The Chemical Age

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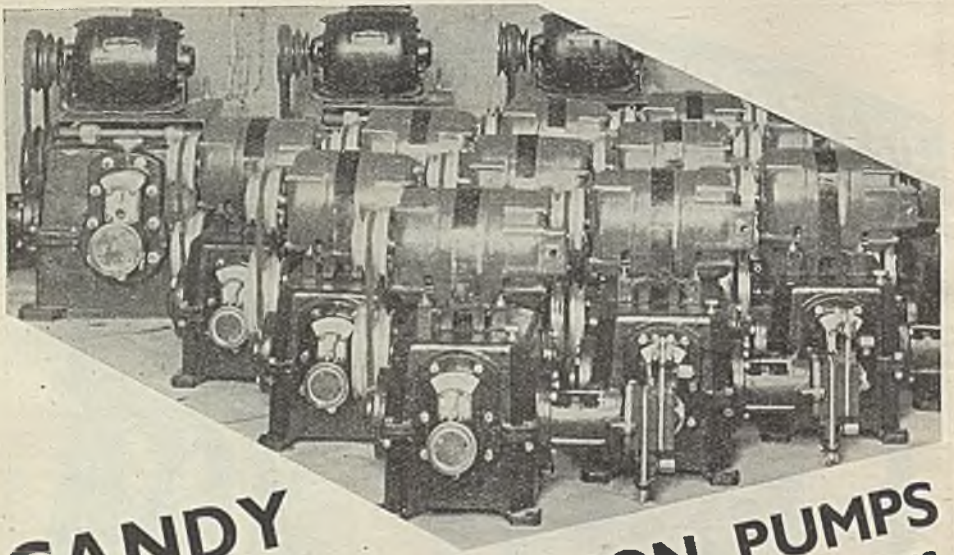

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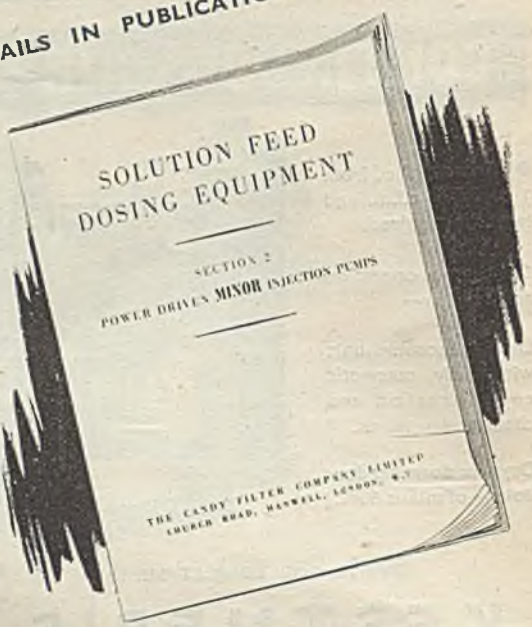

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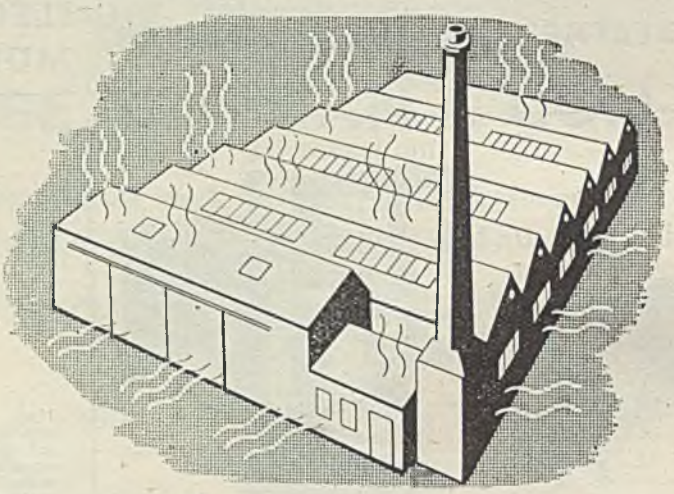

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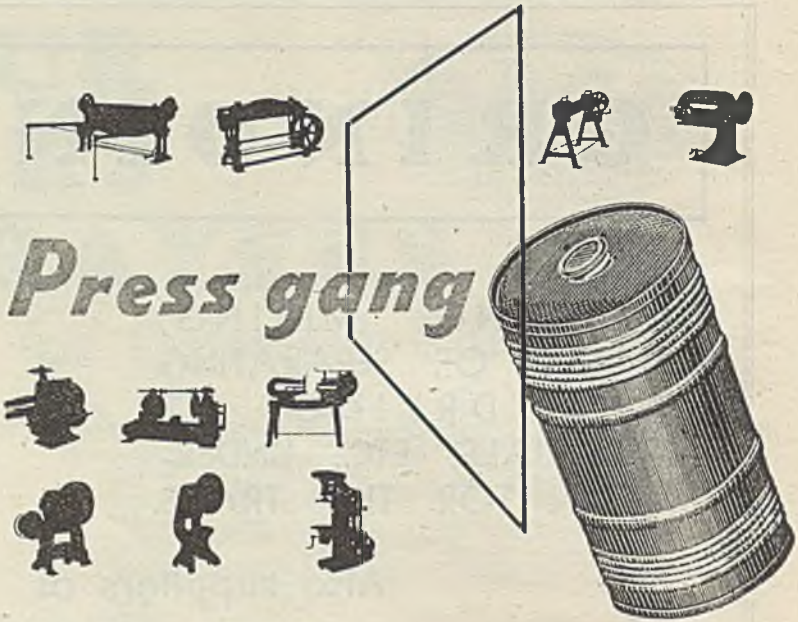

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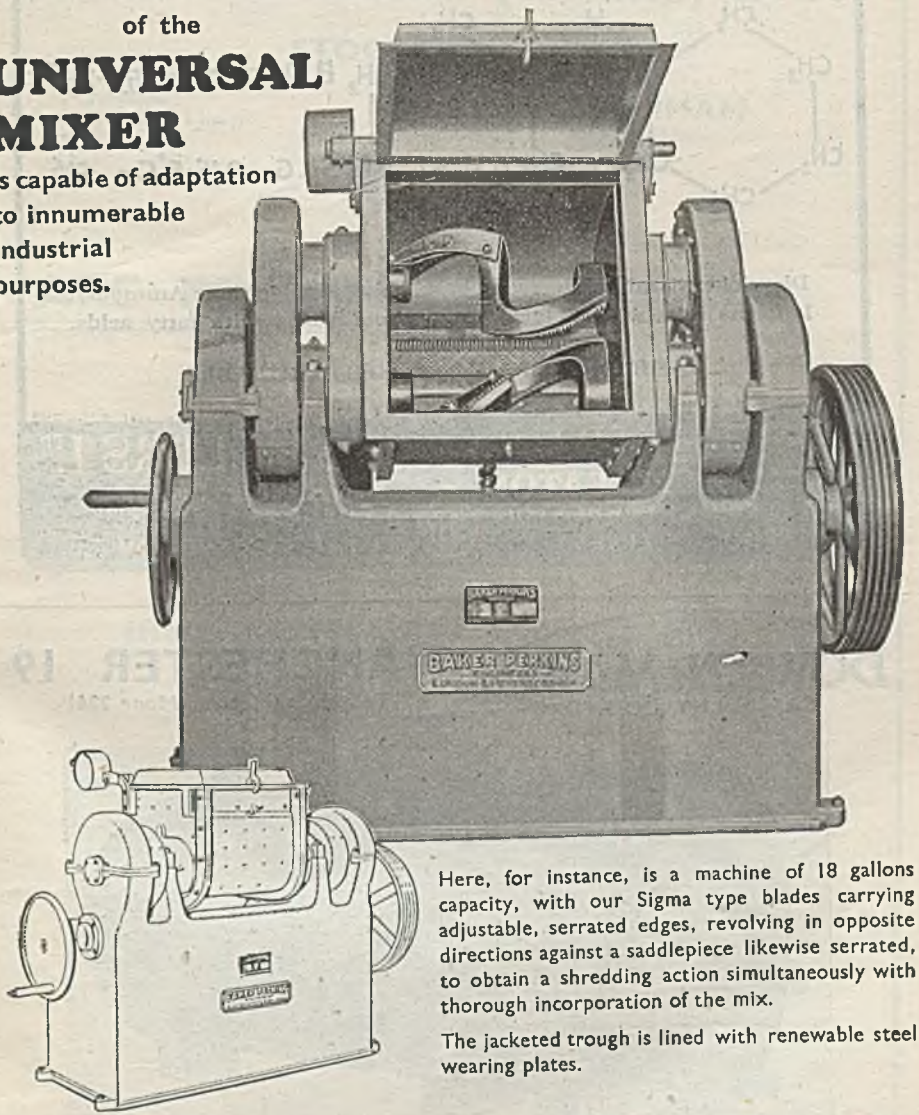

