The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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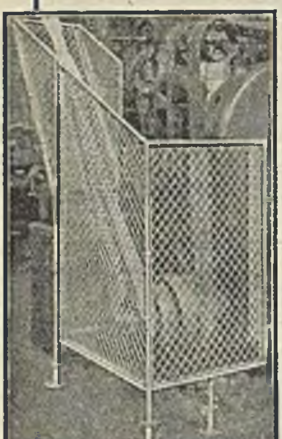

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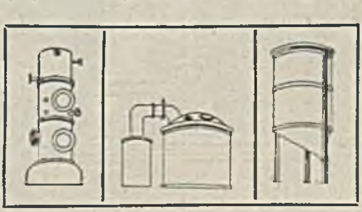

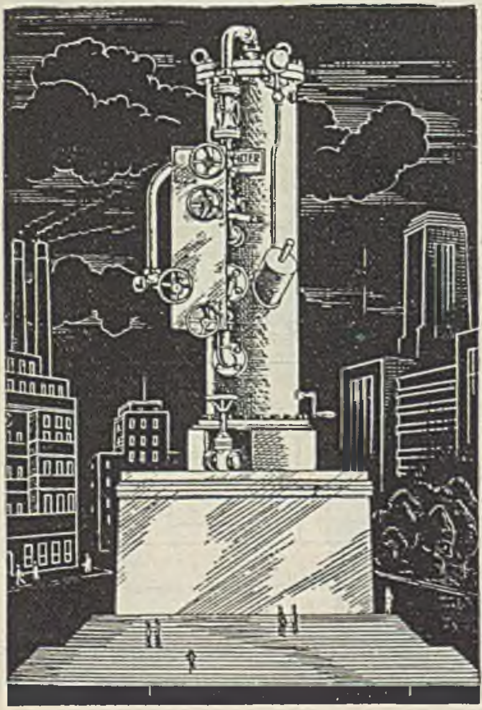

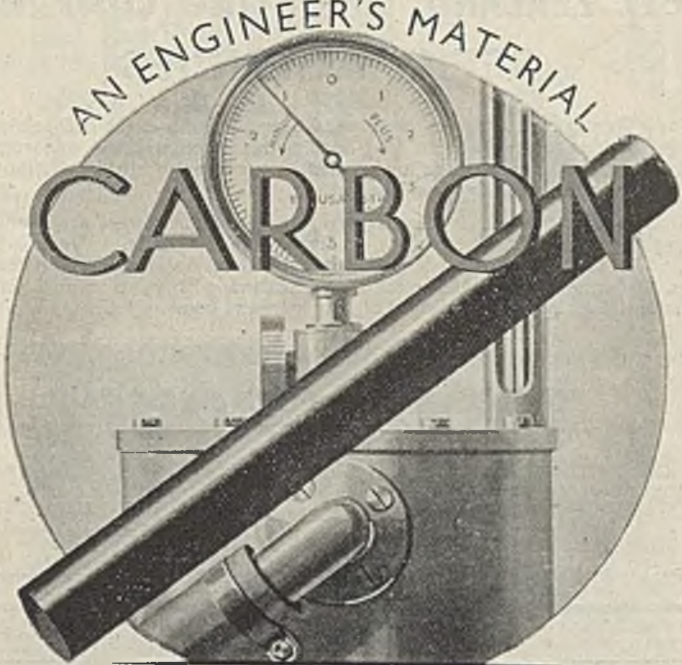

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The Chemical Age

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Atomic Bomb Technology

THE first mention of the atomic bomb interested and even excited the scientific world as few discoveries have done before. There is no doubt that an event has occurred of immense importance in the history of the world. It is an event which on a pessimistic view could mean the end of mankind, or at least of our civilisation, within the lifetime of this present generation. By an optimistic appreciation it could mean the start of a train of discoveries which will make man independent of fuel for heat and power, and perhaps even independent of the sun for light and warmth. It is undoubtedly a tremendous event.

That being so, everyone wishes to know how it was brought about. The scientific man who had followed, or even been engaged in, the scientific investigations in nuclear physics already had a pretty shrewd idea of the way in which it was done scientifically. He could not necessarily even guess how it was put into practice; the technology and the science are separate affairs. Faced by a new technique somewhat different from the physics and chemistry that they were taught at school, the great majority of people know little or nothing of the work involved, of how it was done, or of who did it. They know the part that Britain has played in it from the account prepared by Mr. Churchill and issued by Mr. Attlee. Up to the end of 1941 Britain had done an immense amount of work on the project and in October, 1941, before Pearl Harbour, President Roosevelt suggested joint working between U.S.A. and Great Britain, an arrangement in which we gladly acquiesced. "Accordingly," says Mr. Churchill, "all British and American efforts were joined and a number of British scientists concerned proceeded to the United States." It was then agreed that large-scale plants should be erected in the U.S.A. because this country was too near the enemy for the work to proceed unhindered: in addition, we were already fully engaged on the production of munitions. Mr. Churchill further stated that the work was carried out by the three Governments of U.S.A., Britain, and Canada in partnership, though the whole cost fell on the U.S.A., "who were assisted by a number of British scientists." Among contributions from this side of the Atlantic was the destruction of the German heavy-water

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plant in Norway, a work in which the Norwegians were pre-eminent.

We have been led to remind our readers again of this now ancient history because of the issue of a report by the U.S. War Department entitled: "A general account of the development of methods of using atomic energy for military purposes under the auspices of the U.S. Government, 1940-1945." This is an entirely admirable document. It is long and factual and gives the names of many Americans and some German refugees who took a prominent part in this work. Professor H. D. Smyth, the author of the account, was himself one of the foremost workers upon this great project. His account is obviously an inside story, told with every detail that can be released, but naturally with a great part of the story untold. The principles are set forth, the problems are freely discussed, the work that was done upon them is described, the whole thing is fascinating in the extreme and tells more than has yet been told by anyone. In view of the importance and interest of this work, an extensive account has been written up from this report, the first instalment of which appears in our pages to-day.

Professor Smyth's account is, however, incomplete. Had it been an account of the whole effort, no further comment would be necessary. But it is written wholly from the U.S. angle. Professor Smyth says "References to British and Canadian work are not intended to be complete since this is written from the point of view of the activities in this country" (*i.e.*, the U.S.A.). Whether or not it was desirable for an account of this character of a combined effort to be presented to the world as the achievement of one partner only we will not say. It is quite evident that the British story is yet to be told, but we hear that H.M. Stationery Office is to publish this American account in due course. The only possible effect of this document as it stands is to suggest that the whole credit goes to the U.S.A., and that such work as was done here, or by the British over there, is of little consequence and led to nothing practical.

Why cannot a full-dress British account be published? Why must H.M.S.O. publish a one-sided account? Why cannot a British statement be prepared embodying the facts stated by Professor Smyth, but giving credit to *everyone* who has contributed to the work? We have had occasion to complain bitterly in the past that Britain does not tell the world, and as a result the world goes to Germany or to the U.S.A. for its chemical engineering plant. Over and over again, the credit for work done here goes to other countries, simply because no one seems interested enough to do something about it. The Ministry of Information is still alive; cannot it justify its life by getting Sir James Chadwick, or some other leading scientific man who took part in the whole work to tell the story so that the British part in the work is not forgotten? Or should the job be given to the British Council, whose reputation among the general public could do with a boost?

Having said so much, we must offer our sincere congratulations to everyone concerned on a quite remarkable piece of work in the production of the atomic bomb. Chemical engineering has added new lustre to its crown. An entirely new set of conditions had to be faced and overcome, as will be seen from our account. We have gone into some detail on the engineering side because it is there that our readers can best appreciate the immensity of the problems that were attacked so successfully. The handling of radioactive materials on a grand scale is something new to chemical engineers in general, and some of the techniques will be very important in the future. No doubt there will be further developments, and the report records that in the autumn of 1944 an American committee was appointed to look into technical development along the paths of peace; this committee, we believe, is still in being.

What of the future? A multitude of suggestions has been received from men on the various projects, principally along the lines of the use of nuclear energy for power and the use of radioactive by-products for scientific, medical, and industrial purposes. Professor Smyth sums it all up thus: "While there was general agreement that a great industry might eventually arise, comparable perhaps to the electronics industry, there was disagreement as to how rapidly such an industry would grow; the consensus was that the growth would be slow over a period of many years. At least there is no immediate prospect of running cars with nuclear power or lighting houses with radioactive lamps, although there is a good probability that nuclear power for special purposes could be developed within the next ten years and that plentiful supplies of radioactive materials can have a profound effect on scientific research and perhaps on the treatment of certain diseases in a similar period."

Meanwhile, since efficiency must come into the economic picture, let us remember that "the energy released in uranium fission corresponds to the utilisation of only about one-tenth of one per cent. of its mass." But we shall go on from there. We are only at the beginning.

NOTES AND COMMENTS

Working Parties

AFTER a good deal of ill-informed comment, in the correspondence and other columns of the daily Press, on the advantages and disadvantages of Sir Stafford Cripps's working parties intended for the better management of the major British industries, it is satisfactory to have the President of the Board of Trade's own version of a matter on which he (after all) is best qualified to speak. The working parties are not to be the "Nosy Parkers" that some supposed them; their terms of reference do not cover relations between employers and employees; their only guiding principle is the national interest; and their sole function is to inquire and report. It is all very well to say that there is small necessity for such inquiry and report at the moment. Sir Stafford makes it quite clear that he is thinking of the lean years ahead, with which (as most of us agree) British industry is likely to be faced. The tripartite nature of the "parties" is a reasonable insurance against collusion between employers and employees for the benefit of their trade and their trade alone. Such of the "independent" members (who make up one-third of the parties) as we are acquainted with are personages of the highest integrity and disinterestedness, and the chairmen's names alone, in the five parties already organised, should be sufficient to remove any suspicion of sectional favouritism. Indeed, an important and avowed purpose of the scheme is to keep watch over consumers' interests—and about time too, we can hear it said. The fundamental thing, however, is, as the President of the Board of Trade himself said, to "make our industries more competitive in the markets of the world" and to "provide us at home with the best goods at the cheapest price consistent with good conditions for those in the industry."

Industrial Health

THAT the chemical engineer should be concerned with the majority of occupational hazards, and not merely with those likely to occur in the chemical industry, was only one of the many valuable points made by Dr. Merewether, H.M. Senior Inspector of Factories, in a recent address to the Institution of Chemical Engineers and the Chemical Engineering Group. While we have hitherto been used to consider inanimate factors, such as the availability of raw materials, electricity, transport, near markets, etc., when erecting or extending an industrial unit, we shall have, in future, to think more of the animate personnel. Adequate transport and housing, technical education, medical and nursing arrangements, not to mention adequate canteens serving well-prepared and valuable food, all essential in themselves, play an important part in the *prevention* of accidents. Dr. Merewether's axiom that health of industry is synonymous with industrial health is by no means generally accepted. Human greediness and obstinacy and an aversion to change what has been done for years are responsible for many accidents that need never have happened. The award of the George Medal, for instance, for a dangerous rescue, represents no solution of the problem, and it is far better to let an obsolete factory burn down rather than to endanger lives by mopping up, say, nitric acid. There is, furthermore, a universal need for more standards to work on, and a no less urgent need for correct spacing, as "space dilutes risk."

