correlation of the data in terms of the theory of corresponding states shows that the average deviation is not greater than 2·9%, and that the corresponding state relationship may be used to obtain the viscosity of any light paraffin hydrocarbon with an average error of 3·5%. J. W. H.

1008.* Catalytic Chemistry. A. V. Grosse. *Industr. Engng Chem.*, 1943, **35** (7), 762. —The scope of catalytic chemistry is reviewed, and the present state of knowledge discussed in terms of broad principles. J. W. H.

1009.* Correlation of Aliphatic Hydrocarbon Densities in the Critical Region. T. G. Stevenin and J. G. Allen. *Industr. Engng Chem.*, 1943, **35** (7), 788.—A simplified correlation of the densities of paraffin and, to a limited extent, olefin hydrocarbons is presented which is based on the theorem of corresponding states. The data are presented in the form of a graph, and it is shown that the calculated data agree to within 2–5% of the experimental values. J. W. H.

1010.* Composition of the Dew-Point Gas in the System Ethane–Water. H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1943, **35** (7), 790. —Experimental data are given for the composition of the dew-point gas of the ethane–water system over the range 100–460° F. and at pressures up to 10,000 p.s.i.

These data are compared with similar data obtained on the systems water–methane and water-nitrogen. J. W. H.

1011.* Relative Volatility Calculations. Correspondence by R. Edgewoth-Johnstone and J. Griswold. *Industr. Engng Chem.*, 1943, **35** (7), 826.—The correspondence extends the formulæ put forward by J. Griswold (*ibid*, 1943, **35**, 247) by the presentation of a formula which enables the value of the relative volatility of wide boiling hydrocarbon systems to be calculated from a knowledge of the boiling points.

J. W. H.

Synthetic Products.

1012.* How an Alkyl-Rubber Plant Works. Anon. *Nat. Petrol. News*, 2.6.43, **35** (22), 18.—The article gives a semi-technical description of one of the Rubber Reserve Co.'s plants for the preparation of Buna S. The rated capacity of the plant is 90,000 long tons p.a. The works comprises 4 butadiene units and 2 styrene units delivering their products to the copolymer unit. Butadiene is prepared from fermentation alcohol, the nature of the catalyst being undisclosed. 98·5% purity is achieved by distillation and washing. In the preparation of styrene benzol and ethylene are passed over a catalyst and the resulting ethyl benzene is dehydrogenated to styrene. An aqueous emulsion of 3 parts butadiene and 1 part styrene is polymerized catalytically, the resultant latex being coagulated by treatment with acid and salt. The final product is recovered by screening, washing, squeezing, and drying. A few relevant statistics are furnished. H. G.

1013.* The Second Mile. L. B. Sebrell. *Industr. Engng Chem.*, 1943, **35** (7), 736.—A review is given of the technical progress which has been made in the development of synthetic rubber. Particular attention is given to the comparative physical properties of natural and synthetic rubbers. J. W. H.

Analysis and Testing.

1014.* Servicing Recording Calorimeter Used to Determine Heating Value of Gas. R. O. Cox. *Petrol. Engr*, September 1942, **13** (13), 69.—The theory of the C-H Thomas Recording Calorimeter is discussed. The instrument consists essentially of a tank unit or calorimeter wherein the heating value of the test gas is measured by imparting to a stream of air all the heat given by its combustion and measuring the rise in temperature of the air. The air and gas are initially brought to the same temperature by means of a common water-bath, and are kept in fixed proportion by motor-driven geared metering devices. A recorder unit translates the heat measurements into B.Th.U.'s and records them graphically.

Calibration of the instrument with hydrogen, methods of applying moisture allowances, and the general testing and maintenance arrangements used by the Lone Star Gas Co. are described. J. C.

Motor Fuels.

1015.* Oil Industry has Met the Problem of 100 Octane Gasoline. O. W. Willcox. *World Petrol.*, December 1942, **13** (13), 54.—A non-technical article which claims that of all American basic industries the petroleum industry, under the leadership of the O.P.C., has carried furthest general collaboration, including pooling of material resources and exchange of technical knowledge. The successive stepping up of the demands for 100 octane fuel since 1940 and the methods for keeping production ahead of the demand are discussed, success being ascribed to increased plant capacity and development of new processes such as catalytic cracking, isomerization, alkylation, precision fractionation, etc., leading to tremendous increases of yield for a given amount of crude. Confidence is expressed that the industry will be able to carry whatever new burdens are imposed, provided the required engineering materials are allocated. J. C.