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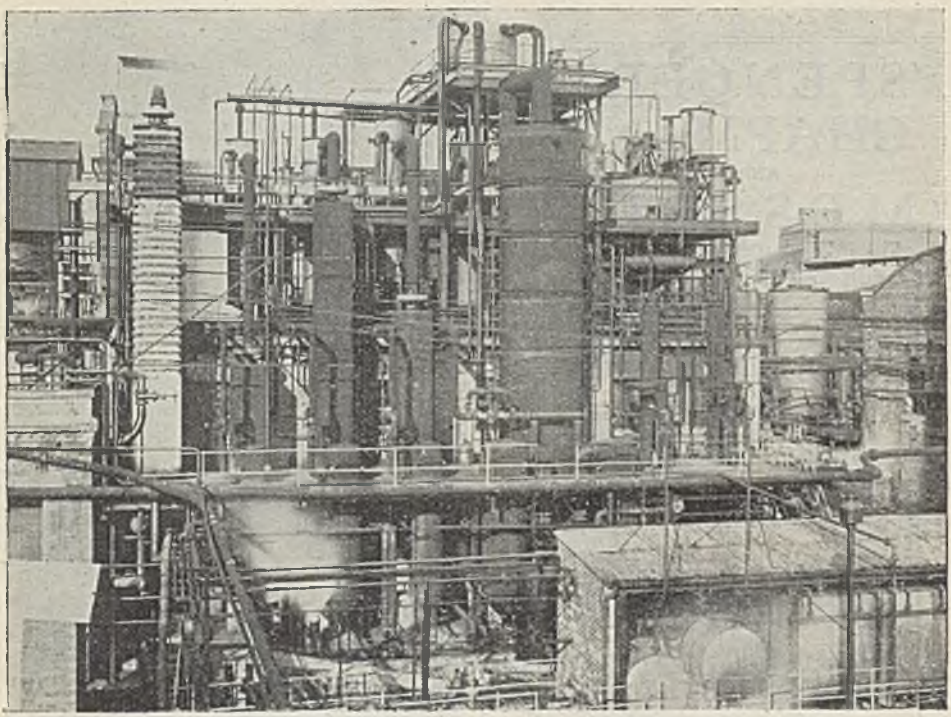

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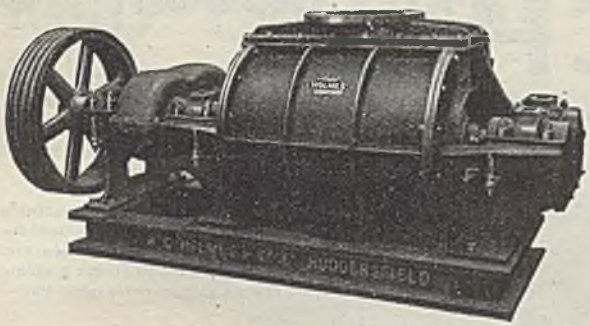

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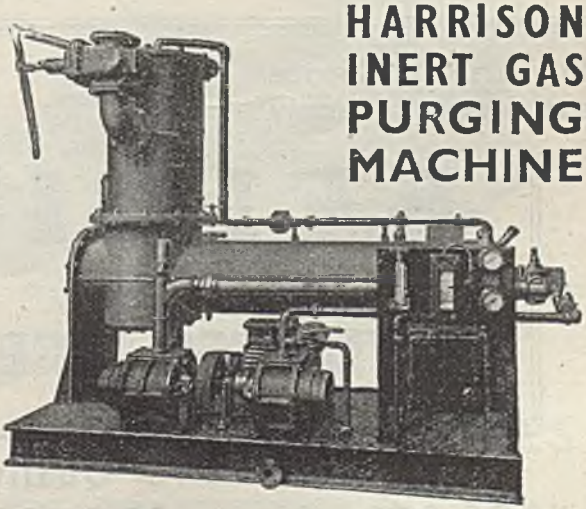

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Retrospection, Introspection and Prospection

THE year 1945 has passed into history. It is a year that will be remembered so long as there shall be a record of these stirring times in which we live. For this is one of the great periods in history, a period to which the adventurous of other and later generations will look back with envy that they did not live in a time when such deeds were done. Once history has thrown her golden haze over this opening half of the 20th century, our struggles will take on a romantic colour. We shall be the heroes of the books of adventure of future generations. In the meantime we have to face hard realities.

The great and crowning mercies of the victory that has been vouchsafed to us over two savage foes would mark 1945 as one of the great dates of the world's history. This year has seen one of the decisive battles of the world, the outcome of which will settle the course of history for many generations to come. In those battles, and in the events that made them possible, the British Empire has played no mean part. This has been an industrial war. It was fought in the works and factories and laboratories just as much, and perhaps more decisively, than upon the field. Industry throughout the world has been right in the front rank, not only through work done, but also through exposure to enemy attack which has made the factory-worker endure perils not greatly inferior to those of the soldier, and certainly over a more extended period. That we have won the victory is convincing proof that Allied industry in general, and that includes British industry, is highly efficient and in no way inferior to that German industry about whose wonders some folk have been wont to wax eloquent. Our record in these fateful years has proved beyond a doubt, as we shall show, that British industry and British scientists are among the best in the world.

The victory over Germany has enabled us to send teams of visiting scientific men and technologists—less kindly known to the Forces by irreverent initials—to inspect German factories of all kinds. Many of these reports have been published and still more are open to inspection. The secrets of German industry have been laid bare. Our belief is that while there are bound to be directions in which any industrial nation must be ahead of its competitors, taken as a whole we have been as advanced in our technology as the Germans. This conclusion holds also for the chemical industry, in

On Other Pages

which the Germans have so long convinced a gullible world that they were on a pinnacle alone.

Germany had a vast export market in chemicals and in chemical plant. What will happen to that market in the future? That is a question to which as yet there is no answer. Certain it is that Germany must not again in our generation be permitted to build up industries that can be of assistance in making war. It is equally certain that within a limited period the Allies must allow Germany *some* export trade and must allow her to re-start *some* branches of the chemical industry. Let us remember, however, that what constitutes a chemical or an industry of war potential to-day, may not do so to-morrow. To-day, we should not permit the Germans to make explosives, nor to build plant that could be modified to that end. To-morrow the United Nations may well decide that the atomic bomb has made all other known explosives obsolete, so that everything made by Germany before the war can again be permitted to her. The position here is that the war has given us a breathing-space in which the propaganda value of what was done in Germany has been wiped away, and in which we have an opportunity to forge right ahead of the pre-war Germany. Who can doubt that in time Germany will again be in full competition with us? We must set to work to build up an unassailable position.