Publicity for Safety

OPTIMUM conditions were maintained, Dr. Merewether claimed, by (i) supervision and discipline; (ii) the maintenance of protective measures; and (iii) the watching of changes in materials, processes, and general environment. To this he added a powerful plea for an improvement in the diffusion of knowledge about developments in industrial health. During the war, much knowledge and experience has, no doubt, been gained which, on account of the unfortunate lack of the publicity spirit, will never be of general use. In order to overcome this serious lack, the formation, if possible on an international scale, of a Society of *Industrial* Health and Safety, the establishment of a Group by one or more of the chemical societies, the holding of annual conferences, and the publication and distribution of papers and literature on the subject of industrial health and safety, must not be postponed if British industry is to prosper. The importance of this subject is underlined, if underlining were needed, by the National Insurance (Industrial Injuries) Bill, the second reading of which was moved in the Commons last week.

Paper Salvage

THERE is an erroneous impression current that, with the end of the war, the need for paper salvage has diminished. Nothing, in fact, could be further from the truth, and we are informed by an official of the Thames Board Mills, Ltd.—who should know, as his company claims to be the largest producer of board in England—that the production of board for boxes and cases will be seriously curtailed in the near future unless more waste paper and cardboard is salvaged forthwith. Both peace-time domestic industry and the export trade require huge quantities of board, and never more urgently than during the present period of reconstruction. The downward curve of the waste-paper salvage graph has been violently accentuated in 1945, largely owing to the natural impression mentioned at the outset of this paragraph. It is not entirely the public's fault, however. We are told that the municipal salvage schemes for waste paper are still in being; this may be so in theory. In fact, however, in our own particular London borough, we were somewhat discouraged the other day to see the contents of a carefully kept sack of waste paper dumped by the dustman into the general mass of household rubbish in his cart, the special paper-sack of war time having disappeared from its hook on the side of the vehicle. The Thames Board Mills announce that they are preparing a publicity campaign for salvage this autumn. More power to their elbow, we say; but if the campaign is not to lose much of its effect, let them see that it is directed to the proper quarter.

Our Oldest Ally

IT is only just over a year since Portugal occupied the attention both of Parliament and the public for her supplying the then still formidable German war machine with wolfram and tin. While several British dailies cannot rid themselves of the secrecy complex, bred by years of censorship—even after the Press has been liberated from that institution—the *Manchester Guardian* has again rendered public service by calling attention to the strong influence German interests are still exercising in Portugal. The paper's Lisbon correspondent states that these interests operate from the shelter offered by the Franco régime in Spain and that, since 1936, the technical direction of Portugal's industry has largely been in German hands. Chemical and pharmaceutical products now come from Barcelona, instead of from Leverkusen, thus usually securing a market long before a British catalogue ever arrives. Neutrality has served certain Portuguese interests well enough during the war; it is high time that in the interests of her oldest alliance she should forthwith cease to further German schemes.

American Work on the Atomic Bomb

I—The Problems Involved

A COMPREHENSIVE report on the work leading to the production of the atomic bomb has been written for the War Department of the U.S.A. by Professor H. D. Smyth, of the Department of Physics of Princeton University. This account gives as much detail as can be released at the present time, and there are obvious gaps. It is, however, believed by the U.S. Government that such information as is possible to release should be made available to those able to understand it in order that they may be able to "explain the potentialities of atomic bombs to their fellow citizens." The account has been written primarily from the U.S. angle, and does not profess to give a complete record of the work also undertaken in Britain and Canada.

The possibility of obtaining power from the atom depends on the equivalence of matter and energy. It is now believed that the generation of heat by combustion also involves the conversion of matter into energy, but the quantity of heat that corresponds to a certain amount is so great that it is not possible to measure by balances the loss in mass in normal processes; consequently, the principle of the conservation of mass cannot be disputed by experiment, though we now know that the real principle is that of the conservation of mass-plus-energy.

The Neutron

The nucleus of the atom consists essentially of neutrons and protons, these being similar in mass, but the proton carries a positive charge, whereas the neutron is uncharged. The constituents of the atom are held together by short-range forces not fully understood, in spite of the mutual repulsion of the protons contained in them. The neutron, having no charge, is not subject to the repulsions which affect other constituents, but it is affected by the short-range forces. Consequently, a free neutron goes on its way unchecked until it makes a "head-on" collision with an atomic nucleus. The nuclei are very small, and such collisions occur but rarely. Since the neutron is not subject to normal forces, it is very difficult to control. The only means of controlling free neutrons is to put nuclei in their way so that they will be slowed down and deflected, or absorbed by collisions; this effect is of the greatest practical importance and is the basis of much of this work.

Free neutrons can only be obtained from nuclear disintegrations; there is no natural supply. They are commonly produced by the bombardment of certain elements, notably beryllium and boron, by natural alpha-particles from radium, or by bombarding suitable targets with protons or deuterons (the nuclei of "heavy" hydrogen, mass 2). The peculiar properties of neutrons led to the deduction by Fermi that because of their lack of charge they should be effective in penetrating nuclei, especially those of high atomic number which repel protons and alpha-particles strongly. The neutron is the basis of nuclear physics and hence of the atomic bomb and of the release of atomic energy.

Stability of the Nucleus

Certain facts are known about the stability or instability of the nucleus. Stability is governed by the ordinary electric forces or repulsion between positive charges, and (acting in the contrary sense) the very short-range forces of attraction between all the particles. If in a nucleus the neutrons and protons are few in number (as in the elements of lowest atomic weight), stability occurs when their numbers are about equal. For larger nuclei the proportion of neutrons required for stability is greater. Finally, at the end of the periodic table, where the number of protons is over 90 and of neutrons nearly 150, there are no completely stable nuclei.

One form of nuclear reaction occurs when an unstable nucleus is formed artificially by adding an extra neutron or proton; eventually a change to a stable form occurs. Curiously enough this is not accomplished by ejecting a proton or a neutron, but by ejecting a positron or an electron. (These are minute particles much smaller than the nucleus, having respectively a positive or a negative charge.) Apparently within the nucleus a neutron converts itself into a proton and an electron and the light changed particle is ejected. This reaction, as will be seen, may be a nuisance, but has been put to useful purpose. The new nucleus formed may be stable, but is very often unstable and then disintegrates by radio-active change ("artificial radio-activity") progressively from one substance to another until a stable form is reached.

A very important observation was the discovery of a few of these nuclear reactions which were produced by the agency of neutron bombardment, and which produced as their product, not electrons, but more neutrons. This suggested that a self-multiplying chain reaction might be initiated under the right conditions.

Since the proton and the neutron are the fundamental particles out of which all nuclei are built, it would seem natural to use the mass of one or other of them as the unit of mass. The mass unit used in atomic and nuclear physics, however, is one-sixteenth of the mass of the predominant oxygen isotope, O^{16} and is equal to 1.6603×10^{-24} gram. Expressed in terms of this unit, the mass of the proton is 1.00758 and of the neutron 1.00893.

This leads us to the conception of " nuclear binding energies." It is a general principle in physics that if a stable system is to be broken up, work must be done upon it. Thus, if an assemblage of protons and neutrons forming a nucleus is stable, energy must be supplied to separate its constituent particles. Since energy and mass are equivalent, the total mass of the stable nucleus must be less than that of the separate protons and neutrons which go to make it up. This mass difference is equivalent to the energy required to disrupt the nucleus completely, which is called the " binding energy." Thus, the total mass of the separate constituents of the helium nucleus is

$$2 \times 1.00758 + 2 \times 1.00893 = 4.03302,$$

whereas the mass of the helium nucleus itself is 4.00280. Neglecting the last two places of decimals there is a difference in mass of 0.030 units, which is the binding energy in the helium nucleus. Einstein, from the Theory of Relativity, predicted that the energy, E, equivalent to a mass, m, is given by the equation, $E = mc^2$, where c is the velocity of light. A mass of 0.030 units is thus equal to 4.5×10^{-5} ergs per nucleus, or 2.7×10^{19} ergs per gram-mol. of helium. This is the origin of the energy released by breaking up the atomic nucleus. Prior to 1941, it could not be employed usefully because (1) the amount of energy used in bringing about these fissions experimentally was far greater than the amount of energy generated, and (2) the only way of obtaining a supply of neutrons without this limitation, *e.g.*, the radium-beryllium source, was barred by the scarcity of radium. The only possibility was that of starting the self-supporting neutron chain reaction previously mentioned.

Nuclear Fission

With the knowledge that the neutron is the most effective particle for inducing nuclear changes and that it is particularly effective on elements of the highest atomic weight, there came an important development early in 1939—the discovery of an entirely new form of break-up of the nucleus caused by absorption of neutrons. Two refugees from Germany, O. R. Frisch and L. Meitner, suggested to Niels Bohr that the absorption of a neutron by the uranium nucleus might cause that nucleus to split into approximately equal parts with the release of enormous quantities of energy, a process now referred to as " nuclear fission." It is clearly a different type of nuclear reaction from the absorption by the nucleus of a neutron with the liberation of an electron. It also seemed possible that neutrons might be liberated in the process, thus opening up the near possibility of setting up a chain reaction. These guesses were proved right by experiment during the early part of 1939. The way was opened to the release of atomic energy on a useful scale, but much remained to be done. Among other difficulties, natural uranium contains three isotopes: U-234 (0.006 per cent.); U-235 (0.7 per cent.); and U-238 (99.3 per cent.) U-235 reacts with neutrons quite differently from U-238.

When the Work Started

Professor Smyth thus summarises the information that was " generally known " in June, 1940, and which thus formed the basis of the secret work done since that date:

(1) That three elements—uranium, thorium, and protoactinium—when bombarded by neutrons, sometimes split into approximately equal fragments, and that these fragments were isotopes of elements in the middle of the periodic table, ranging from selenium ($Z = 34$) to lanthanum ($Z = 57$).

(2) That most of these fission fragments were unstable, decaying radio-actively by successive emission of beta-particles through a series of elements to various stable forms.

(3) That these fission fragments had very great kinetic energy.

(4) That fission of thorium and protoactinium was caused only by fast neutrons (velocities of the order of thousands of miles per second).

(5) That fission in uranium could be produced by fast or slow (so-called thermal-velocity) neutrons; specifically, that thermal neutrons caused fission in one isotope, U-235, but not in the other, U-238, and that fast neutrons had a lower probability of causing fission in U-235 than thermal neutrons.

(6) That at certain neutron speeds there was a large capture cross-section in U-238 producing U-239 but not fission.

(7) That the energy released per fission of a uranium nucleus was approximately 200 million electron volts. (1 electron volt $= 4.45 \times 10^{-20}$ kWh).

(8) That high-speed neutrons were emitted in the process of fission.

(9) That the average number of neutrons released per fission was somewhere between one and three.

(10) That high-speed neutrons could lose energy by inelastic collision with uranium nuclei without any nuclear reaction taking place.

(11) That most of this information was consistent with the semi-empirical theory of nuclear structure worked out by Bohr and Wheeler and others; this suggested that predictions based on this theory had a fair chance of success.

New Elements

Neutrons have been shown to react differently on U-235 and U-238. Slow-moving neutrons cause fission of U-235 nuclei with formation of new elements about half the atomic weight of U-235 together with neutrons which have a high velocity. It seemed likely at this time that fast neutrons would be absorbed by U-238 and would give rise to a nucleus of atomic number 92 and mass 239. This in turn would be a fairly stable mass emitter and might form a new element of atomic number 93 and mass 239. This was later found to be so and neptunium was discovered. Neptunium, it was found, underwent fission when bombarded by thermal neutrons, a fact which might well be of great importance to the maintenance of the chain reaction. In doing so it gave rise to another new element: plutonium (atomic number 94, mass 239).