Special Products.

1016. Organic Loading Fillers as a Substitute for Rubber. T. R. Dawson, R. C. W. Moakes and R. G. Newton. *Industr. Chemist*, February 1943, **19**, 80. *Paper read before the Institution of the Rubber Industry, London, Jan. 11th,* 1943.—Organic materials used as extenders for rubber include (*a*) non-standard substitutes, (*b*) fibrous fillers, and (*c*) hydrocarbon extenders. In class (*a*), in addition to vulcanized oils, a very wide variety of products have been suggested (see Pearson " Crude Rubber and Compounding Ingredients," 1920), some of which may be of interest in view of the rubber shortage. An example is given of " Resinolines " invented by E. Cadonet of Paris and prepared by saponifying various oils by the use of a metallic carbonate (preferably lead), decomposing with nitric acid, decanting, and saturating with an alkali. The soap is resinified with acid and purified by alcoholic extraction. The resins are remarkably flexible, and are similar to natural resins.

Fibrous fillers include fabric and fibre cuttings, wood-flour and shavings, coconut shells, cork dust, ground carbonized peat, and waste leather. These may be used where loss of elasticity is not important, as in floorings, soles and heels, etc., but are variable in quality because of difficulties in vulcanization, and reduce tensile strength. They are of value as reinforcing fabric, bonded products, and as cores for rubber articles, saving a high proportion of rubber. Hydrocarbon extenders (asphalt) were considered by Hancock in his original patent B.P. 9952/1843, and L. Wray in B.P. 2270/1858 included mineral caoutchouc (Elaterite) in an electric insulating composition. Mineral rubber is normally used to the extent of 5–10% on natural rubber without appreciable effect on the mechanical properties and assisting in processing. At present 30–40% is added, giving useful products, and even up to 60% has been used where loss of strength is not a serious factor. Other industrial pitches and resins have been tried in the past, but pine tar, used as a softener and tack producer, is the only product to become established. The best known of present extenders are the Naftolens, which consist of aromatic hydrocarbons of boiling range 200–380° C., obtained from mineral-oil acid tars. They are unsaturated, having a probable general formula $(C_3H_4)_n$, and are capable of being vulcanized. C. L. G.

1017. Vinyl Copolymer Resin for Air Drying Coatings. Anon. *British Plastics*, April 1943, **14**, 647.—Vinyl copolymer resin V.M.C.H. produced in experimental quantities by Carbide & Carbon Chemicals Corporation, is an improved vinylite resin which gives satisfactory adhesion over impervious surface and good chemical resistance when air dried, stoving at relatively high temperatures being necessary when using previous types. It should be particularly useful on all kinds of maintenance work or on entire industrial buildings and equipment exposed to corrosive atmospheres—*e.g.*, petroleum storage tanks. Air-dried coatings on magnesium or aluminium alloys are particularly resistant to salt water. Coatings on paper improve the adhesion of oil-base inks, and blends with high-melting paraffin wax have improved moisture resistance for, *e.g.*, food packaging. Clear emulsions of the resin should be useful sealers for alkaline composition board, plaster, brick, or cement surface. Incorporation into baking finishes reduces the baking temperature necessary to give good adhesion. C. L. G.

1018. War Products from Natural Gas and Natural Gasoline. P. M. Raigorodsky and F. H. Dotterweich. *Oil Gas J.*, 15.4.43, **41** (49), 94.—Major attention is given to the actual commercial processes by which light petroleum fractions may be converted into vital war products. It may be expected that increased discoveries of deep petroleum deposits will increase the percentage of light fractions in the total products available, thus ensuring adequate supplies to enable continued development of recent processes.

The most important war products derived from natural gas and natural gasoline sources are synthetic rubber, carbon black, aviation fuel, and explosives. War-time restrictions preclude a detailed review, but a general report on the more important commercial developments is given.