Our Chemical Exports

We do not hope for, nor expect, a dominating position in the supply of chemicals and chemical plant to the world, nor would this be in the interests of international amity; but at least we expect and must strive for a fair share of the market. Our share in the export market, for reasons that are well known, must be far larger than would have been necessary before the war. We have allowed our export markets to disappear in order that Germany might be defeated. We do not regret the action we took. It is better to starve than to be slaves. But neither do we wish to continue to starve. In the face of powerful competition from the U.S.A. and other countries we must build up a much greater export trade than we have ever possessed before. We cannot do better than quote in this connection the words of Dr. Isherwood, as Chairman of the A.B.C.M.: "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 export 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 quality, novelty, 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 users."

Aiding Backward Nations

What, then, must be our industrial policy in the export field? First, let us rest assured that other countries are being industrialised at a considerable rate, and that this movement will continue. They will need plant for this. We cannot sit back and refuse to supply it; if we do not supply the necessary equipment, others will. Our policy must be to help the nations of the world to become industrialised, if they so desire; we have always done this, and we must continue to do so. In this way we shall help backward nations and colonial nations to become wealthier so that they can in turn buy from us. They must continue to buy from outside, for few nations can keep themselves in all they need from their own resources, and the richer they are the more goods can they buy from outside. We, ourselves, are an outstanding example of this. Once we bought so freely in the world's markets that we were the best customer of many nations. Now we deny ourselves almost the necessities of life, because we are too poor to buy them. Once we have the means again, we shall buy. Once backward nations are given the means, they will buy. Therefore let us help other nations to follow the lead we gave them in the 19th century.

The chemicals and other goods that we shall then supply will be such as they can-

not supply for themselves. They will comprise, for the most part, goods that require specialised knowledge or plant for their manufacture. That means that, technically, we must always keep at least one jump ahead of the rest of the world. That in turn means research and yet more research, not only on the laboratory scale, but also on the large scale, with bold and practical application of the results.

In chemical manufacture our policy in assisting other nations should not be confined to giving them the plant and showing them how to operate it. It should be to link ourselves with those projects in any way which seems most suitable, in order that we may help in regulating and organising the trade of the world. It would not be in the interests of mankind to allow fierce, unrestricted, cut-throat competition to spring up again between the nations of the world. There is ample place for everyone, and it is not desirable that any one nation should dominate. What we have to do is to see that the trade of the world is shared among the *efficient* producers. Industry believes that that can be done by the way of cartels; these cartels can be open freely to Government inspection, provided that politics do not thereby come into the picture and cause the interests of one nation to be set against those of another. The American Government, and probably the British Labour Government, are not in favour of cartels. There are undesirable features in some cartels, it is true, but we are still unrepentant in our belief that the regulation of world industry by industry, provided it is free from these undesirable features, is the best method of controlling international competition and of so regulating the trade of the world that international jealousies do not arise. But—and it is a very important but—any arrangements that are made must be such as to favour the efficient manufacturer at the expense of the inefficient.

Chemical Plant Supply . . .

The supply of chemical plant to the world was in the hands of Germany to a greater extent than was desirable, because the German Government assisted its nationals to export equipment and goods in order to secure foreign exchange. It seems probable that there was also a technical reason in that manufacturers of chemical plant were associated with manufacturers of chemicals more closely in Germany than in this country so that they had a greater opportunity of securing expert knowledge of specialised design and operation. It would appear from this that the condition for export of chemical plant is that there shall be home manufacture of the chemical for which the plant is used and that the chemical manufacturer shall collaborate with the plant manufacturers.

. . . and Demand

This conclusion becomes important in the light of Sir Frederick Bain's speech at the annual luncheon of the B.C.P.M.A. Sir Frederick pointed to the demand for chemical plant in many countries, such as India, Egypt, Turkey, China, and South America, and he indicated the imperative necessity for British chemical plant manufacturers to meet these demands. He went on to urge the co-operation between firms to produce comprehensive schemes and he suggested that while " for certain types of plant, the chemical plant manufacturers of this country are as good as any in the world, it might be that some well considered and wisely planned groupings would be to the advantage of the industry and the country." Sir Frederick went on to point out that in the U.S.A. and Germany before the war " there were links between the plant construction industry and the chemical producing industry which made closer working and freer exchange of information possible. . . . Therefore the possibilities of achieving a similar result in this country should be reconsidered and re-examined seriously and responsibly by both the plant manufacturers and the chemical producers. There are grounds for believing that in the circumstances of to-day there is more likelihood than ever before of achieving valuable and practical results from such an examination."

Among the oustanding events of the year has been the complete change of national policy brought about by the general election. We doubt whether there has ever been an election so heavily fraught with consequences to the industries of the country.

In industry it is wise to make changes with circumspection, at each stage making sure that the right policy is

being pursued as shown by its results. As a result of this election, however, there is to take place a wholesale reorientation of British industry on new theoretical lines and without any assurance that a disastrous mistake will not be made. Common prudence would suggest that within the lifetime of this Parliament the experiment should be tried upon one industry only, the obvious one being the coal industry. If that had been the policy, most people would have agreed with it and would have watched with interest to see whether that policy should be further extended. We have grave doubts of the wisdom of the wholesale change from private ownership to public ownership in so many major industries which is now about to be put into effect. We do not for one moment expect that these industries will be run more efficiently than they are now. We do not for one moment expect that the output per man-shift in the coal industry under national ownership will be greater than it would be under private ownership if those employed in the industry pulled their weight in either circumstances. Unfortunately, the well-tried and honest principle of a fair day's work for a fair day's pay seems to be disappearing. Instead, we hear only of demands for a 40-hour week, for joint management by labour, or even control of management by labour, and for compulsory nationalisation on the ground that while the workmen will give a fair day's work for a fair day's pay to the State they are not prepared to do so when they are employed by the private employer. It is a pernicious doctrine; for, let there be no mistake about it, this country will never again be prosperous unless those who inhabit it, whatever their station, are prepared to work hard.

Our "Inefficiency"

During the past year it has once again become the fashion to denounce British industry as inefficient. Politicians have repeated this accusation, no doubt in order to prepare the way for their nationalisation schemes. Quite frankly, we do not believe it. Any attack of this sort at this moment must catch British industry off its balance. It has been suffered under rigorous Government control for some years; it has been subjected for the same period to enemy attack; it has been compelled by circumstances to put production first and efficiency second; it has been manufacturing unaccustomed products; and it has had neither the time nor the facilities for carrying out the necessary maintenance work nor for replacing outworn plant. Nevertheless, our war achievements give the complete lie to any suggestion of inefficiency. There is no space here to chronicle our many achievements. During the last six months of the year the individual contributions to victory of many firms have been published. We would, however, refer those interested to our leading article on April 7 and to Lord McGowan's statement of I.C.I.'s record in our issue of June 2.

Atomic Energy

Technically, the outstanding achievement of the year has been the successful utilisation of atomic energy. An account of the work so far as it can be published has been given by Professor H. D. Smyth and has been published by H.M. Stationery Office. An extended summary of this work was given in our columns of October 20 and 27, while on November 10 we published an account of Canada's contribution to the work. With the coming of peace our attention is now devoted to making use of atomic energy for industry. One method is already open to us—the generation of heat from the "pile" which has been used for the production of plutonium. This method is that of the splitting of a heavy atom into lighter ones of approximately equal atomic weight. In this way some 15 million times as much energy per unit of matter are derived as are obtained from the combustion of the same weights of matter. The cost of this process is high and it is not likely that it will be a commercial proposition for some time. It seems, moreover, that at present the temperature of the heat that can be harnessed for useful purposes is too low to make it valuable. There is enough uranium in known deposits in the earth's surface to provide power by this means, at the present rate of power consumption, for a thousand years. A very much greater source of power is obtainable from elements at the other end of the periodic table by building up heavier atoms such as helium from lighter atoms such as hydrogen. There is infinitely more of the raw material available and

the amount of energy obtainable per atom from this type of process is far greater than from the decomposition of uranium. It may well be that the discovery of the method of utilising atomic energy will, in the eyes of historians in future centuries, mark the importance of the year 1945 far more than its achievements in war or politics.