Practical Problems

Obviously, the first key was the possibility of setting up a self-maintaining chain reaction. Whether a chain reaction goes on or does not go on depends on the result of a competition between four processes as affecting the neutrons: (1) escape from the mass, (2) non-fission capture by uranium, (3) non-fission capture by impurities, and (4) fission capture (which produces neutrons). If the loss of neutrons by the first three processes is less than the surplus produced by the fourth, the chain reaction occurs; otherwise it does not. Further, the probabilities of processes (2) and (4) are different for different isotopes of uranium as we have seen. The probabilities are moreover different for neutrons of different energies.

The problem of neutron escape involves the critical size of the device. Fission capture occurs throughout the material and is a volume effect, whereas the escape of neutrons is a surface effect depending on the area of the surface. The problem arose as to whether the critical size would be found too large for practical purposes.

Reduction of non-fission capture could be tackled by the use of a "moderator." Thermal (slow-moving) neutrons have the highest probability of being caught by and producing fission of U-235, but the neutrons emitted in the process of fission have high speeds and would thus not be unlikely to be caught by U-238 so that they would not necessarily produce further fission. Unfortunately, the speed at which non-fission capture (by U-238) is most probable, is intermediate between the average velocity of the high-speed neutrons emitted in the fission process and the speed at which fission capture is most probable. This difficulty might be met if the uranium were mixed with a moderator in such a way that the high-speed fission neutrons, after being ejected from uranium and before re-encountering U-238 nuclei, would have their speeds reduced below the speeds for which non-fission capture is highly probable.

The choice of substance as moderator lay between hydrogen, deuterium, beryllium, and carbon; it must be a substance of low atomic weight having little or no tendency to absorb neutrons. A high degree of purification was necessary in any moderator that might be used in order to avoid non-fission capture by impurities. The maximum permissible concentration of many impurity elements, both in the uranium and the moderator, was not more than a few parts per million. This in itself opened up a whole range of problems.

Another method for the reduction of non-fission capture was by separation of U-235 from U-238, the latter being discarded. The point here is that U-238 is likely to produce U-239, and thus ultimately plutonium, whereas it is not fissured by the capture of neutrons. The magnitude of this problem may be seen from the fact that in 1940 no large-scale separation of isotopes had ever been achieved except for hydrogen.

It seemed likely that by using neutron absorbers a powerful chain reaction could be controlled. This is partly a problem of the application of the atomic energy to the arts of peace. The major difficulty was conceived to lie in the attainment of high-temperature operation. To run a chain-reacting system at a high temperature and to convert the heat generated to useful work is very much more difficult than to run a chain-reacting system at a low temperature. For a bomb, the chain reaction must be built up extremely rapidly, and no premature explosion must occur. Professor Smyth stated in June, 1945, that "this detonation problem was and still remains one of the most difficult in designing a high-efficiency atomic bomb."

Plutonium

Plutonium is now believed to be comparable in value for the purpose of atomic energy to U-235. Pu, though induced from U-238, is a different chemical element. Therefore, if a process could be worked out for converting U-238 to plutonium, a chemical separation of the plutonium from uranium might be more practicable than the isotopic separation of U-235 from U-238. The chain of reactions goes somewhat as follows:

$${}_{92}U^{238} + {}_{0}n^{1} \rightarrow {}_{92}U^{239} \rightarrow {}_{93}Np^{239} + {}_{-1}e^{0}$$

$${}_{93}Np^{239} \rightarrow {}_{94}Pu^{239} + {}_{-1}e^{0}$$

where $_0n^1$ represents the neutron and $_{-1}e^0$ the ordinary (negative) electron. Np is neptunium. Two possibilities were now open—to make a bomb from purified U-235 or from Pu.

A further possibility of creating a self-maintaining reaction lay in what were called "enriched piles." The three ways of increasing the likelihood of a chain reaction, namely, use of a moderator, attainment of high purity of materials and use of the special materials U-235 or Pu, are not mutually exclusive. Combinations of these, such as the use of small amounts of separated U-235 or Pu in a lattice composed primarily of ordinary uranium and of a moderator or two different moderators, were proposed; these constitute "enriched piles."

Finally, an additional problem was that of health hazards. The danger from the radiations was a new and special one, especially when such large amounts of radioactive materials were to be handled. Neutron radiation is comparable to gamma-rays as regards health hazards. Uranium is poisonous chemically. This was the stage reached in the U.S.A. in June, 1940, based upon knowledge generally available to everyone. It showed the problems. It indicated the work to be done. Now a start could be made with intensive research work.

Three Questions

Three questions required an immediate answer and were the subject of simultaneous work over the next 18 months. This work will be touched upon briefly.

Question 1. Could any conditions be found under which the chain reaction would go?

The essential difficulty is this: Slow "thermal" neutrons are absorbed by U-235 and will cause the nuclear fission necessary to produce a supply of neutrons. The neutrons emitted in this fission are high-speed and as such are not readily captured by U-235. They are, however, captured readily by U-238, when they produce U-239 and do not cause nuclear fission but liberate an electron only. In order to keep up the supply of neutrons necessary to maintain a chain reaction it was thus necessary to find means of slowing down sufficient fast neutrons to the speed of thermal neutrons before they had been absorbed by U-238 to enable the U-235 fission to be maintained to an adequate extent.

The method adopted was the use of carbon or beryllium as a moderator. A lattice structure or "pile" was built up with commercial uranium (mixture of isotopes) concentrated in lumps regularly distributed in a matrix of moderator. If uranium and moderator were mixed homogeneously, the velocity of any neutron would not be lowered sufficiently before contact with U-238, but by spacing the uranium lumps at large intervals in the moderator the energy lost during passage from one lump of uranium to another is larger. The first lattice structure set up consisted of a graphite cube about 8 ft. edges, containing some 7 tons of uranium in iron containers distributed at equal intervals throughout the graphite.

When a radium-beryllium source of neutrons is placed near the bottom of this structure the number of neutrons can be measured at various points throughout the lattice. Absorption by U-238 tends to reduce the number of neutrons; fissions tend to increase their number. The lattice described above was too small to be chain-reacting, but the rate of increase of neutrons, the so called "multiplication factor," k, could be calculated for a lattice of infinite size. If $k > 1$ the lattice is chain-reacting. In the autumn of 1941 Fermi reported k_∞ for the above lattice as 0.87. The uranium used contained 2-5 per cent. of impurities and it was recognised that this value could be increased by greater purity of materials, different lattice arrangements, etc. Beryllium was found to act similarly to carbon but was abandoned as too difficult to produce in sufficient quantities and in the required form.

In May, 1941, came the report from E. O. Lawrence, at California University, which showed that (a) Pu, atomic weight 94, is produced as a result of capture of a neutron by U-238 followed by two successive β-transformations, and that (b) this element undergoes fission by slow neutrons and thus behaves like U-235. Thus, the suggestion arose that Pu could be manufactured from U-238, which would increase one-hundred-fold the available material and initiate a chain reaction with fast neutrons. An interesting "by-product" of this work was the discovery that in a chain-reacting "pile," radioactive fission products build up as the reaction proceeds. Since they differ chemically from uranium they could be extracted and used as a particularly vicious form of poison gas. Defensive measures were immediately planned in case the Germans should make this discovery.

Question 2.— Could the isotope U-235 be separated on a large scale?

Preliminary experiments were made using three methods: electromagnetic separation, previously rejected as impracticable; centrifuging, a method which depends on the fact that the forces on each isotope are slightly different because of their difference in mass; and gaseous diffusion, in which the rates are again slightly different because of their difference in mass. The only gaseous compound of uranium known was the hexafluoride. In the centrifuge and diffusion methods only a small degree of enrichment was to be expected in each "stage." Preliminary experiments indicated that about 5000 stages would be necessary for one type of diffusion system and that an area of many acres of diffusion barrier would be required in a plant separating 1 kg. of U-235 per day; the cost would be many millions of dollars. A similar production by centrifuges was estimated to require 22,000 separately driven, extremely high-speed centrifuges. Another method suggested at this time was thermal diffusion in liquid uranium hexafluoride; preliminary experiments suggested that this method was promising. This work will be described later.

Question 3. Could moderator and other materials be obtained in sufficient purity and quantity?

Work was done on the production of heavy water, and on the production and purification of carbon and beryllium. The presence of 1 part in 500,000 of boron in commercial carbon was regarded as undesirable. The work done up to the end of 1941 showed no evidence that this question must be answered in the negative, but the problem was far from solved.

At this stage two investigators were sent to England to see what was being done. It was found that British work was on similar lines to that of U.S.A., that heavy water was favoured as a moderator rather than graphite, that extensive work had been done on the diffusion process, including the general theory of cascades. The British were already convinced that a U-235 chain could be achieved. It was known that several kilos a day of heavy water were being produced in Norway and that the Germans had ordered considerable quantities of paraffin to be made using heavy hydrogen. It was feared that if the Germans got atomic bombs before the Allies did the war might be over in a few weeks. The Americans took back with them a sense of great urgency.

Researches, 1942

In spite of these conclusions it was still uncertain at the end of 1941 how much work should be put into the atomic bomb. That depended on whether it was to be a decisive weapon or a supplementary one. It was decided, however, to increase the effort on the uranium project, since it was generally accepted that an atomic bomb of enormous destructive power could be made either from concentrated U-235 or from plutonium. Work progressed along four lines.

(1) *The Materials Problems.* The uranium oxide position was so improved that its impurities were reduced to 1 per cent. and 15 tons per month were obtained. A pile with this uranium gave $k_\infty = 0.98$. J. J. Hoffman found that by using an ether extraction method, all the impurities are removed by a single extraction of uranyl nitrate. This method was henceforth used for purification and 1000 lb. of metal was produced per day by electrolysis of KUF_4, and the price dropped from $1000 per lb. to $22 per lb. Other concerns were able to produce graphite with a neutron absorption some 20 per cent. less than the standard commercial materials previously used. The materials problem was solved.

(2) *Experimental Proof of the Chain Reactions.* Experiments designed to accumulate more accurate data strengthened the belief that a pile could be built with $k_\infty > 1$. When sufficient material had accumulated (in July, 1942) a pile was built which showed by experiment $k_\infty = 1.007$. Finally, in the autumn of 1942, some 6 tons of metal were available—not really enough—and other materials of varying quality out of which was constructed a pile which first operated as a self-sustaining system on December 2, 1942: a red-letter day! Professor Smyth adds: "So far as we know, this was the first time that human beings ever initiated a self-maintaining chain reaction." It first generated a maximum energy of ½ watt. On December 12 the intensity was seen to be about 200 watts, but it was not felt safe to go higher because of the danger of radiation to operators.

This experiment also bore on the production of plutonium. Theory suggested that to produce 1 kg. of Pu per day a chain-reacting pile must be releasing energy at a rate of 500,000-1,500,000 kW. If a single bomb required 100 kg. of Pu, the pile just described would require 70,000 years to produce a single bomb.