Butadiene.—In the production of butadiene by catalytic dehydrogenation of *n*-butane the commercial process of greatest importance is the Houdry. The differences between the one-stage process, to be used in a Sun Oil Co. plant having a capacity of 15,000 tons a year of butadiene, and the original two-stage process are enumerated. New critical material requirements of the one-stage plant are relatively small.

Thermal cracking of ethane–propane to yield ethylene which can be subsequently converted into ethyl alcohol provides another potential method of producing butadiene from natural-gas sources. The various methods available for converting ethyl alcohol into butadiene are briefly described, although it appears that at present alcohol manufactured from natural gas is not being used for butadiene production. Petroleum Chemicals, Inc., has designed and built a semi-commercial unit for cracking of hydrocarbons by regenerative heating and for the separation and purification of the olefins produced. The furnace is an adaptation of one designed for production of acetylene, and a flow-sheet and general description of the process are given. Heavy naphtha is used as charging stock, and a yield of 5·2% wt. of butadiene is reported. The possibility of producing ethylene, propylene, and benzene mixtures by this process is worthy of note when overall yields of desirable unsaturated hydrocarbons are of importance.

Carbon Black.—The advent of synthetic rubber has resulted in an increased demand for carbon blacks and a change in type most suitable for compounding for tyre manufacture as compared with natural rubber requirements. To meet this demand increasing quantities of furnace and thermatomic blacks are needed. Both processes are briefly described. In general, the efficiency of the furnace process increases with increased particle size and yields of from 3 lb. to 20 lb. per 1000 cu. ft. of natural gas are obtained as compared with 1 lb. to 5 lb. by the channel process.

Aviation Gasoline.—The importance of natural gasoline in augmenting aviation gasoline supplies is indicated and a scheme outlined whereby finished super-fuels could be produced entirely from natural gas sources by the utilization of stabilization, isomerization, dehydrogenation, polymerization, hydrogenation and alkylation processes.

Explosives.—Approximately half of the current production of synthetic ammonia is prepared with the aid of hydrogen obtained from natural gas by the steam conversion process. General outlines and a flow sheet of this process are given, and alternative methods for removal of CO_3 described. Synthetic ammonia is not only of importance in the production of explosives, but also used as fertilizer base, rubber accelerator, and in the preparation of nitroparaffins. Future exploitation of the nitroparaffins may produce explosives of such a nature that natural gas may develop into a still more valuable source of explosives than at present. Benzene and toluene required for explosives manufacture, etc., may also be obtained from natural gas sources by thermal cracking or catalytic reforming. R. A. E.

1019.* Quenching Oils of Mineral Origin. E. R. Varley. *Petroleum.* August 1943, **6** (8), 120–122.—A short historical sketch of quenching is given and the theory is briefly discussed. Theoretically, water is the most efficient quenching medium, and actually oils, not only mineral, but also animal and vegetable oils, are only 15–45% as effective as cold water, and indeed even less so than certain aqueous solutions. Quenching with oils is frequently preferable where, for metallurgical reasons, a rate of cooling less rapid than that given by water is required. Another advantage of oils is that they tend to give more uniform characteristics throughout the cooling range, whereas the efficiency of water, though high at low temperatures, falls off considerably as the temperature rises. On the other hand, although oil is frequently used at or near atmospheric temperatures, it may with advantage be pre-warmed to something in the region of 35–60° C. It is probable that this is a result of the warmed oil enabling the vapour phase to be more readily achieved and the convection currents in the bath to be accelerated. Results of quenching in oil and in water are tabulated for comparative purposes. Further tables give the testing and properties of quenching oil.

As a result of such work on both sides of the Atlantic, it has been found that the mineral oils, as hydrocarbons, are vastly superior for quenching purposes to animal and vegetable oils, which are the glyceryl esters of higher-molecular fatty acids. This is well summarized in the report of the Alloy Steels Research Committee, which comes to the conclusion, after exhaustive tests on the line indicated on mineral, animal, vegetable, and compounded oils, that high-grade lubricating oils obtained by solvent extraction, and similar oils in which the more oxidizable portions of the oil have been removed, are the most suitable of all oils for the quenching of alloy steels. Hence, the nature and origin of an oil, as well as the method by which it is to be refined, will be prime considerations for the producer of quenching oils. Perhaps more important to the user, however, will be an empiric determination of how well a particular oil behaves in a particular job. It is of the highest practical importance to note that an oil suitable for quenching one specific alloy may be quite unsuited on metallurgical grounds for quenching another alloy, and even with the same alloy an oil suitable for treating small intricate articles made from it may be far from ideal for quenching a large solid object of the same material.