While upon the subject of power, mention may be made of the final disappearance, in the present state of knowledge, of any possibility of obtaining cheap water power in this country. The report of the Severn Valley Barrage Committee has shown that even in that rather favourable scheme the cost of this power would be similar to that of coal-fired stations, and that the scheme will pay only if the price of coal rises continuously at the rate of about 4d. per annum. In Scotland there are more favourable schemes, but the total power available in the British Isles is only a small fraction of our requirements. The possibilities of the establishment of industries in this country that require cheap power seem to be remote.

Hydrocarbon Oil Duties

The year has seen the report of the Ayre Committee on hydrocarbon oils, dealing with the effect of the hydrocarbon oil duties on the supply of raw materials to, and the development of, the chemical industries in this country, and the extent to which any change in those duties would affect industries engaged in the production of similar products from coal. The Committee accepted the view that the existing duties were a hindrance to the development of the organic chemical industry, and that the industry should not be asked to pay the tax on imported oil, nor on home-produced oil used for the purpose of chemical synthesis. This includes both aliphatic and aromatic oil derived from petroleum or coal. It was further agreed that the carbonising industries should not be deprived of the advantage that had been given them through tariff protection. The Committee suggested, and the Government accepted the view, that the present level of taxation on imported oils should stand, but that the chemical industry, for specific purposes of chemical synthesis, should be allowed imported oil tax-free and should receive a payment of 9d. a gallon in respect of home-produced light hydrocarbon oil, and of 1d. a gallon on heavy oils used as raw materials in the course of chemical synthesis.

The May Committee examining the tax position on industrial alcohol came to the conclusion that the whole of the existing allowance of 5d. per proof gallon should be withdrawn. In effect, this recommendation, which also has been accepted by the Government, withdraws a subsidy given to alcohol made from imported molasses and will considerably improve the prospects of the production of alcohol from home-produced ethylene. Given sufficient market at a reasonable price, ethylene can be extracted from coal gas in huge quantities and can be the basis of a considerable organic chemical industry.

Chemicals from Coal

This brings us to the important question of the production of chemicals from coal. Reference has already been made to the production of ethylene; methane and other gases can also be produced in whatever quantity the chemical industry requires them. An important report has been published by the Coal-Processing Industries Panel of the Northern Industrial Group on the general possibilities of the production of chemicals from coal, and, in particular, on the production of alcohol from ethylene and the production of ethylene from coal gas.

It is felt by many that the possibilities of coal tar as a source of chemicals are by no means exhausted. The development of the manufacture of chemicals from coal and its derivatives has been urged powerfully for some years, more particularly since the petroleum industry started a parallel line of manufacture from the gases derived from petroleum refineries. It is therefore very gratifying to find that I.C.I. have bought an estate near Middlesbrough for the erection of a factory for the large-scale production of heavy organic chemicals from coal *and* oil. Full particulars of this scheme, and of the report of the Northern Industry Group, were given in our issue of December 15. Reference should also be made here to the work of the Gas Research Board on methane synthesis, and on the production of a high yield of gas, rich in methane, by the carbonisation of coal under 50 atmospheres pressure in presence of hydrogen. The latest information derived from Germany on the development of the Fischer-Tropsch process may encourage

the building of a plant in this country. The developments of the last few years have clearly done much to bring nearer the synthetic manufacture of organic chemicals from coal, and it appears that we are now on the verge of large-scale production.

Instrumentation

The importance of instruments in chemical works has never been so obvious as it is to-day. The keeping of records involves maintaining instruments in good order. Many plants are automatically controlled by instruments; and few plants can be operated efficiently unless there are accurate and well-maintained instruments available to show the operators what is going on. All too often instruments are found to be out of order, or not to be reading correctly. From the conferences on instruments that have taken place this year it has become abundantly clear that unless a qualified instrument mechanic is employed on the works, instruments should be regularly serviced by their manufacturers. Moreover, instrument makers should be consulted, in the earliest stages, on the design and installation of every instrument, however simple. The British instrument industry is high in quality, but is perhaps not organised as it should be. There has been a proposal during the year (to which reference was made in our leading article of April 25) that instrument makers should combine to organise production with a view to avoiding dissipation of their efforts. It has been suggested that instrument makers engaged in the manufacture of each type of instrument should form groups to allocate the work between them, that each group should form its own selling agency, and that competent design and research staffs should be established by each group. Sir Frank Smith, speaking at the Joint Conference on Instruments on October 19-20, pointed out that instrument manufacture is essentially a key industry, and that although the British instrument industry is to-day in a much better position than it was in 1914, "in many respects it requires strengthening." A good beginning to 1946 was made by the opening, on January 1, of the Physical Society's exhibition of scientific instruments and apparatus at Imperial College.

Education and industrial recruitment are among the most important of the problems that lie ahead. The increasing complexity of manufacture involves the need for more numerous technical staff and for higher training of operatives. Perhaps the most important educational event of the year was the publication of the Percy Report, discussed in detail in our leading article of November 17. It is not yet known whether its recommendations are accepted by the Government. If the industry of this country is to develop in the way suggested earlier in this review it is essential that we should have more trained technologists and scientists.

Facing the Future

This year has been one of immense importance. Peace, Nationalisation and the Atomic Bomb foreshadow further great toil before this country is rehabilitated and once more back to prosperity; and before the world returns to sanity. For this reason we cannot review our past and our present or muse on the future "as one who sits and gazes on a faded fire, when all the goodlier guests are passed away." Rather must the future be faced with firmness, with bold planning to secure industrial prosperity. We have no illusions and no false modesty; but we do not like to blow our own trumpet. Here then, to conclude, is evidence that we have the ability to drag ourselves out of the mire in which the war has left us. It is a "leaderette" from an American paper published in Michigan. It is headed "Much Credit for England," and it runs thus: "We Americans are smart people. We admit it—and we can prove it if necessary. We made colossal contributions to winning World War II. But there are other smart people on earth. And they made colossal contributions to victory, too. The outstanding spectacular weapons of World War II were radar and the atomic bomb. The English also were pioneers in jet propulsion. They invented and perfected the Bailey Bridge. They designed and built the prefabricated portable harbour which made the invasion of France possible—and successful. They built airplanes second to none in the world. And Sir Alexander Fleming, of London, discovered penicillin, the wonder drug responsible for preserving the lives of thousands of Americans and others in battle. England's accomplishments in World War II are little short of miraculous. It has been frequently said that we saved England. We are not so sure that it was not England that saved us!"

The Heavy Chemical Industry in 1945

by P. PARRISH, F.R.I.C., F.C.S., M.I.Chem.E., F.I.I.A.

Mr. P. Parrish.

WORLD War No. 2 came to an end on August 15, 1945, after nearly six years of unprecedented effort and hardship. How far the end was hastened by the dropping of atomic bombs, or by the declaration of war by the U.S.S.R. on Japan, may never be accurately assessed. It will be recalled that the first atomic bomb exploded over Hiroshima on August 6, and this date is surely significant. "The British people," said the King in his broadcast on the evening of the Allied victory, "have added lustre to the true fame of our islands," and we must make certain that the "peace gained amid measureless trials and sufferings shall not be cast away."