(3) *Plutonium.* By prolonged bombardment of several hundred lb. of uranyl nitrate with the aid of the cyclotron some $500\mu g$. had been obtained as pure Pu salts. Though less than a pinhead in size it was sufficient to determine the properties of the new element. It resembles uranium and might even be regarded as the second member of a new rare-earth series beginning with uranium. It has four states of oxidation corresponding to valencies of 3, 4, 5, and 6, and its properties are such that it can be separated chemically from the other materials in the pile. These experiments had considerable significance for, as we shall see from the experiments on this almost microscopic speck of material, the whole plutonium recovery and purification plant was successfully designed.

(4) *The Fast Neutron Reaction.* As the design of the bomb was the last thing to be tackled, this work was not considered urgent and during this period preliminary researches only were carried out. However, the effectiveness of the atomic bomb was seen to be greater than had been suspected but its critical size was still unknown, while methods of detonation were uncertain.

(*To be continued*)

Industrialising Turkey

Sümer Bank's Programme

FURTHER steps towards the industrialisation of Turkey have just been revealed in the plans of the Sümer Bank, a semi-Government institution, for construction projects the bank intends to finance within the next three to five years. The programme is roughly estimated to cost £T80,000,000, and interested firms may obtain specifications by direct contact with the bank at Ankara.

Industrial Chemicals

In the industrial-chemical field, four major operations are planned. Near Kutahya, a plant will be built to provide an annual production of 6000 metric tons of nitric acid, and 3000 metric tons of ammonium nitrates. A power station will be installed, probably to be operated with lignite. At Izmit, near Istanbul, the bank plans to construct a plant for the production of sodium carbonate and sodium bicarbonate, with a yearly capacity of 5000 metric tons of each product. At Karabuk, a plant is projected to produce copper sulphate at the rate of 4000 metric tons per year. In the city of Gemlik, on the Sea of Marmora, a carbon bisulphide plant will be erected with an annual capacity of 600 metric tons.

Cement and Paper

The Sivas cement plant, in Central Turkey, already produces about 90,000 metric tons of cement per year. It was originally regarded as the nucleus of a much larger project, and it is now planned to carry out this expansion and increase output to 200,000 metric tons annually. Construction of a refractory-brick plant to produce 15,000 metric tons a year, is planned for Filyos on the Black Sea.

Two paper factories in Izmit will have their production capacities increased above the present 20,000 metric tons per year. A third plant will be constructed in Izmir (Smyrna), to produce 16,000 metric tons annually. Izmir will also be the site of a new factory for the manufacture of insulating materials from wood shavings and sawdust, the capacity being from 6000 to 7000 metric tons annually.

Expansion of Steel Output

Several plants for the manufacture of steel products are contemplated for Karabuk. One of these is a plant which will turn out wire of less than 10 millimetres diameter at the rate of 30,000 metric tons a year. Another is a rolling mill capable of producing 20,000 metric tons of sheet steel annually. A third is a steel-pipe foundry with a yearly capacity of from 10,000 to 15,000 metric tons.

Discovery of X-Rays

Fiftieth Anniversary

TO commemorate the 50th anniversary of Röntgen's discovery of X-rays, a number of societies and institutes, including the Royal Society, the Royal Society of Medicine and the Institute of Physics, have organised celebrations to take place on November 8, 9 and 10. On November 8, at 4 p.m., there will be a public meeting at the Central Hall, Westminster, when Sir Lawrence Bragg will deliver an address on "The Scientific Consequences of Röntgen's Discovery of X-rays." A series of papers on "Applications of X-rays to Physics and Chemistry" will be read at the Royal Institution on the mornings of November 9 and 10. The celebrations will conclude with a session of historical reviews of the development of the apparatus and its use in industry, to take place between 3.30 and 7.30 p.m. at the Institution of Electrical Engineers on November 10. The hon. secretary of the Joint Organising Committee is Mr. H. S. Tasker of Ilford, Ltd., Watford, Herts.

New Control Orders

Glue and Gelatine

THE Control of Glue, Gelatine and Size (No. 2) Order, 1945 (S. R. & O. 1945, No. 1162), revokes and remakes with amendments the No. 1 Order, 1943. The amendments are: (1) the acquisition and disposal of glue, gelatine, and size, and of adhesives in the preparation of which any such material has been used, is freed from control; and (2) while the control of treatment, use, and consumption is continued, the amounts which may be treated, used, or consumed without licence are determined for each quarter of the year instead of over a running period of three calendar months.

NOBEL PRIZES THIS YEAR

After having been postponed since 1939, the distribution of the Nobel Prizes was resumed last year. This year seven Nobel Prizes are available for distribution. The Royal Swedish Academy of Science will award three prizes, *viz.*, one in physics and two in chemistry, one of which is the reserved prize for 1944. The Carolinian Institute and the Swedish Academy have each one prize to award, in medicine and literature respectively. The Nobel Peace Prize will be given this year for the first time since 1938. The solemn Nobel festivity—always held on December 10, the anniversary of Alfred Nobel's death—at which the prizes are handed over to the winners by the King of Sweden is expected to be revived this year.

Association of British Chemical Manufacturers

The Task of Reconstruction

Dr. P. C. C. Isherwood.

THE 29th annual meeting of the Association of British Chemical Manufacturers was held in London on October 11, with Dr. P. C. C. Isherwood, O.B.E., in the chair.

In moving the adoption of the annual report, the chairman referred to the conclusion of the European war, and the release from war-time duties of Mr. Davidson Pratt, whom they welcomed back as a full-time official of the Association. His title was now Director and Secretary, and they had elevated Mr. Drake and Mr. Holden—who carried on the work of the Association with such devotion and success during the past five years—to the position of joint managers.

After recording the passing of three great men who played a leading part in the development of British chemistry and chemical industry: Sir Martin Forster, Sir Christopher Clayton, and Sir David Milne-Watson, the chairman spoke of the tasks that lay ahead. These would, he said, be as great as, and in some ways greater than, those which confronted us during the last six years when we were fighting for our life as a nation. We have to rebuild a shattered world and especially a devastated Europe.

The Most Basic Industry

"Our problems," said Dr. Isherwood, "are industrial and commercial, and their solution will determine the prosperity or otherwise of these islands and our Empire for centuries to come. The fundamental nature of the chemical industry cannot be emphasised too often. It is the most basic of all industries, because there is no form of manufacture or production, including agriculture, which is not dependent on the products of the chemical manufacturer in some form or other. You, I know, are all well aware of this, but I doubt whether Government departments, who direct our destinies, and the general public yet fully appreciate what this means—in spite of the lessons of this war and the last.

"The chemical industry . . . must be accorded the highest possible priority in its task of reconversion and post-war development if the rest of the industry is not to be restricted in its activities by lack of chemical raw materials. This is true both as regards home and export trade and must be continually emphasised to the Government departments on which we depend for the necessary priorities for labour, buildings, plant, and raw materials. Many raw materials must be imported, some of them from so-called 'hard-currency' countries. It is fully appreciated that some form of import licensing under present conditions is an unfortunate necessity; nevertheless, I make the strong plea that promptitude be exercised in the granting of such licences. Most important of all, means must be found for the speeding up of release for labour in the chemical industry."

Export Trade

Speaking of the need for a vigorous campaign for the rehabilitation of our export trade, the chairman continued: "In the immediate pre-war days we were unable entirely to bridge the gap between imports and exports. Since then our foreign investments, which contributed several hundred million pounds sterling to our invisible exports, have virtually disappeared, thus greatly widening the gap. Exports have also had to be drastically reduced during the last six years to enable us to provide munitions of war, and we have now to find ways and means of obtaining a large permanent expansion of our export trade, and promptly to restore our lost goodwill. Some of our foreign markets have shrunk, because of domestic industrial developments, but there are others (previously supplied mainly from Germany) such as Scandinavia, which we should be able by vigorous action to secure and hold. We have also to face a powerful competitor in the United States, whose avowed policy is to increase her exports to all parts of the world.

"The chemical industry can make an important contribution to the solution of this problem. It is not perhaps generally appreciated that great though the direct exports of chemical products may be, the chemical industry can make an even greater contribution by the indirect export of its manufactures in the form of goods made therefrom; for example, the contribution of our dyestuffs industry is to be measured not only by the export of dyestuffs as such but by the export of textiles and goods in which dyes play an essential part. We cannot command export trade. It is true that there is much goodwill towards this country throughout the world, but this is not enough; we must beat our competitors in novelty, quality or price. This can only be achieved by the continuous and energetic application of research, and still more research to devise new products and improve the quality and efficiency of existing manufactures, coupled with a vigorous and up-to-date policy of salesmanship and technical service to the user.

A Long-Term View

"The Association and its groups will have to consider what additions to our present methods are needed to cope with these export problems. In case there is any misunderstanding, I wish to make it clear that what I have said is in relation to the long-term position. The world has been starved of many important commodities for the last six years, and colossal war damage has to be made good. Hence, for the next few years demand will exceed supply and outlets will be easy to find. This will not last indefinitely. The boom will be followed by an era of intensifying competition, as it was after the last war, and there will be a slump unless great foresight and care is exercised. We must prepare now on the basis I have suggested to find permanent markets which will outlast the boom and enable us to remain solvent as a nation.

"I make no apology for giving you my personal views on the subject of cartels—a word which apparently has acquired a somewhat sinister implication by reason of political ramifications in certain well-known cases. I believe, however, that under proper safeguards to prevent abuse, the orderly planning of production and marketing between firms manufacturing the same or similar products is both necessary and desirable. I claim that such arrangements are in the national interest which comprises manufacturer, worker, and consumer. The manufacturer because it enables him to plan ahead with full statistical knowledge of what other producers are doing; the worker because it ensures to him steady and remunerative employment; and the consumer because he can contract ahead without fearing that his forward purchases will be subject to violent price fluctuations. Finally, it seems to me illogical that the worker who rightly wants security of wages at the highest economic level and steady employment should be denied equal security for the products of his labour.

"I do not propose to say more than a few words on the subject of Germany. The statesmen of the United Nations will decide her future place in the world's economy. Her chemical industry will be her greatest asset in any further attempt at world domination. This must be rigorously curtailed so that the menace is removed for all time. This Association is already giving the Control Commission every possible assistance. There is one aspect which the Council views with great anxiety and on which it has made strong representations to the Minister of Supply, who is at present the responsible sponsor for most of the chemical industry, *viz.*, the great delay that is occurring, compared with what is taking place as regards America, in the despatch of industrial teams to investigate the German manufacturing processes and in the release of the information to industry. At present we are having to start from behind scratch. Our trade position is so serious that British industry must not be subjected to this handicap. When we get the German information we must take active steps to apply it to the development and improvement of our industry, so that we can remain in the vanguard of progress and be in a position to supply everything chemical that British industry as a whole and the export markets require. We must never relax in our efforts. The race will be long and hard but, unless we get complacent, we can win through just as we have done in the fight for freedom."

At the conclusion of his two years' period of office as chairman, Dr. Isherwood stressed the great contribution the Association had made to the war effort, and expressed not only his sincere appreciation to the Members of Council and the Association for their cordial co-operation, but also his gratitude to all members of the staff, and, in particular to the joint managers, Mr. Drake and Mr. Holden, for their devotion and loyalty.

Points from the Report

Ten new members, including five subsidiaries of existing members, joined the Association during the year. A previous member resumed membership. Two members resigned and two subsidiaries of an existing member were liquidated. The membership at the end of the year was 183. The normal basis of subscriptions laid down in the Articles of Association was increased by one-third as from July, 1944.