The paper is given in Spanish as well as English. A. H. N.

1020.* Effect of Petroleum Products on Buna S Vulcanizates. R. E. Morris, P. Mitton, J. C. Montermoso, and T. A. Werkenthin. *Industr. Engng Chem.*, 1943, **35** (6), 646.—The conventional tests for swelling and loss of tensile strength are misleading when applied to Buna S vulcanizates, since they give no indication of the loss in tear resistance which has been found to be appreciable in the case of these products. J. W. H.

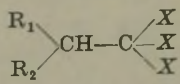
1021.* Effect of the Properties of Carbon Black on the Conductivity of Rubber-Tread Stocks. L. H. Cohan and J. F. Mackey. *Industr. Engng Chem.*, 1943, **35** (7), 806.—The conductivity of rubber-tread stock compounded with 50 parts of carbon black increases exponentially as the particle size of the black decreases. As the crystal structure of the carbon becomes graphitic the conductivity increases sharply, but this effect is of less importance than particle size. Removal of the surface constituents of the black by heating in a non-oxidizing atmosphere results in a product which, when incorporated in the rubber, increases the comparative conductivity tenfold.

J. W. H.

1022.* Solvent Properties of the C_8 Aromatic Hydrocarbons. P. D. Hammond and E. H. McArdle. *Industr. Engng Chem.*, 1943, **35** (7), 809.—Data for the surface tension and dielectric constant of pure samples of the C_8 aromatics are given, and measurements have been made of the solvent power with respect to Kauri-butanol, mixed aniline point, polybutene-*n*-decanol, and maleic resin values.

From these data it is shown that *o*-xylene is a most desirable solvent, since it combines the greatest solvent power with the lowest solution viscosity. J. W. H.

1023. Insecticidal Possibilities of Diphenyl Trichlorethane Derivatives. Anon. *Soap*, July 1943, **19** (7), 101.—British Patents Nos. 547,871 and 547,874 have been issued to J. R. Geigy, A.G., of Basle, for the use in the form of water emulsions, and powders, respectively, of insecticides containing compounds of the general type



where X is Cl or Br, R_1 an organic radicle containing at least 3 carbon atoms, and R_2 an organic radicle containing at least 5 carbon atoms. The toxicity is high, the odour in no way disagreeable, and there is no irritant action on the eyes, nose, or throat. Examples of the specific toxic compounds covered include :—

1. *pp'*-Dichlorodiphenyl trichlorethane—a solid of m.p. 103–105° C.—which can be dissolved in solvents and emulsified with sulphonated castor oil and ammonia, sulphonated fatty alcohols, etc., and used to control flies, moths, plant lice, beetles, etc. Insecticidal powders can also be obtained by mixing the above solution with talcum powder, porous materials such as charcoal, kieselguhr, bole, magnesia, chalk, etc., drying, and grinding. The products are suitable as moth-repellents or toxicants, or, in some forms, as general contact or stomach poisons. They are claimed to be able to replace rotenone completely. Solutions are used to control bed-bug infestation.
2. *pp'*-Dimethyldiphenyl trichlorethane, a solution of which can be emulsified with soft soap to give a stable insecticidal emulsion or used in the solid form.
3. *pp'*-dibromodiphenyl trichlorethane, a solution of which, heated with a cation active compound, gives an emulsion on dilution with water which is highly toxic to insects.
4. Diphenyl trichlorethane on bentonite milled with gelatine and potassium bichromate solution yield a paste from which a spraying mixture of excellent adhesive properties is obtained.

A mixture of 90% of pyrophyllite and 10% of *pp'*-dichlorodiphenyl trichlorethane is in use in the U.S. as a louse powder, the toxic product, a dyestuff intermediate, being in production. Details are given of the method of manufacture of the active compounds and of the insecticides. C. L. G.