Few can be unaware of the difficulties of the immediate years ahead. Only by labour and a sense of understanding and mutual accommodation shall we be able to arrive at a solution of the many problems with which we are faced to-day. Is the nation likely to be a victim of a contracting economy? Labour is demanding, and indeed receiving, more money every few months. How long can this continue? Is labour responding to these monetary incentives and giving greater production?

The Road to Recovery

The Labour Government may nationalise the Bank of England: it may nationalise the coal mines, and it may contemplate the nationalisation of other services. But it has definite limitations in other directions. It cannot control labour, neither can it alter immutable economic laws. If the British nation in future is to depend for its existence on exports it must be prepared to face competition. It must meet the conditions of work and wages in other countries. If we fail to regain our foreign trade, how can we pay for our imported food, and if we cannot do this, the prospects are indeed gloomy. Our European clients are in reduced circumstances at the present time, and when recovery comes their way, how shall we, with our higher wages and more leisurely conditions, be able to compete?

The Rt. Hon. William Mabane,[1] writing on the subject of "A Policy for Wages," remarked: "In the national interest, no less than in the interests of their members, Trade Unions have the responsibility of persuading their members that the way to a high national income, and to higher real earnings, is to be found only by relating earnings to output. The Russians, be it noted, are in no doubt about the matter, and apply the principle very thoroughly in practice."

The Ammonia-Soda Process

One branch of the heavy chemical industry which is replete with romance is the ammonia-soda industry. It is one of the most secretive: rarely is anything revealed concerning improvements in technique, and only from the U.S. are statistics freely published relating to the manufacture of this product. One sees occasional paragraphs in the technical press that an ammonia-soda factory has started, but learns, a year or so later, that the results have not been an unqualified success. Yet a study of what has been published about the lives of Ernest Solvay, of Rebecq, Belgium, John Tomlinson Brunner of Everton, Liverpool, and Dr. Ludwig Mond, reveals that they were faced at the outset with almost insuperable difficulties in the establishment of the ammonia-soda process. Indeed, it is known that the two partners (Brunner and Mond) worked six days and three nights per week: they slept most of Sunday, when the works were closed: but during the first few months "everything that could break down did break down, and everything that could burst did burst." Mond apparently looked after the manufacture at Winnington, near Northwich, and encountered many difficulties, but finally he overcame them all.

A patent embodying the fundamental reactions of the ammonia-soda process was granted to Dyar and Hemming in 1838, and works were erected in Whitechapel, London. But this factory was not a financial success, nor indeed were other works installed by Muspratt at Newton, or by Gaskell at Widnes. Ernest Solvay was granted an English patent for an improved process in 1863, and two years later erected a works near Charleroi. Soda ash from this works was shown at the Paris Exhibition in 1867. Thereafter the process was gradually improved and developed, and it ultimately ousted the Leblanc process. It was in 1872

that an arrangement was reached with Mond for the working of the Solvay process in England, and this year marked the date of the partnership between Mond and Brunner.

The ammonia-soda process is based on the following reactions:

(1) $NaCl + NH_3 + CO_2 + H_2O = NaHCO_3 + NH_4Cl$;

(2) $2NH_4Cl + Ca(OH)_2 = 2NH_3 + CaCl_2 + 2H_2O$.

Thus, it will be seen that brine is rendered ammoniacal with gaseous ammonia in an absorber, and that CO_2 is passed into the ammoniacal brine to form sodium bicarbonate in the carbonator. Under correct temperature conditions sodium bicarbonate is sparingly soluble in ammonium chloride. The CO_2 for the carbonating process arises from the decomposition of limestone at the lime kiln, mixed with CO_2 from the Thelan pan (calciner), where the sodium bicarbonate is decomposed to produce soda ash (the normal carbonate), by the application of heat. The mother liquor containing ammonium chloride is treated with milk of lime in the distillation unit and the ammonia is cooled and passed to the absorber. There is a base exchange reaction between the milk of lime made in the slaker and ammonium chloride, ammonia is released, and calcium chloride is found in solution in the effluent liquor leaving the stills. Fig. 1 is a diagrammatic representation of the process. It will enable readers to visualise more clearly the foregoing description.

The process, judging by the chemical equations, appears to be a relatively simple one, yet the physical chemist has been called in to determine the conditions of concentration and temperature which allow the following reversible reaction to proceed to completion:

(3) $NaCl + NH_4HCO_3 \rightleftarrows NaHCO_3 + NH_4Cl$.

The practical steps in the process of manufacture may be represented thus:

(a) The manufacture of lime (CaO).
$CaCO_3 = CaO + CO_2$.

(b) The production of ammoniacal brine by absorption of ammonia in the saturated brine.

(c) The carbonation of the ammoniacal brine
$2NaCl + 2NH_3 + 2H2O + 2CO_2 = 2NaHCO_3 + 2NH_4Cl$.

(d) The decomposition of the sodium bicarbonate.
$2NaHCO_3 = Na_2CO_3 + H_2O + CO_2$.

(e) The recovery of the ammonia by distillation with milk of lime.
$2NH_4Cl + Ca(OH)_2 = CaCl_2 + 2H_2O + 2NH_3$.

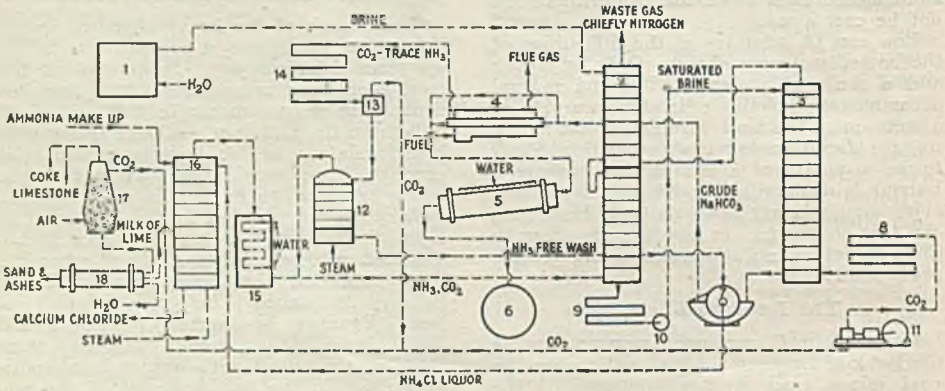


Fig. 1. Manufacture of soda ash by the ammonia-soda process.

1. Brine. 2. Absorber (for ammoniated brine). 3. Carbonator. 4. Calciner (Thelan pan). 5. Cooler. 6. Sodium carbonate storage. 7. Filter. 8. CO_2 cooler. 9. Cooler. 10. Pump. 11. Compressor. 12. Ammonia still. 13. Condensate tank. 14. Gas cooler. 15. Ammonia cooler. 16. Ammonia liquor still (dissociator). 17. Lime kiln. 18. Mechanical slaker.

The materials involved in the production of a ton of soda ash are given below:

Salt	1.5 -1.75 tons.
Coke	0.095-0.11 ,,
Coal (calciners)	0.16 -0.25 ,,
CO_2	1000-1200 cu. ft
Limestone ...	1.2 -1.35 tons.
Coal (for boilers)	0.25-0.5 ,,
Ammonia	4-9 lb., as ammonium sulphate.
Cooling water ...	17,500 gals.

From the above it is seen that from 3.205 tons to 3.9 tons of raw materials are involved per ton of soda ash produced, and these figures must obviously be taken into consideration in selecting a suitable site for a soda ash factory. The immediate question is: why has there been so much difficulty in establishing factories for the manu-

facture of soda ash outside the recognised group? One can only venture an answer to this question. In some cases it is believed that market research has not been pursued adequately; that some factories have not necessarily been located at the best or most ideal sites. It is not enough to ensure precision of design of all the various parts of the plant. It is important that there should be an adequate number of trained men, who appreciate fully what is involved in the various sections of the works.