The Association has continued to work in close contact with Government departments and, at the request of the Ministry of Supply, it collected information in regard to orders for chemical plant for reconversion, in order to secure that the needs of the chemical industry received proper consideration and that due weight was given to all relevant factors, including export possibilities.

German Chemical Industry

A memorandum outlining the policy which the Council considered should be adopted towards the German chemical industry after the war was submitted to the Government. The keynote of the policy was the elimination of Germany's ability to prepare for another war, by the destruction of plants primarily serving war purposes, together with the strictest control of production and materials.

It was realised that in the immediate post-war period of acute world shortage, German chemical production might be needed to meet pressing demands, but this should be kept to the minimum and reduced as soon as Allied countries were able to take it over. Consumers in all countries must be prepared to go short if this is necessary to prevent the manufacture of potential war materials by Germany. Particulars were collected from members as to the German chemical works which might repay technical investigation and as to suitable experts to form teams for this purpose. The information so collected is to be available equally to all *bona fide* manufacturers in Allied countries.

Mr. L. P. O'Brien, chairman of the A.B.C.M. for the current year.

At the request of the Allied Control Commission, the Association sought help from members in providing men for the higher resident technical staff of the Chemical Industries Branch of the Commission. An advisory panel, under the chairmanship of Dr. Isherwood, was appointed as the channel for consultation on any points arising in Germany on which special advice seemed desirable. A similar panel was appointed by Group D to advise the Board of Trade in connection with dyestuffs.

A detailed scheme for annual production data for each fine chemical, replacing the much less detailed pre-war scheme, was introduced by Group B. This will provide data of considerable value in dealing with import licensing and applications for exemptions from Key Industry Duty. Safeguards have been taken against the leakage of what is highly confidential information. The preparation of a revised edition of the Directory of British Fine Chemicals has also been authorised. A new edition of the main Directory will be published as soon as permission is obtained.

Key Industry Duties

The proposals of Group B in respect of the Key Industry Duties were incorporated in the Post-War Planning Report submitted to the Ministry of Supply. The Government was pressed for an early indication of its intentions in regard to a long-term policy for key industries and, although no announcement of Government intentions was possible at the time, a much more satisfactory assurance than might have been expected was given by the permanent officers of the Board of Trade. Later, the Board of Trade itself recalled that a number of important fine chemicals had been removed from the dutiable list earlier in the war; and they invited the Association to submit suggestions for reversion to the dutiable list in respect of those items for which the production was considered adequate in relation to the home demands. As the result a number of items became dutiable on importation at the rate of 33⅓ per cent. *ad valorem*.

As the result of discussions with the Chemical Council, the Association's representatives were charged with rendering at each meeting of the Council reports on the Chemical Council's work as represented by the deliberations at the latter's monthly meetings. In particular, the Association's representatives were asked to devote special attention to the work of the Chemical Council in relation to the nature and quality of scientific publications which came within its purview, as the improvement of these publications was the main objective of members in making the very substantial financial contributions that they had provided during the previous seven years. Dr. Isherwood and Mr. Duncalfe were appointed as representatives to fill two vacancies which arose.

Representatives of the Association have co-operated with those of the Royal Institute of Chemistry and others in the revision of the 1931 edition of the Suggested Clauses for Incorporation in Contracts of Service for Chemists.

Indian Branch

A proposal to set up an office of the Association in India brought an indication of widespread interest, more than half the members indicating their support of the proposal in principle, while many of the remainder were anxious to be kept informed when more precise details had been worked out. A sub-committee, charged with working out detailed plans, has presented its recommendations, and the project is being brought into operation as quickly as possible. In connection with this subject, the Council was addressed by Sir Thomas Ainscough, late British Senior Trade Commissioner in Bombay, who gave a most useful picture of the position and prospects for future British trade in India. In addition, the director was able, in the course of a journey on behalf of the Ministry of Supply, to collect valuable information in India on the potential scope and value of a branch office of the Association in India. The Council has expressed its view that co-operation between British and Indian chemical manufacturing interests was desirable in order that Indian developments may be guided into channels which are economically and technically justified and where Indian manufacturing developments would therefore tend to be of mutual interest and minimum avoidable hardship to U.K. trade.

Representatives of the Association gave evidence before the Committee of Inquiry into the Hydrocarbon Oil Duties, whose recommendations, published in April, represented an essentially satisfactory proposal for the favourable treatment of the chemical industry without seriously prejudicing the interests of indigenous hydrocarbon oils.

The Association also submitted evidence to the Treasury's Industrial Alcohol Committee. The report was unfavourable to users of industrial alcohol but, after careful consideration, the Association's Industrial Alcohol Committee concluded that no action could usefully be taken to secure modification of the proposed removal of the allowances. It recommended that steps be taken to ensure the implementation of one of the Treasury Committee's recommendations—the provision of machinery to investigate schemes for State assistance for prejudiced industries.

The Industrial Information Service, inaugurated last year, has been used to about the same extent during the year under review, some 11 cases having been dealt with. As in the previous year, a number of other cases put up for treatment under this service were more effectively dealt with by other means. There is no question as to the value of this scheme, for the members who have used it have readily testified to the help they have secured. The office would welcome the opportunity to deal with more of the problems which face members and for the solution of which the service was introduced.

Public Relations Officer

Group B recommended to Council the appointment of a Public Relations Officer to the Association; it had concluded that, while it would, as a group, find such a man most useful and could provide him with a fair volume of work, it could not wholly occupy his time, while in any case publicity for the various sections of the chemical industry should be properly co-ordinated. The Council has referred the proposal to the several groups for consideration. The present position is that two groups (B and C) support it and one group (D) opposes it. The Council has itself approved the proposal in principle, but will be reconsidering the matter on the basis of a statement which the Director has been asked to prepare.

The Association joined with other interested bodies, as a matter of urgency, in representations to the Ministry of Labour to ease the present shortage of chemical engineers.

Surplus Stores

A conference held with representatives of the Ministry of Supply and other Departments resulted in the formation of the Pharmaceutical and Allied Chemicals Disposals Association, Ltd. In the meantime, although there was a wide miscellany of other chemicals, bought during the war by Government Departments, it was agreed that no useful purpose could be served by the formation of a disposals association to cover this wide range; the arrangement was therefore made that, first, all surpluses of such chemicals would be handled by the Raw Materials Department; secondly, any surplus chemical would be offered back to the manufacturer or manufacturers who had supplied it in the first instance; finally, to the extent that the surplus was not taken up by the manufacturer or manufacturers, the Association would be consulted in order to ensure that it was then offered for disposal through the normal channels of trade.

Early in the year under review, the Council of the Association agreed with the Union of Polish Chemical Industries the text of a joint declaration of mutual collaboration after the war.

Council for the Year

President: Mr. C. F. Merriam. *Vice-presidents*: Dr. E. F. Armstrong, F.R.S., Dr. F. H. Carr, C.B.E., Mr. R. Duncalfe, Dr. E. V. Evans, O.B.E., Mr. C. A. Hill, B.Sc, Dr. P. C. C. Isherwood, O.B.E., Mr. R. G. Perry, C.B.E., Mr. E Wallace.

Elected members: *Chairman*: Mr. L. P. O'Brien; *Vice-chairman*: Sir F. W. Bain, M.C.; *Honorary treasurer*: Mr. C. E. Carey. *Members*: Mr. T. R. G. Bennett, Dr. A. E. Everest, Mr. C. G. Hayman. Mr. G. E. Howard, Mr. W. M. Inman, Mr. H Jephcott, Mr. W. F. Lutyens, Mr. J. H. Olliver, Mr. D. J. W. Orr, Mr. F. M. Roberts, Mr. K. H. Wilson, Mr. H. Yeoman.

Co-opted members: Mr. A. D. Daysh, Mr. D. Spence, Mr. T. D. Morson, Lord Trent.

Honorary vice-presidents: Mr. N. N. Holden, Lord McGowan. *Director and Secretary*: Mr. J. Davidson Pratt, O.B.E., M.A., B.Sc., M.I.Chem.E., F.R.I.C. *Joint managers*: Mr. R. M. Drake, O.B.E., M.Sc., Mr. A. J. Holden, B.Sc., F.R.I.C.

Leather Chemists' Meeting

The Second Procter Memorial Lecture

AMONG a number of interesting lectures delivered on the occasion of the annual meeting of the British Section of the International Society of Leather Trades Chemists, held at Leeds University on September 21-22, was the second Procter Memorial Lecture, given by Professor A. C. Chibnall, F.R.S., F.R.I.C. His subject was "The Contribution of the Analytical Chemist to the Problem of Protein Structure."

The problem of protein structure, he said, could be approached along two different paths. The intact protein molecule itself could be the object of study, and on account of its relatively enormous size we had to rely largely on physical measurements. Alternatively, the molecule could be resolved into its constituent amino-acids and an attempt then made to find out how these were originally linked together.

New Analytical Methods

A brief summary was given of certain new methods of analysis, evolved in the last five or six years, many of them based on entirely new principles, such as partition chromatography, bacterial enzymes, and microbiological assay. The great need for examining the accuracy of these newer methods was stressed, some of which required no more than a few milligrams of the protein for analysis covering eight or ten amino-acids. World shortage, due to the war, of protein foods had focussed attention on the amounts of the dietetically essential amino-acids which these contained, and the method of biological assay was convenient for such an investigation. It was, nevertheless, being used in an uncritical way. For nutrition studies, an error of about 10 per cent. in the determination of any amino-acid was probably permissible, but for structure studies much greater accuracy was needed.

From a review of these new methods the conclusion was drawn that many of the amino-acids, especially the bases and the dicarboxylic acids, could now be determined with the accuracy needed for protein structure studies, but additional methods, preferably based on new principles, were required for many of the mono-amino-acids, so that the results now available could be confirmed.

The lecturer discussed some recent work carried out in his laboratory on the structure of the protein insulin. The amino-acids given on hydrolysis have been more or less completely identified and calculation from the results indicates that the submolecule, which may be one-third or one-quarter of the protein molecule itself, has a molecular weight of about 12,000. This sub-molecule has been shown to consist of four peptide chains by a new method which identified the terminal residue carrying a free amino group. These component chains are probably linked together by disulphide bridges. In the same way, the protein edestin was shown to consist of six sub-molecules of molecular weight about 50,000, each of which is one long peptide chain carrying a terminal glycine residue. Collagen and gelatin have not yet been studied in detail, partly because they contain large amounts of hydroxyproline, for which no accurate method of analysis is available, and partly because these proteins may not be homogeneous; but much more would be known about gelatin and collagen within the next few years.

Chemist and Engineer

Mr. J. Crosby-Veale, A.M.I.C.E., followed, with a paper on "Co-operation between Chemist and Engineer in the Tannery," in which he quoted a number of experiences in which chemist and engineer had had opportunities for collaboration. The solution of iron by tanning liquors, for example, gave rise to troubles far too frequently. There were two aspects; contamination of liquors, and destruction of plant. Serious contamination could occur without any considerable damage to plant and *vice versa*. Examples included timber and brick pit construction; solution of iron in pools of liquor on alloys between pits; building materials and plant containing iron and the rapid destruction of unit circulators in colour pits. Pump gland troubles were next mentioned and an interesting illustration given. The hardening of a gland caused repeated failure of an impeller shaft. The suggested cause was the formation of a synthetic resin on the gland which was successively used in the pumping of cresylic acid, formaldehyde, and sulphuric acid. The method of overcoming the trouble was to instal a self-priming pump so that it could keep above the level of the material being pumped, thus keeping the gland under a suction and minimising the impregnation of the packing.