1024. Water Emulsion of Pyrethrum. Anon. *Soap*, July 1943, **19** (7), 105.—It is reported from India (P. F. Russell, F. W. Knipe, and T. R. Rao, *Ind. Med. Gaz.*, **77**, 477) that kerosine as a carrier for pyrethrum can be successfully replaced at a third or a sixth of the cost by an aqueous emulsion. A dilution of 1 gal. of extract (from 2 lb. of pyrethrum flowers) with 3 or 7 gal. of water in the presence of Gardinol, sodium lauryl sulphate, or Perminal E.M.L. emulsifiers gives a satisfactory product, slightly greater amounts of the emulsion being required owing to the heavier droplets compared with those of the kerosine spray. C. L. G.

Coal and Shale.

1025. Use of Mixtures of Oil and Coal in Boiler Furnaces. W. C. Schroeder, *Mech. Engr*, November 1942, 793.—In a paper presented at the annual meeting of the Fuels Division of the American Society of Mechanical Engineers at St. Louis on 30th September, 1942, a review was given of information on the burning of ground coal suspended in oil with a view to encouraging its use at present under stationary boilers. For marine use its value lies in the more widespread availability of coal and the greater heat content (1–4%) per unit volume over that of oil fuel, but the ash disposal is dangerous in war-time, so that its use on land in boilers equipped for oil-firing is being considered.

Work was first carried out in the U.S. in 1917 by the Submarine Defence Association, using 0·5–5% of lime rosin soap to suspend 30–40 parts of coal in 60–70 parts of oil, but the product was insufficiently stable, steam purging of the jets being necessary at intervals. Attempts were later made to improve stability by increasing the viscosity of the oil by oxidation, emulsification, and prior removal of ash. The use of gels from metal soaps was also investigated. Attempts to use anthracite instead of bituminous coal failed owing to difficulty in grinding, high ash content, slow ignition, and poor wettability by oil.

In England experiments were made with resins, soaps, rubber, tars, and petroleum pitch as stabilizers and a plant built to produce the mixture, but the venture failed. Later full-scale tests were carried out in various Cunard liners, probably using lime rosin stabilizers with coal-cracked fuel oil, but while full data are not available, they were believed to be unsuccessful, possibly owing to the high-ash content, low-grade coal used. The Fuel Research Board made experiments with oils gelled with sodium stearate to improve the stability, while in the U.S. it was found that the use of tars instead of petroleum produced a gel-like structure of improved stability. In Japan the use of metallic soaps as stabilizers was found unsatisfactory, but a low-temperature tar from selected brown coal was a suitable peptizing agent. A tar-oil peptizer was also found satisfactory in Germany.

Various methods of grinding the coal have been tried, including the use of a colloid mill, grinding the coal and oil mixed, steam pulverization. In general, a particle size of 60–70 μ is required. In practice the presence of ash presents difficulties in furnaces designed for oil-firing, and operation at a lower rating only is possible. Further difficulties are the equipment necessary for grinding the coal at the plant or shipment of the pulverized coal, which is explosive, to the plant.

In general, it is felt that tests hitherto carried out have not been sufficiently systematic or extensive, nor have all the results obtained been rendered available. Some successful demonstrations have undoubtedly been made, and considerable activity is going on in this field. It is proposed that a survey should be made of oil-burning plants on the Eastern coast to consider where such mixtures could be used.

C. L. G.

1026.* Sweden Develops Large Output of Shale Oil and Makes Wide Use of Producer Gas. Anon. *Oil Wkly*, 12.7.43, **110** (6), 71.—More than three out of every five motor vehicles run on producer gas, and the country is exporting producer gas generators to several countries.

It is proposed to increase the shale oil production of the Vaestergoetland province from 37,000 metric tons to 81,000 metric tons. The plant at Kinne-Kleva now gives over 30,000 metric tons of fuel oil per year. The production of light benzine from gas formed in shale distillation is being developed. The Kinnekulle shale deposits may provide 25,000,000 tons of oil.

Ostergotland is estimated to have shale deposits capable of giving 250,000,000 tons of oil, and Narke province may yield 50,000,000–60,000,000 tons of oil.

In the Ljungstroem method of producing oil from shale, the shale is electrically heated underground. Shale oil is also produced by three other methods.