Special Features of the Process

Some of the aspects of manufacture that call for special attention are (a) best-quality caustic lime should be produced, and the milk of lime should be relatively free from calcium carbonate; (b) the free ammonia should be dissociated completely in the free section of the distilling unit; (c) carbonates should be absent from that section of the still where an interchange is occurring between ammonium chloride and calcium hydrate; (d) the bubbling hoods in the various sections of the distilling unit should allow of a minimum quantity of liquor by being dished, and maximum agitation of the mixed liquors containing suspended matter undergoing ammonia dissociation should be ensured; (e) large manholes should be provided in each section of the bottom portion of the still, in order to admit of easy access for the removal of the incrustations which arise; (f) each step in the process has to be considered separately: each involves input of heat; (g) with too great a temperature reduction ammonium bicarbonate is precipitated along with sodium bicarbonate and, again, too low a temperature produces an unfavourable physical condition of the sodium bicarbonate precipitate, which renders the subsequent washing, in extreme cases, practically unworkable; (h) in view of the limitations indicated, nothing remains but to aid the conversion of sodium chloride into sodium bicarbonate by the influence of mass action, which, under practical conditions, can be achieved by working with a considerable excess of sodium chloride and ammonium bicarbonate, assisted by the sparing solubility of sodium bicarbonate in strong solutions of sodium chloride; (i) the importance of operating with as concentrated a solution of sodium chloride as is possible becomes self-evident; and (j) a special method of working is necessary, in order to avoid undue blockages at the carbonators.

One can now appreciate that the ammonia-soda process is one which not only necessitates considerable precision in the design of the various units of plant, but there must be exactitude in the correlation of the various units of the process. Even with correct plant design it is important that there should be an adequate number of trained men available for starting up the plant, who appreciate what is involved in each stage of the process.

Many questions arise in the organisation of a *large* soda ash manufacturing works. If no attempt has been made to train the personnel, that is, if they have to be recruited from outside, when erecting a new works, at least a nucleus of staff familiar with the process and the unit operations involved should be drawn from an existing factory. Those who are intended for process work should be given an opportunity of witnessing the erection of the plant, and the nuclear staff, in their own interests, and in the interests of the efficiency of the subsequent working of the factory, should explain the meaning and purpose of the equipment. Only in this way will it be possible to disseminate a correct appreciation of what is involved.

In the U.S. the consumption of soda ash[2] has increased from 3,934,000 short tons in 1942 to 4,701,000 short tons in 1944. The four main uses of soda ash are for the manufacture of glass, about 27 per cent.; for the production of caustic soda and sale as bicarbonate, 24 per cent.; for other chemicals, 21 per cent.; and for pulp and paper, about 4 per cent. The production of caustic soda in the U.S. increased from 1,464,000 short tons in 1942 to 1,883,000 short tons in 1944. The demand for chlorine in America became so brisk that authority was given for the erection of electrolytic caustic soda plant, without suitable finishing equipment for caustic soda, but later it was necessary to supply the missing equipment, as it became clear that a balance of the two products could be achieved.

Questions have been raised during the year about the price of soda ash, but where contracts have been arranged prices are actually lower than in 1939, despite the sensibly increased prices of raw materials, fuel, labour and repairs, and maintenance materials. In view of the inactivity of soda ash factories on the continent, it is certain that the demand for soda ash in this country has increased appreciably during 1945. It is learned that the Solvay works at Monfalcone (Italy) have started: that the Varangeville factory near Nancy[3] is now in operation, and that the Lenin Soda Factory at Voroshilovgrad-Oblast (U.S.S.R.)[4] has been partially restored, and is now producing 230 tons of ammonia-soda per day. Before the war this factory produced 400,000 tons of soda ash per annum, or more than half the total production of the Soviet Union.

Aluminium

Although the aluminium industry, in common with other industries, is faced with a difficult transition period, the ultimate absorption of the world's aluminium production, and indeed of increased fabricating

facilities, has been confidently foreshadowed.[5] An Aluminium Development Association has been formed, with the object of intensifying research and increasing the application of the metal to civilian needs.

The T.V.A. method of producing aluminium from clay has been described. This process, using sulphuric acid, obviates the difficulty associated with dissolved iron, which has hitherto been experienced. Calcined clay is reacted with rather less than the quantity of sulphuric acid necessary to combine with the iron and aluminium. The sulphate solution is then separated from the insoluble residues and the iron removed with manganese sulphate and ozone, or alternatively by electrolysis. Silica is next removed by concentrating the solution in the presence of insoluble clay residues. The aluminium sulphate solution is then evaporated to dryness, dehydrated and desulphurised, the SO_2 being recovered as sulphuric acid for re-use in the process. The crude alumina thus formed is finally leached with dilute sulphuric acid and dried to give a substantially pure product. The clay used contains 30 to 40 per cent. of Al_2O_3, 43 to 55 per cent. SiO_2, and 0.5 to 1.8 per cent. Fe_2O_3. After iron removal the Fe_2O_3 content is reduced to 0.05 per cent., while the silica treatment reduces this impurity from 0.26 to 0.08 per cent.

It is reported[6] that the activities of the International Aluminium Co., Ltd., have been drastically reduced, as a result of the termination of the war. The alumina works at Hebburn-on-Tyne have been closed and it is doubtful whether production can be resumed economically.

Barium Compounds

The preparation of barium chloride from barytes has been effected commercially by either of the following processes: (1) Coke is mixed in equal proportions with the ore and the mass heated to 600°, and gaseous hydrochloric acid or chlorine is then passed through the furnace (U.S.P. 1,167,061). (2) Barytes is reduced to the sulphide and then treated with fused calcium chloride in an atmosphere of chlorine or hydrochloric acid (Russ. P. 27,048).

These and various other methods have been investigated[7] in the laboratories of the Indian Council of Scientific and Industrial Research, with the result that a new process has been evolved and put into large scale operation by the Mettur Chemical and Industrial Corporation, of Mettur.

A finely-divided mixture of barytes and coal is fed to a furnace, together with a small proportion of a flux, and maintained at a temperature of 1000-1050°. The mass is mechanically agitated for about 4 hours, when 90-95 per cent. of the barium sulphate is reduced to BaS. The sulphide is then extracted by leaching with boiling water and the solution, heated to 90°, is chlorinated in closed vessels. The chlorine reacts not only with the barium sulphide, converting it to barium chloride and sulphur, but it also forms hypochlorous acid, which causes oxidation of some of the BaS to $BaSO_4$. Barium chloride of 99.94 per cent. purity is recovered by evaporation and crystallisation, while sulphur (approximately 190 lb. per ton of barium chloride) is obtained as a by-product

Calcium

An interesting addition to the list of new metallurgical processes is the production of high-purity calcium by thermal reduction of CaO in vacuo.[8] The method, which is based on the Pidgeon magnesium process, was originally developed as the result of a substantial demand for calcium hydride, to be used as a convenient and portable source of hydrogen for the inflation of weather balloons. The reducing agent found to be most satisfactory is aluminium powder. This material, mixed with calcined lime, is briquetted and fed to regenerative type automatic reversing furnaces, fired with producer gas. The retorts in which reduction and distillation take place are constructed of nickel-chromium alloy, and extending through the furnace walls are the cold ends, in which the metal is condensed. These "cold ends" are of mild steel, and are provided with a water jacket. For the purposes of the vacuum system the retorts are joined by headers into groups. Calcium is liberated in the hot section of the retorts, which are operated at about 1200° C., and passes to the cold end by diffusion, where it condenses from the vapour to the solid phase. The operating cycle may vary from 8 to 24 hours. The metal is removed from the condensers in the form of hollow cylinders of crystalline metal, having one closed end. The product contains 98-99 per cent. calcium, the chief impurities being magnesium and aluminium.