The advice of the chemist was useful to the engineer in designing chemical storage tanks. Non-vegetable greases, for example, had been used to some effect in protecting plant and buildings from sulphur dioxide and general moist conditions tending to lead to corrosion.

Speaking on "The Constitution of the Catechol Tannins," Mr. W. R. Atkin first described the older classification of the tannins into the pyrogallol and catechol groups, and then enlarged on the later classification by Perkin into (a) depsides, (b) ellagitannins, and (c) condensed tannins. He mentioned that it had been shown that the tannin of valonia did contain a COOH group. He pointed out that catechin solution when exposed to air develops tanning properties, and he indicated the relation existing between catechin, flavones and flavonals. The flavonal fisetin, which was present in quebracho extract, fluoresced in ultra-violet light; it was likely that the quebracho tannin might be the flavone corresponding to fisetin.

Braunschweig, in a recent paper, suggested that the bisulphiting of quebracho tannin resulted in an "olated" quebracho tannin, but this could not be so, as it pre-supposed a five-C atom which was impossible. The author considered the oxidation of a CHOH group to COOH more likely. The work of Humphreys and Douglas, recently confirmed by Page, indicated that the tannins were not uniform entities, but differed in size, the larger molecules being preferentially absorbed by the hide. Reference was also made to the decolorising of a tanning extract with blood albumin. This resulted in some precipitation of the larger tannin molecules which had the darker colour.

Macromolecules

The most generally interesting paper on the second day was Dr. W. T. Astbury's lecture on "Macromolecules." To the leather chemist, he said, these suggested chiefly proteins, and among proteins chiefly collagen and related fibres. Protein molecules, nevertheless, are intimately associated with other biological macromolecules, and especially in the case of collagen do we call to mind the polysaccharides. Above all we must look to the absorbing problem of the interaction of the proteins, with the nucleic acids and all that that means in biosynthesis and the phenomena of reproduction and growth.

X-rays show that there are two broad families of fibrous proteins, the keratin-myosin-fibrinogen ("k.m.f.") group, and the collagen group. Within each a master plan is adhered to in spite of the marked variations in chemical constitution. The members of the k.m.f. group are notable for their long-range elasticity, and the common molecular plan is based on a system of intramolecular folds in the polypeptide chains that straighten out and reform during the process of extension and release. The collagen chains also crumple up under certain conditions of temperature and swelling, but normally they are (stereochemically) in an extended configuration, even though their effective length is considerably shortened by the frequent interposition of proline and hydroxyproline residues. In both groups the full period of repetition along the chains is very great, and it has recently been established independently by Bear and Kratky that for collagen it is as high as about 640 A.U. This brings us well within the range of the electron microscope, and by means of this newest research tool, Schmitt and his collaborators have now shown that the finest collagen fibrils are indeed crossed by a regular series of light and dark striations corresponding to the macro-period observed by X-rays. This macro-period can be varied or destroyed by mechanical and other treatments, while the small-angle X-ray pattern remains very much the same. The building of the collagen fibril thus involves successive levels of organisation and "patterns within patterns."

A Clue from Alginic Acid

A new approach to the stereochemistry of the polysaccharides has been made through the X-ray analysis of the structure of alginic acid, the poly-β-*d*-mannuronic acid from seaweed, from which "seaweed rayon" is now manufactured. Contrary to expectation, it is found that the fibre period is only 8.7 A.U. as compared with 10.3 A.U. in cellulose. A new chain configuration is revealed that is an alternative to the well-known cellulose configuration. Both configurations are based on the strainless "armchair" ring, and they are theoretically interconvertible by intramolecular oscillation. The alginic acid configuration appears to hold also for pectin (poly-α-*d*-galacturonic acid) and the general conclusion from these findings is that the possible configurations of the sugars and polysaccharides can be inferred geometrically by the use of interatomic bond angles and distances already established for simpler organic molecules.

To the artificial filaments made by the regeneration of natural polysaccharides must now be added artificial protein fibres formed by spinning polypeptide chains liberated from originally corpuscular molecules, the theory of the process being again mainly an inference from X-ray studies. Neither proteins nor polysaccharides have yet been synthesised by strict laboratory methods, but in the field of plastics simpler man-made macromolecules are now in extensive use.

It is becoming increasingly clear that a large part of the responsibility of biosynthesis is borne by that other great group of natural macromolecules, the nucleic acids. A promising dimensional clue is offered by the X-ray observation that the period of successive nucleotides in thymonucleic acid is the same as the distance apart of successive side chains in an extended polypeptide, and there is a growing feeling that the interplay of proteins and nucleic acids is essentially a kind of molecular template action.

SAFETY FIRST

A Hazard and its Remedy

by JOHN CREEVEY

IT must never be assumed that freedom from accidents at chemical works, nor safety in industry in general, can easily be attained. In the first place, complete co-operation between executives and work-people, as between the workers themselves, is essential. There must also be complete and continued understanding of all factors which are likely to cause accidents. Sometimes it may be the management's concern to provide adequate safety measures; in other cases, the individual worker has to do a lot of thinking about things, aided by good advice and co-operation from other directions. When an accident happens, investigation of its probable causes should invariably follow, and such safety measures as are indicated to avoid a repetition of the occurrence should be adopted without delay.

A disastrous explosion has occurred more than once as the result of leakage of inflammable gas from a badly maintained valve, the igniting agency being, perhaps, a spark. The spark hazard was given attention early in the days when we began to be safety-minded in industry, so far as sparks were likely to be struck by *tools* made of iron or steel. As a result, certain tools for use in hazardous situations were then made of hardened bronze, and these tools could be used quite safely in the presence of inflammable gases. But it was a long time before any serious attention was given to the adoption of sparkproof floors for works where this hazard of explosion was present, irrespective of whether it was merely due to inflammable gases, or to chemical products officially recognised as "explosive." Flooring materials which could provide the needful sparkproof qualities were known, but each had its apparent disadvantages, either in contact with chemicals, or from rough usage, to which the floor might be subject.

Jointless Flooring

However, one material in particular offered good prospects for adoption, but it did not, at first, appear to have the hard-wearing qualities required. Its subsequent development turned into channels providing resilient and washable floors for houses and steamships rather than for factories. That material, then known as "jointless flooring," because it could be laid without a joint, just like cement, over the whole surface, was produced by mixing caustic calcined magnesium oxide with a solution of magnesium chloride in the amounts required for ultimate setting to a solid mass of magnesium oxychloride, a sort of cement to which resilient qualities might be imparted by the addition of fibrous fillers in the nature of sawdust and wood-flour. In its early days, this application of Sorel's cement, pre cast into slabs and sheets for constructional purposes, with the advantage that it could be cut with the saw and nailed or screwed, was known on the Continent as *Xylolith*; the cement base used for binding the sawdust (Sorel's cement), had promised many good uses, and shortly after its discovery, the picture-frame maker showed more enterprise than possibly anyone else, for he quickly found a use for it in moulding the relief decoration on those ornate gilded frames which were in vogue for the framing of oil paintings.

Method of Laying

The development of the magnesium oxychloride cement floor was accompanied by many troubles, but in the end some measure of success was achieved, and a flooring was produced which provided reasonably good wearing qualities, and was free from bulging and warping. However, not until the recent war years did this flooring receive any serious attention for use in industry in this country where sparkproof conditions were essential. In their present form these floors are put down in two layers, each ⅜ to ½ in. thick. The bottom layer contains highly resilient fillers; the top layer has especially good wearing qualities, due to the incorporation of harder fillers. These hard fillers will not produce sparks from striking nor by abrasive action. Such a floor offers the safety quality of sparkproofness, and has a surface which is resistant to wear and tear from factory trucks, heavy boots, etc. At the same time, the floor surface is water-resistant, and also sufficiently resilient (thanks to the under-layer) to reduce fatigue of the feet of people walking on it.

As used at various ordnance works in the United States, etc., this type of floor has shown no tendency to produce attrition sparks when in contact with a grinding wheel of 6 in. diameter, rotating at 1000 r.p.m., with striking mechanism upon the wheel surface in the form of small iron chain and still iron wire. In addition, such a floor is sparkproof from static causes, for under test the maximum voltage that can be set up by electrostatic agency proves to be far below the minimum voltage which will cause a spark in air, said to be somewhere about the level of 330 volts. If desired, the build up of static electricity can be prevented altogether in such a floor. This has been achieved by embedding copper wire mesh in the top layer, the mesh being earthed at various convenient points for safely conducting away any static charge. In place of copper mesh, it is sometimes preferable to embed a grid of copper or brass strips, crossing each other at right-angles at centres of 3 to 5 ft., all points of contact being soldered, and suitable earthing connections being provided.

Whatever the hazard (it will be seen), there is likely to be some remedy if search for it is made conscientiously and with effort. The matter of the sparkproof flooring is cited only as an instance. To seek a remedy most effectively, give voice to your grievance; tell others in industry of the hazards with which you are faced, for in the matter of offering advice upon safety matters there should be no selfishness, nor secrecy, on the part of those serving an industry where hazards exist. I put forward the suggestion that, with the experience gained in safety precautions in industry, during nearly six years of production to meet the needs of the war, no opportunity should be lost in arranging for a Conference on Industrial Safety, to be held under the auspices of one of our scientific societies. Much collected experience of those war years might be made available to all who could profit by it.

Industrial Safety Gleanings

Cyanide Furnace Explosions

When pots containing cyanide salts are being heated from cold after they have been out of use for some time they often give rise to small explosions which may lift the lid of the pot and even throw molten salts about the work room.

A North London firm has developed a device which, it is said, practically eliminates this trouble. Essentially it consists of a solid metal cone which is lowered, inverted, into the molten salt before a pot is allowed to cool. It is suspended with its broad end just above the surface of the molten salt. The salt cools, shrinks a little when it cools, allowing the cone to be easily removed when cold. There is then a cone-shaped cavity in the centre of the solid salt. When the pot is reheated this acts as a funnel and allows free passage for molten salts, etc., to rise from the bottom of the bath without forcing their way through the still solid crust.

The dimensions for a cone used in a pot 10 in. wide by 15 in. deep are as follows: base 4 in., height 8 in. The centre of the base is drilled and tapped for a ½ in. Whitworth eyebolt. An alternative method of construction is to use a base of solid metal 4 in. in diameter and 1 in. thick which is tapped for the eyebolt. On this base is welded a sheet-metal cone 7 in. high and of the same diameter as the solid metal disc.

Each hood must be provided with suitable means for suspending the cone in the centre of the pot. In the works at which the idea was evolved it has been found worth while to devise a small metal " jib " with a pulley at both the inner and the outer end. A chain is run over both pulleys and the free end is held by passing whatever link is convenient over a hook that is formed as part of the jib support. The jib is so mounted that it can be swung out of the way when the pot is in use.

Unusual Case of CO Poisoning

It became necessary to clean out a large quenching tank, 25 ft. deep. For this purpose the works fire brigade's trailer pump was used. The suction hose would not quite reach to the bottom of the tank and, after some vain experiments, it was eventually decided to lower the pump bodily a few feet into the tank. This was done and the tank was duly pumped as dry as possible. A labourer then went down a ladder into the tank for a while. When he came out he almost reached the top and then collapsed, falling back into the tank. It was found that he had been overcome by carbon monoxide from the exhaust of the petrol-driven fire pump.