85% of Sweden's shale oil production is fuel oil, and some high-grade aviation gasoline is also obtained.

Sulphur is the chief by-product of the distillation process, and vanadium, molybdenum, and radium are obtained in small amounts.

Tar, used as motor fuel for the fishing fleet, is to be produced at the rate of 8,000 metric tons/year from 20 retort charcoal furnaces.

The experimental production of lubricating oils from crude destructively-distilled pine tar is being undertaken, and while suitable for simple lubrication, they are not satisfactory for internal combustion engines. G. D. H.

INSTITUTE NOTES.

OCTOBER, 1943.

ELECTION TO COUNCIL

The attention of Members is drawn to the following extracts from the By-Laws governing election to the Council of the Institute :

(*a*) The Council of the Institute shall be chosen from the Fellows and Members only.

(*b*) Every Fellow, Member, and Associate Member of the Institute may send in writing to the Council the name of a Fellow or Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Fellows, Members or Associate Members and delivered to the Secretary not later than 30th day of November in any year. No Fellow, Member, or Associate Member may sign more than one Nomination Paper in any one year.

NEW MEMBERS.

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

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

As Fellow.

PIOTROWSKI, Waclaw de Jonosza.

Transferred to Fellow.

MASKELL, Laurence Ormes.

As Members.

ADAMS, Ivan Gifford Barr.
BAINES, Archibald Ernest Walter.
FENTON, Bert Vincent.
GOODWIN, Alfred Frank.
LOW, Peter.
MILLER, Andrew Craig.
TAYLOR, John Ralph Carlisle.

As Associate Members.

BRICE, Frank.
DONE, Albert.
HADLOW, Reginald Edward Eric.
MOON, Sydney Edward Allen.
PATON, Harold.
SMITH, Reginald William.
WILSON, Peter Henry.

As Student.

ROSE, Geoffrey Thomas.

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.

Lawrence, Arthur Stuart Clark, Research Chemist, Imperial College of Science & Technology. (*D. Clayton : S. E. Bowrey.*)

MacLean, Alan Douglas, Chief Engineer, Trinidad Leaseholds, Ltd. (*C. Dalley ; F. H. Garner.*)

Sen Gupta, Dr. N. C. Research Chemist, Burmah Oil Co. (*A. Reid ; E. T. Vachell.*)

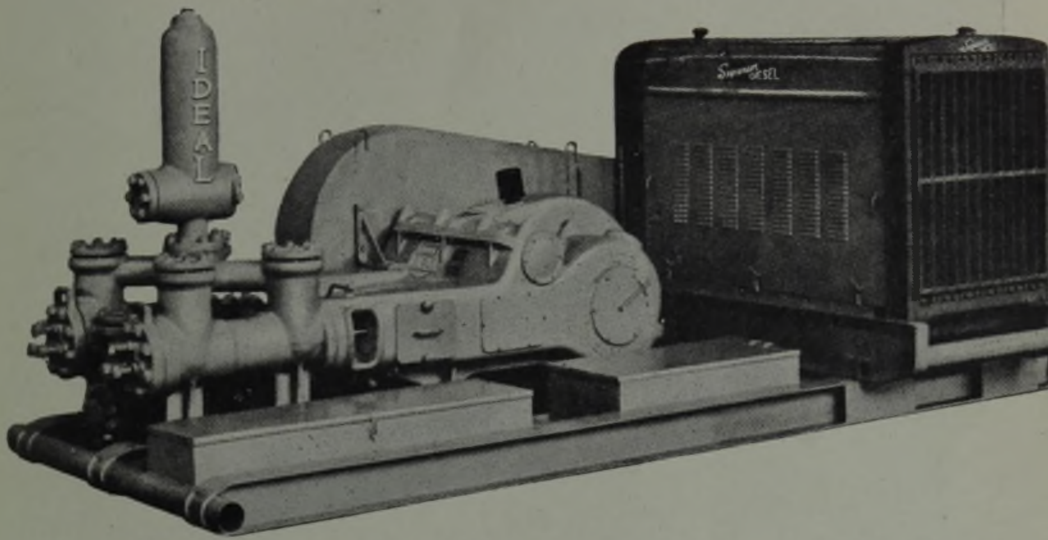
Soulal, Louis, Refinery Manager, Pressure Lubricants, Ltd. (*R. B. Hobson ; E. G. Grant*).