Calcium Carbide

Calcium carbide finds its largest outlet in this country as a source of acetylene for gas welding. It is also used in the chemical industry for producing acetylene as a raw material for certain chlorinated solvents and in the production of such plastics as polyvinyl chloride. Where cheap electric current is available, the range of products using acetylene derived from calcium carbide is more extensive and includes acetone and acetic acid, calcium cyanamide and synthetic rubber. In the early stages of the war, when acetone required for the manufacture of cordite was in very short supply, a plant sufficiently large for the entire requirements of the country was designed to produce calcium carbide from the indigenous materials, coke and lime.

stone.[9] The erection in South Wales and successful operation of this plant, in spite of war-time difficulties, constitutes an outstanding achievement in the chemical engineering history of the country. The plant incorporates three large electric arc furnaces, fitted with 4-ft. diameter Söderberg self-baking electrodes. These electrodes, in operation, carry a load of about 80,000 amperes.

The production rate is of the order of 100,000 tons per annum, and the current consumption is about 3300 kWh per ton. As the coke requirement is 0.9 ton per ton of product, the plant is conveniently situated in relation to the coke ovens of South Wales. Limestone is calcined in rotary kilns, the original installation, consisting of three kilns 8 ft. diameter by 128 ft. long, being fired by pulverised coal. The plant was extended subsequently by the erection of a larger kiln, 9 ft. diameter by 178 ft. long. Approximately 5 tons of burnt lime are produced per ton of coal consumed.

There appears to be every reason for optimism regarding the ability of post-war industry to absorb the output from this plant. In fact, a considerable increase in capacity would be necessary to supply the requirements of acetylene from home-produced carbide.

Cyanamide

A new method for the manufacture of cyanamide, which obviates the intermediate production of calcium carbide, has been investigated. The process consists of treating calcium carbonate, or a mixture of calcium and magnesium carbonate, with ammonia and carbon dioxide at high temperature. Using finely-divided calspar and a reaction temperature of 800°, and with a gas mixture containing 95 per cent. ammonia and 5 per cent. carbon dioxide, a cyanamide yield of 92-94 per cent. was obtained. Much lower yields resulted from the substitution of ground limestone for the calspar, this being attributed to the decomposition of ammonia by the catalytic influence of traces of iron oxide present in the limestone. This adverse influence can readily be obviated, however, and the process shows definite promise of successful industrial application.[10]

Cyanamide is becoming increasingly important as a raw material in organic synthesis. It is a crystalline solid, extremely soluble in water, very soluble in alcohol or ether, but only slightly soluble in benzene or petroleum ether. It melts at 42° and polymerises with explosive violence when heated to 150°, with the formation of its trimer, tricyantriamide or melamine. In strong acid solution it is hydrolysed to urea. Although this method is now seldom used for the production of urea, the acid hydrolysis is important since, in many respects, it is similar to the reaction of cyanamide with dry alcohols in the presence of acid. These reactions lead to the formation of salts of the substituted isourea ethers which, in turn, produce a number of important derivatives.

Dicyandiamide is the starting point for the so-called melamine resins. It is also used in the production of guanidine compounds, guanylurea, barbiturates, and many other chemicals. One of the best-known of the guanidine compounds is the nitrate which is formed by heating dicyandiamide with two molecules of ammonium nitrate and anhydrous ammonia under pressure. Guanidine nitrate has become an important industrial and military explosive, much of the value of which lies in its comparatively low explosion temperature.

The manufacturing process for dicyandiamide comprises essentially three main steps: (1) the preparation of a free cyanamide solution by the extraction of commercial calcium cyanamide, (2) polymerisation of the solution, and (3) crystallisation and drying of the finished product. Polymerisation is effected in conversion tanks equipped with steam heating and water cooling coils. The reaction is started by steam heating to 165°, the *p*H of the solution being 8.50. The temperature then rises spontaneously to 180° or more, owing to the exothermic nature of the reaction, and it is necessary to use cooling coils and maintain the temperature at 170° for two to three hours. The hot liquor is then filtered and pumped to vacuum crystallisers.[11]

Glass Manufacture

Window Glass, Glass Bottles, Tumblers and Household Glassware. The destruction of glass during the war years in this and other countries was colossal. Clearly, there is now an unusual demand for this commodity. This demand extends not only to European countries, but to many parts of the world. It is desirable, therefore, that a few words should be said on the manufacture of glass, which is essentially a chemical industry, although it is a highly specialised trade, and skilled mechanical engineers are a necessity.

Raw Materials. The chief raw materials for window and bottle glass are sand, soda ash, and lime. The mixture from which colourless glass for automatic machine operation is made contains: sand (iron oxide less than 0.03 per cent.), 100 parts; soda ash, 33-40 parts; salt cake, 10-15 parts; burnt lime, 10-13 parts; white arsenic oxide, 0-0.2 part. In addition, 30-60 parts of cullet are added. To neutralise the greenish tinge of even small amounts of iron oxide, a decoloriser is added, containing essentially the element selenium with cobalt oxide, on an average about 0.05 oz. to 0.1 oz. of the former, and 1/120 oz. of the latter, per 100 parts of sand.

An increase in the lime content and reduction in the soda content increases the rate of setting of the glass, and hand-made bottles usually contain more lime and less soda than the machine-made ones. An increase of soda reduces the resistance of the glass bottles to the action of water or fluid preparations placed in them, and the bottles or jars should not contain more than 18 per cent. of soda. Milk bottles and food containers which have to be processed under steam pressure should not contain less than 17 per cent.

Fig. 2 gives a diagrammatic layout of a plant for the manufacture of window glass, where three methods of drawing are represented. One is by the well-known and popular Fourcault process; another by the Colburn process; and the third is the continuous sheet process.

Tanks and Pots. Where glass is prepared in significant quantities, regenerative furnaces are used and the glass is contained in a large tank, instead of in pots, which are employed where lesser quantities of glass are involved. Pots are usually made by the glass manufacturer. As they have to withstand a temperature of about 1000°C. over many months, the greatest care has to be exercised in their preparation. Special fireclay is used together with a certain amount of grog. The mixture is kneaded in an established way. The pot maker is a craftsman, and follows an established technique in the construction of the pots, which are left for from three to twelve months at ordinary temperature. The covered "duckhouse" pot appears to be favoured for lead glass, as protection from contamination by particles of carbon or reducing gases is essential.

There has been a considerable advance in the building of tanks during the last few years. Generally speaking, tanks are built 12 ft. or so above the floor level on a substantial steel framework, and strong steel joists are used at predetermined centres, on which the "Coreheart" blocks rest. These blocks normally come from France, although during the war years they have been supplied by America. No attempt is made to join the "Coreheart" blocks. They should be fabricated with almost mathematical exactitude as regards shape, and they are rubbed together and fit like a globe. Any minute spaces are filled in time with glass, which solidifies and renders the floor of the tank tight. The tank sides and arches are built of silica bricks, using a silica cement supplied in plastic form. The complete