The two cases recorded above are reprinted from the current issue of *Industrial Accident Prevention Bulletin.*

Arsine Poisoning

An unusual occurrence, resulting in the death of a research chemist, is reported in *Chem. Eng. News.* Dr. C. J. Sommerville, research chemist to an American firm, the Eagle-Picher Lead and Zinc Company, died recently as the result of arsine poisoning while experimenting with the extraction of germanium. An account of his work on germanium appeared in the June issue of the Monsanto Chemical Company's magazine.

The Ministry of Supply announces that it is officially reported that so far stocks of tin metal amounting to 17,000 tons have been discovered in Malaya.

Personal Notes

SIR GUY LAYCOCK has resigned as director of the Federation of British Industries after 14 years in that position. He will be succeeded by MR. N. V. KIPPING.

MR. J. M. AUSTIN, a student member of the Institute of Fuel, has been awarded the Student's Medal and Prize of books or instruments of £5.

PROFESSOR I. M. HEILBRON, F.R.S., and DR. L. H. LAMPITT, the chairman and secretary of the British National Committee for Chemistry, have left on an informal visit to Paris to re-establish contact with French men of science.

PROFESSOR E. L. HIRST, D.Sc., Ph.D., F.R.S., F.R.I.C., Professor of Chemistry in the University of Manchester, has been appointed as the scientific "independent" member of the Working Party for the Cotton Industry set up by the President of the Board of Trade.

PROFESSOR NORMAN FEATHER, the new occupant of the Chair of Natural Philosophy in the University of Edinburgh, and one of the team of British scientific workers engaged in the research on the atomic bomb, delivered his inaugural address last week on the subject: "The Concept of Energy in Physics—Old and New."

MR. E. DACRE LACY, publicity manager of Murex Welding Processes, Ltd., has now been released from military service and will shortly return to the firm. For the last twelve months he was on the staff of General Sir Bernard Paget, C.-in-C. Middle East Forces as Staff Captain in the Adjutant-General's Branch, G.H.Q., Cairo.

PROFESSOR G. I. FINCH, F.R.S., left by air last week to carry the greetings of the Royal Society on behalf of the men of science of Great Britain to their colleagues in Belgium and Holland. The purpose of his visit is to renew and re-establish scientific contacts and to see what help can be given by British science towards the rehabilitation of science and scientific education in these two countries. In Belgium, Professor Finch will be the guest of the Académie Royale in Brussels, and in Holland he will be the guest of the Koninklijke Akadémie van Wetenschappen.

The Lord President of the Council has appointed PROFESSOR H. MUNRO FOX, F.R.S. (Professor of Zoology, London University), PROFESSOR I. M. HEILBRON, F.R.S. (Professor of Organic Chemistry, Imperial College, London), and DR. C. C. PATERSON, F.R.S. (director of the G.E.C. Research Laboratories) to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. Professor A. V. Hill, Sir Felix Pole, and Sir Robert Robinson retired from the Council on completion of their terms of office on September 30.

The Minister of Supply has agreed to release MR. HOWARD CUNNINGHAM and MR. F. C. O. SPEYER from their posts of Fertilisers Controller and Industrial Ammonia Controller. The functions of the Fertilisers and Industrial Ammonia Controls will in future be discharged by directorates under the Raw Materials Department. MR. E. T. CASDAGLI, the assistant secretary concerned in the Department, will also act, for the time being, as Director of Fertilisers, with MR. R. FULLER as Assistant Director. MR. C. R. MAXWELL ELEY has been appointed Director of Nitrogen Supplies and will be responsible for the work relating to industrial ammonia (including nitrogen fertilisers) hitherto carried out by the Industrial Ammonia Control. The offices of the Directorate of Fertilisers will be at 56 Mount Ephraim, Tunbridge Wells, and those of the Directorate of Nitrogen Supplies at 3 Buckingham Gate, London, S.W.1.

Obituary

Mr. H. E. Mussett, the late chairman and managing director of Shawinigan, Ltd., whose death was recorded in our columns last week.

MR. E. H. WHARTON-DAVIES, managing director and founder of Cattle Food Supply Co., Ltd., and for 28 years hon. treasurer of the Liverpool Seed, Oil, Cake & General Produce Association, died at Aigburth, Liverpool, on October 6.

Parliamentary Topics

University Grants

When the House of Commons reassembled after the recess on October 9, Captain Charles Smith asked the Chancellor of the Exchequer whether, in view of the importance of increasing the number of qualified specialists of all kinds, he would call, as a matter of urgency, for a special report from the University Grants Committee on the immediate needs of the universities.

Mr. Dalton : The University Grants Committee presented to my predecessor last January a full report on the financial needs of the universities, and effect has already been given to their recommendations for the current year. They are now engaged on a further survey.

Release of Students

Mr. Ernest Davies asked the Minister of Labour whether he would reconsider the release of science students whose studies were interrupted by voluntary enlistment in the Armed Forces.

Mr. Isaacs : Yes, sir; it has been decided that certain science students shall be eligible for release from the Forces in Class B to enable them to resume their studies at universities. Those eligible are students in release groups 1 to 49 inclusive, selected by their universities as being in one of the following categories :

First, students of first-class or high second-class honours standard selected as research students or third-year students, and second, other students of high promise, who were called up before the end of their normal deferment and before they had an opportunity of taking an Honours degree.

Surface Minerals

Replying to Major A. Jones, the Minister of Town and Country Planning declined to amend the Town and Country Planning (General Interim Development) Order, 1945, so as to enable interim development authorities to regulate the working of surface minerals over the whole of the land in their areas.

Scientific Research

Sir G. Fox asked the Lord President of the Council whether he was in a position to make any statement as to the Government's research programme; and what arrangements were to be made for making available to industry all the scientists no longer essential to military requirements.

Mr. H. Morrison replied that he was not yet in a position to make a statement regarding the Government's research programme. Applications for the release of individual scientists from the Forces (Class B) should be made through the appropriate Departments. Moreover, in the case of scientists for whom the industrial demand is heaviest, the Ministry of Labour ensures that these requirements are brought to the notice of scientists leaving civilian war work.

Metalliferous Resources Inquiry

After considering the report of the committee of technical experts, appointed by my predecessor, the Minister of Fuel and Power, in reply to Commander Agnew, said he had come to the conclusion that the changed circumstances and economic conditions resulting from the war called for a comprehensive inquiry into our metalliferous resources. He was proposing to appoint a committee with wide terms of reference, to review this question as a whole. These investigations would extend to the Cornish tin-mining industry, and the report of the technical committee would be made available to them.

INDIAN MICA INDUSTRY

The annual report of the Kodarma Mica Mining Association for 1944 shows that the industry, despite inadequacy of labour and machinery, has been able to produce all the mica required. The inadequate supply of mining equipment, such as air compressors and boilers, has led to a serious situation, particularly because the number of mines engaged in mica mining has greatly increased. The Joint Mica Mission investigated the cost of mica production, and on its recommendation the Government of India decided to increase the price of mica from May, 1944. The report draws attention to the continued existence of mica thefts. Although the amendments to the Mica Control Order, prohibiting the sale of crude and bima mica, have proved beneficial, illicit mica trade is still prevalent, and in the opinion of the Association, effective prevention of theft is fundamental to the progress of the industry.

THE PROBLEM OF SOLUTION

Among the books which Ernest Benn, Ltd., are offering for Christmas is a small gem that was first published in 1923, from the pen of Dr. Stephen Miall. *The Problem of Solution* is much more than a scientific treatise—it is a lively discussion set out as "a tavern talk between certain chymists and others," and reflects the humour and wide scholarship for which the author is noted.

The pamphlet (price 2s.) has an introduction by the late Professor H. E. Armstrong, F.R.S., together with critical letters by Professor T. M. Lowry, F.R.S., and Professor Alexander Findlay, now president of the Royal Institute of Chemistry.

General News—From Week to Week

DTD Specification No. 504, on silicon-nickel-copper alloy bars has been reprinted, incorporating Amendment List No. 1.

The Institute of Physics announces the election of 29 new Fellows and 37 new Associates. Eleven subscribers and 14 students were also admitted.

The Treasury has made an Order under Section 20 of the Finance (No. 2) Act, 1940, entitled "The Purchase Tax (Exemptions) (No. 2) Order, 1945," the effect of which is to exempt from Purchase Tax a number of expensive drugs.

The British Aluminium Co., Ltd., temporary head office, Salisbury House, London Wall, London, E.C.2, announce that their telegraphic address has been changed to Britalumin Ave London. Address for cables will be Britalumin London.

British Industrial Plastics has formed a £100,000 private company, with the title B.I.P. Tools, Ltd., to acquire the business carried on by it at Tyburn Road, Birmingham. The new company will manufacture moulds, dies, jigs, tools, etc., for use in the plastics and other industries.

An increase in output of industrial alcohol is planned by the Industrial Alcohol Company of Ireland, according to reports received from Dublin. Recruitment of more technical staff for the company's five distilleries is already under way. Output of the industry last year was 277,535 gallons.

L. A. Mitchell, Ltd., chemical and industrial drying engineers, have now resumed business activities at their pre-war address, 37 Peter Street, Manchester, 2. The new telephone number is Blackfriars 7224. Their temporary premises at Didsbury have been closed down.

The principal of Widnes Technical College, Mr. W. Ibeson, has announced that Dr. J. P. Baxter, who (as already reported) has returned to Widnes from his work on atomic energy in the U.S.A., will deliver two lectures on the subject of his work there to the students of the Technical College towards the end of next month.

The Board of Trade is advised that a number of firms in Northern Ireland and elsewhere are having difficulty in contacting their former suppliers who have changed their address as a result of war-time bombing or for other reasons. Firms who have changed their addresses during the war are, therefore, asked to assist their old customers by making their new addresses known to them.

Some particularly well-reproduced electron micrograms taken at the Shirley Institute are included in the current issue of *J. Text. Inst.* (1945, 36, 140-141). They illustrate an excellent paper on the Electron Microscope, delivered by Mr. D. G. Drummond to the Lancashire section of the Institute in February this year.

Two new issues have appeared in the series of Commercial Reviews begun last March by the Department of Overseas Trade. These are for Canada and Turkey and are obtainable, together with those previously published, from H.M.S.O., or through any bookseller at 6d. or 1s. each, according to length. The series will ultimately cover 28 countries.

According to statistics issued by the Department of Industry and Commerce in Dublin, there was a further improvement in the value of imports of chemicals, drugs, perfumery, dyes and colours into Eire during August when the total was £151,511, against £120,638 in the same month of 1944. These importations bring the figures for the first eight months of the year up to £1,146,816 compared with £978,475 a year ago.

An offer by the Distillers Company of a grant of £500 per annum for three years in the first place to enable one or two students to undertake a programme of work in the field of polymerisation, under the general direction of Professor Melville, was accepted at a meeting of Aberdeen University Court last week. The offer was contained in a letter from the research department of the company.