Van den Berg, Gerard Bastiaan, Asst. Exploitation Engineer, Diadema Argentina S.A. de Petroleo. (*H. de Wilde ; R. B. B. Wrixon.*)

Ford, George William Wallace, Acting Manager, G. & B. Dept., Stemco, Ltd. *F. H. Garner ; F. Tipler.*)

Kindly mention this Journal when communicating with Advertisers.

LIGHT DUTY



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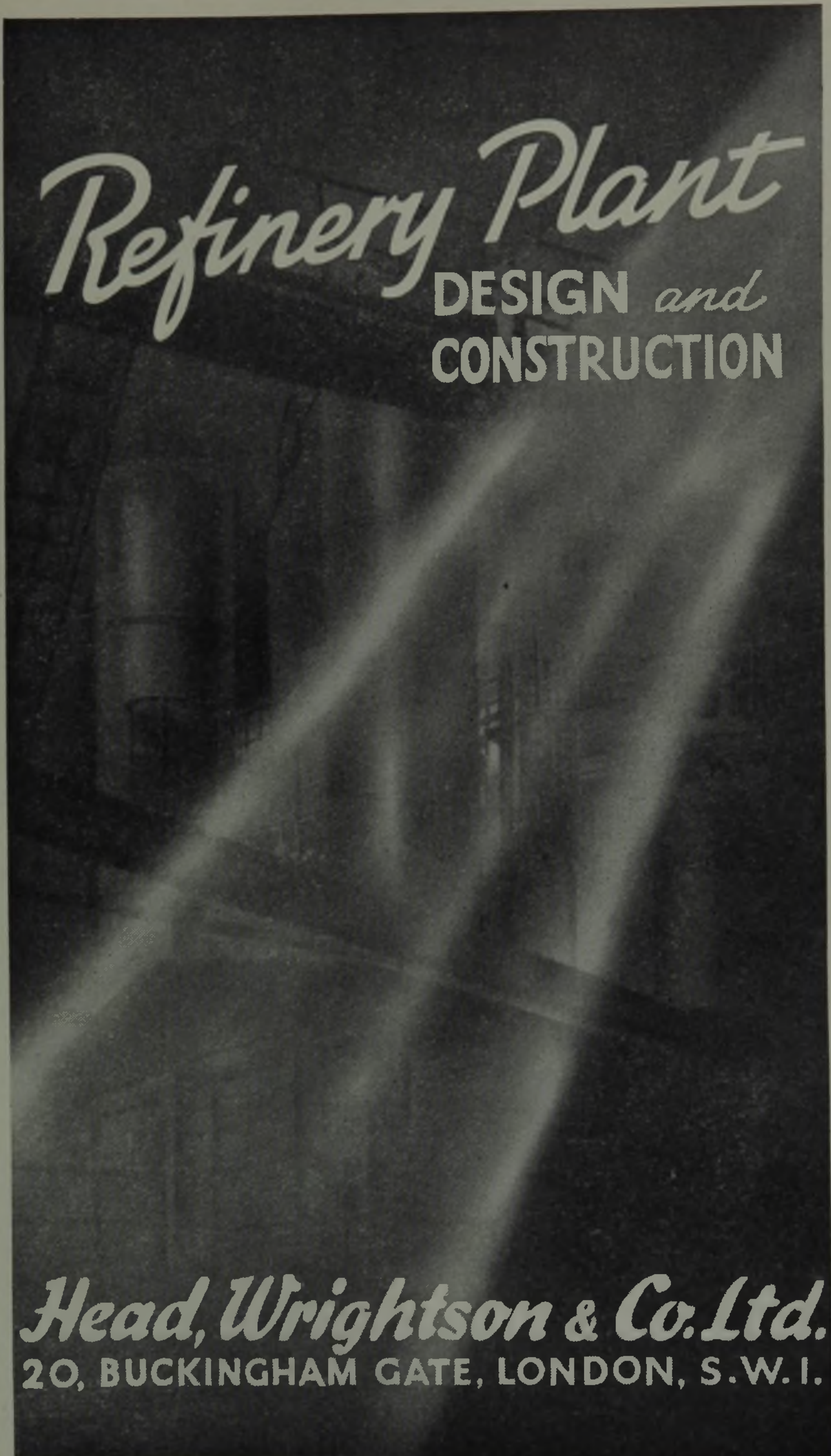
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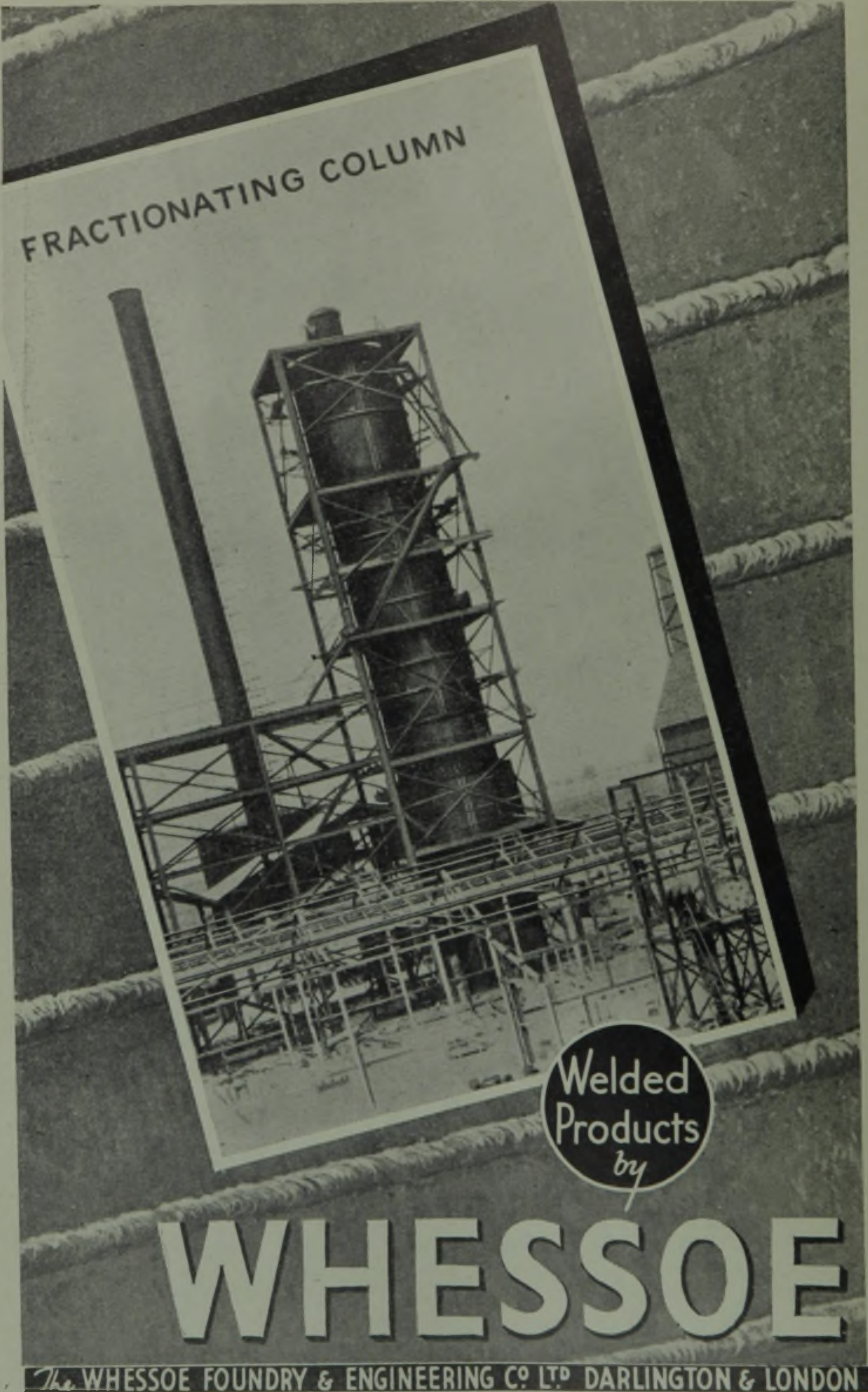
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