Successful experiments by Salford Health Department on the disinfestation of houses and industrial premises by means of DDT and Gammexane, were recorded by Dr. J. L. Burn, the city's medical officer of health, at a meeting of the Royal Sanitary Institute at Hope Hospital annexe, Salford, last week. The heads of 1000 children had been kept clean by DDT emulsion, while a minute dose of Gammexane had cleared weevil infection at a flour mill.

The tenth meeting of the Manchester group of the International Society of Leather Trades' Chemists was held on October 13 at the Engineers' Club, Manchester. Papers on "Post-war Plans for the Leather Chemist" were given by Mr. D. Woodroff, and on "The Technology of Synthetic Resins and their possible use in the Leather Trade," by Messrs. H. Jones and E. Chadwick. The next meeting will take place on November 17.

The wholesale price index number for all articles for September fell by 0.6 per cent., from 170.6 to 169.6, prices of industrial materials declining by 0.12 per cent., from 175.5 to 175.3. The fall of 1.6 per cent. in the index number of chemicals and oils from 150.0 in August to 147.6 last month, as compared with 151.4 in September, 1944, is due to the reduction in the price of petroleum products. The index numbers for coal, iron and steel, and non-ferrous metals remained unchanged.

H.M. Government has decided that inventions made in Germany since September 3, 1938, shall not be allowed to form the basis of valid applications for the grant of patents, or for registration of designs in the U.K., and, accordingly, such applications will not be accepted by the Comptroller of the Patent Office. Any rights lawfully acquired by non-enemies before September 3, 1939, in inventions for which protection was applied for in Germany in the twelve months preceding that date will be safeguarded.

United Kingdom exports of chemicals, drugs, dyes and colours totalled 3570 (in £'000) in July this year and 3296 in August. The monthly average for the first eight months is 2915, compared with a yearly average of 1857 in 1938. Imports fell from 2184 in July to 1196 in August, the average figures being 1850 and 1134, respectively. As trade is still largely affected by transport and supply conditions, the monthly figures do not necessarily indicate significant changes.

The need to develop "safe" hair dyes was emphasised at the National Conference of the National Hairdressers' Federation, at which resolutions from a great many branches concentrated on the situation which users of hair dyes find themselves in because of the lack of a guaranteed "safe" dye which can be used on human hair without detrimental results to the scalp and without harm to future hair treatment. It is understood that, following ventilation of the problem, I.C.I. contacted the Federation and offered its assistance in research work on this subject.

Forthcoming Events

October 20. Society of Public Analysts (Physical Methods Group and North of England Section). Engineers' Club, Albert Square, Manchester. 1.30 p.m. Four short papers on "Polarographic Analysis."

October 20. Royal Institute of Chemistry (London and S.E. Counties Section). London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, 2.30 p.m. Discussion: "The Publicity of Science, with special reference to Chemistry."

October 23. Textile Institute (Lancashire Section). St. Mary's Parsonage, Manchester, 6.30 p.m. Mr. C. D. Weston: "Plastics for the Textile Industry."

October 23. Society of Chemical Industry (Yorkshire Section) and **Leeds University Chemical Society.** Chemistry Lecture Theatre, Leeds University, Woodhouse Lane, 6.30 p.m. Mr. G. Roche Lynch: "Some Medico-Legal Experiences."

October 23. Society of Chemical Industry. (Newcastle Section, Plastics Group) and **Institute of Plastics.** Neville Hall, Newcastle-upon-Tyne, 6.30 p.m. Dr. K. W. Pepper and Dr. F. T. Barwell: "Fabric Base Plastics."

October 24. Textile Institute (Midlands Section). College of Arts and Crafts, Waverley Street, Nottingham, 6.45 p.m. Mr. G. E. Cowlishaw: "Oils Used in the Processing of Textile Fibres."

October 24. Institute of Fuel (Midland Section). James Watt Memorial Institute, Birmingham, 2.30 p.m. Chairman's address.

October 25. Imperial College Centenary Celebration. Royal Albert Hall, London, S.W.7, 8.30 p.m.

October 25. Association for Scientific Photography. Alliance Hall, London, S.W.1, 6.30 p.m. Mr. C. W. Bradley: "The Organisation of an Industrial Photographic Unit."

October 25. Royal Institute of Chemistry (Belfast and District Section). Physics Lecture Room, Royal Academical Institution, 7.30 p.m. Mr. G. Elliot Dodds: "Recent Developments in the Organisation and Activities of the Royal Institute of Chemistry."

October 26. British Association of Chemists (St. Helens Section). Y.M.C.A. Buildings, 7.30 p.m. Mr. A. Rees-Jones: "From Lab. to Full-Scale Production."

October 26. Chemical Society (Sheffield Section) and South Yorkshire Section of the **Royal Institute of Chemistry.** Chemistry Lecture Theatre, Sheffield University, 6 p.m. Professor D. T. A. Townend: "Flame."

October 26. Chemical Society (Glasgow Section), **Glasgow University Alchemists' Club** and **Andersonian Chemical Society.** Large Lecture Theatre, Chemistry Department, Glasgow University, 3.30 p.m. Sir Robert H. Pickard, F.R.S.: "Long Chain Molecules."

Company News

Aspro, Ltd., has declared for the year to June 30, a final ordinary dividend of 15 per cent., making a final of 25 per cent. (same). Trading profit for the year was £311,260 (£292,922); and net profit totalled £284,512 (£275,840).

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

BASIC MINERALS, LTD., 15 George Street, E.C.4, mineral, metal, ore and chemical merchants, etc. (M., 20/10/45.) September 14, 1945. Debenture, charged on the company's property, present and future, including uncalled capital, to secure £5350.

Chemical and Allied Stocks and Shares

AWAITING attitude again prevailed in stock markets, attention being focussed on Tuesday's interim Budget, although the prevailing view is that important reductions in taxation are unlikely until next year. British Funds became firmer, and home rails were higher on balance. Encouraged by hopes of "fair compensation" in the event of nationalisation, colliery and electric supply shares maintained an upward trend. Bank of England stock was higher on balance, but two points below the best level touched since the purchase terms were announced by the Government. Shares of companies whose earnings are affected severely by the incidence of E.P.T. came into better demand on Budget hopes, although textiles were dull and slightly lower on balance, reflecting uncertainty as to Government policy in regard to the industry.

Shares of chemical and kindred companies were little changed, small movements predominating. Imperial Chemical further strengthened to 40s. in view of the company's widespread home and overseas interests, and on talk that a higher dividend than the 8 per cent. basis of recent years may be in prospect when E.P.T. is reduced. Lever & Unilever changed hands around 50s. 3d. xd in front of the full results and the chairman's annual statement; but, pending the dividend announcement, Wall Paper deferred at 42s. lost a little ground. Turner & Newall receded to 80s. 6d. Rise in Gas Light & Coke units to 22s. 1½d. was attributed to hopeful compensation views should nationalisation eventually be proposed.

B. Laporte were again firm at 87s., W. J. Bush around 78s. 9d., Fisons more active and quoted at 55s., and Monsanto Chemicals 5½ per cent. preference 23s. Burt Boulton remained at 26s. awaiting the dividend, and Cellon were again 26s., but elsewhere British Glues 4s. shares eased slightly following their recent advance. Further rise to 41s. in British Drug was attributed to E.P.T. reduction hopes. Lawes Chemical 10s. shares were again 11s. 6d., and Greeff-Chemicals Holdings 5s. ordinary 9s. Elsewhere, Leeds Fireclay issues attracted rather more attention on the scope for improved results, the ordinary shares changing hands around 6s. 9d., with the preference 14s. 6d. Morgan Crucible 5½ per cent. preference were 27s. 6d., and the 5 per cent. preference 24s. 9d. Canning Town Glass 5s. ordinary changed hands around 9s. 6d. United Glass Bottle were 70s. Triplex Glass receded to 38s. 3d. Blythe Colour 4s. ordinary have been more active around 22s.

Ruston & Hornsby were firm at 56s. on the deal in connection with Ransomes, Sims & Jefferies. Staveley Coal at 49s. participated in the upward movement in colliery shares, Sheepbridge being 43s. 3d., and Powell Duffryn 22s. 4½d. Elsewhere, Allied Ironfounders at 52s. moved higher, also Guest Keen at 40s. 9d., and Babcock & Wilcox at 57s. 6d., while United Steel strengthened to 24s. 9d. pending the dividend announcement.

Steadiness in the units of the Distillers Co., kept the quotation around 116s. 3d. British Plaster Board were 35s. 6d., and United Molasses 41s. 3d. Boots Drug firmed up to 56s. 3d., and Beechams deferred to 20s. 1½d., while Sangers were 31s. 6d., and Timothy Whites 42s. 3d. xd. De La Rue were £11, with British Plastics 2s. shares 6s. 9d., and Erinoid 5s. ordinary 11s. 9d. Oils were inactive and slightly lower, Anglo-Iranian easing to 111s. 10½d., Shell to 80s. 7½d., and Lobitos to 57s.

British Chemical Prices

Market Reports

A CONTINUED steady trade is reported this week in virtually all sections of the London industrial chemicals market. Fresh inquiry and a certain amount of new business has been recorded both for home and export trade and deliveries against contracts are stated to be satisfactory. Among soda products the call for supplies of both salt cake and Glauber salt has been steady and fair quantities of hyposulphite of soda and nitrate of soda are being taken up. The position of soda ash and bicarbonate of soda remains the same and sellers are meeting with a steady call for supplies. A moderate demand for acetate of soda is reported. No change of importance has taken place in the potash section. Yellow prussiate of potash is in short supply relative to requirements and values remain firm. Acid phosphate of potash is in good demand and quotations are firm. In other directions, British-made formaldehyde is well held and a fair trade is passing in peroxide of hydrogen and alum lump. White powdered arsenic is a good market. In the coal-tar products section there is a steady call for supplies of pitch for both home and export account, while creosote oil and cresylic acid are in good call. The greatly decreased (controlled) prices for mercury products came into operation on October 8.

MANCHESTER.—Traders on the Manchester chemical market during the past week have reported a fairly good demand for contract deliveries of industrial chemicals from users in the area, and new inquiries have resulted in moderate additions to order-books. The fresh business has again included bookings of a fairly wide range of materials for shipment, and it is believed that the tendency in overseas trade will continue towards higher levels. Values of chemicals remain steady to firm throughout and no sign of ease has been reported so far as the heavy products are concerned. Fresh bookings on the tar products market locally have been no more than moderate, though for the most part steady contract deliveries are being maintained.

GLASGOW.—In the Scottish heavy chemical trade, the position for the home trade remains unchanged, business maintaining its steady day-to-day transactions. Stoppages at most of the docks, however, are holding up the receipt of goods, and also deliveries. There is no change to report in the export position. Prices remain firm at previous levels.

Price Changes

Mercury Products.—Controlled price per lb. for 1-cwt. quantities: Bichloride powder, 8s. 6d., lump, 9s. 1d.; ammonium chloride powder, 10s. 1d., lump, 9s. 11d.; mercurous chloride, 10s. 2d.; mercury oxide, red cryst., 11s. 7d.: red levig., 11s.; red tech., 9s. 9d.; yellow levig., 10s. 10d.; yellow tech., 9s. 9d.; sulphide, red, 10s. 5d.

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ASSISTANT (25–35) required for Technical Director of Company manufacturing Plastics, London area. Knowledge of Chemical Engineering an advantage. Interesting position with excellent prospects for young man possessing persistence, drive, initiative and thorough knowledge of Factory Administration. Box No. 2239, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

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