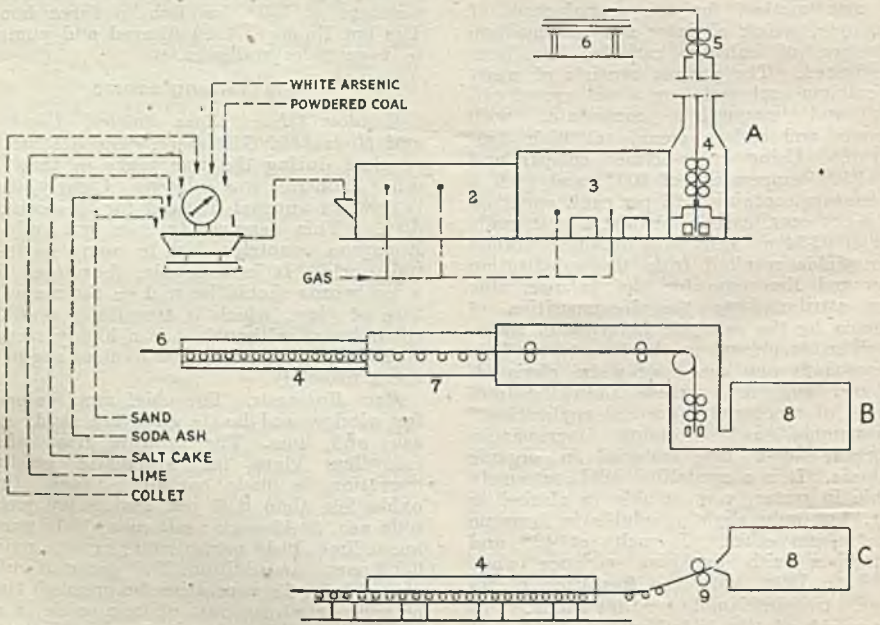


Fig. 2. Manufacture of window glass.

(A) Fourcault process, vertical. (B) Colburn process, horizontal. (C) Continuous process, horizontal 1. Weighing machines. 2. Melting furnace. 3. Drawing chamber. 4. Annealing oven (lehr). 5. Drawing roll. 6. Cutting table. 7. Flattening table. 8. Fused glass tank. 9. Forming rolls.

setting is securely braced, in order to withstand heavy stresses, and generally certain parts of the bracing are adjustable.

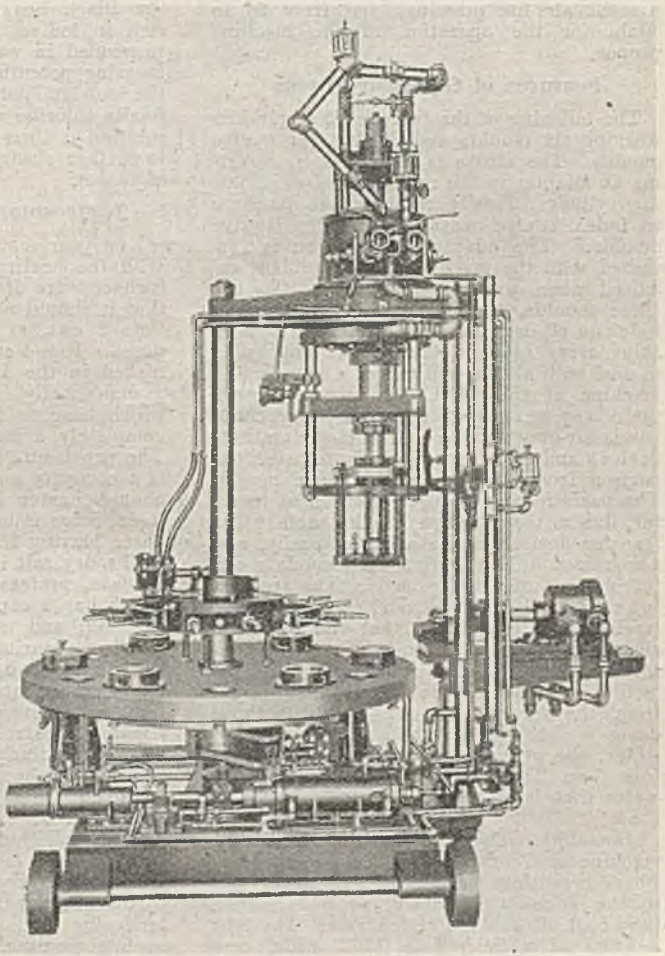


Fig. 3. Lynch Corporation pneumatically driven medium-duty press, P.B.M. model, for making glassware.

(By courtesy of British Hartford Fairmon Syndicate, Ltd.)

Producer-gas and oil firing, or both, are used. Generally, the Siemens type of furnace, or some modification, is employed, and advantage is taken of the regenerative principle to economise heat. Given correct continuous working, there is no reason why a tank should not serve for three years. When the renewal period arises it is not necessary to reconstruct the complete tank. Generally, the side and end walls, as well as the arches, will be in tolerable condition, but may need a certain amount of repair; but the floor of the tank will need to be renewed completely. Tanks are built of varying capacities in this country; an economic unit may be regarded as one manufacturing from 20 to, say, 40 tons of glass per day.

The feeder has a forehearth attached to it, which joins up to the straight face of the tank. The glass flows from the furnace into the forehearth, and is extruded through an orifice by a plunger, or needle, which rises and descends above it. Shears, fixed below the orifice, sever the extruded glass, which falls into the mould below.

Modern Bottle-Making. In the compressed and blown machines the complete parison (with neck) is made by a plunger, which descends into the molten glass contained in the mould. It is then lifted out mechanically from the parison mould, transferred to the finishing mould and blown up to size by compressed air of about 40 lb. pressure. Fig. 3 shows a pneumatically driven medium-duty press, P.B.M. model. This press will make all kinds of glassware, such as tumblers, jellies, table-ware, mixing

bowls, beer mugs, lemon reamers, etc. Generally, these machines are pneumatically driven, and of the intermittent motion rotation type, requiring from 40 to 45 lb. compressed air for pressing, and from 25 to 30 lb. for the operation of the machine proper.

Features of Glassware Press

The indexing of the table is 60 deg. when working six moulds and 30 deg. for twelve moulds. The stroke is shortened by inserting an adapter in the rear head of the rotating cylinder, thus permitting the machine to index twelve ways for working twelve moulds. The adapter in question is furnished with the machine, and should be removed when working six moulds. To use three moulds, the machine is arranged to index to 60 deg. (or six stations), and then skips every other station. It is impossible to deal with all the features of a complicated machine of this kind, but some other of these may be named: the pressing mechanism is air-operated, as indeed is the transfer device, and it is arranged to transfer the parison from blank mould to blow mould. The parison is in a raised position at transfer, due to the cam beneath the table. The transfer device can be adjusted easily, and also raised or lowered to accommodate different sizes of articles made. The transfer jaws are easily changed, and accessible. The machine is designed so that the overhead clearance is sufficient to admit the feeder forehearth to be extended out over the mould and the gob to be dropped direct from the feeder into the mould, without using a shoot. The plunger is cooled by water, the pressure of which should not be less than 25 lb./sq. in. Soft water, or water that is chemically treated, should be used.

Annealing. The hot bottles from the machine are conveyed, either by hand or, where conditions admit, by a conveyor belt to the annealing furnace, or lehr, where they cool off at a regulated rate. The lehr consists of a belt, 4 to 12 ft. wide, continuously travelling along a chamber, or tunnel, about 70 ft. long. At the front, where the bottles are inserted, is a combustion chamber, about 20-22 ft. long, providing a zone sufficiently hot (550-600° C.) to remove any stresses in the glass, previously introduced by chilling. The hot zone is heated by gas or oil burners, but by thorough heat insulation the heat applied externally can be reduced, as in the Hartford-Empire lehr, to a very small amount, the temperature being maintained by the bottles, which are very hot (650-700° C.) when they leave the machine. Sorters and inspectors stand at the cold end of the lehr, carefully but quickly inspecting every bottle, and rejecting defective ones.

In a discussion of the possibilities of a revival of the Scottish seaweed industry, reference has been made[12] to a method for the recovery of iodine that is used in Russia. A red seaweed, which grows abundantly in the Black Sea, and which is particularly rich in iodine, is used. This is chopped, suspended in water and electrolysed at increasing potential. Iodine separates out at the lowest potential, then bromine and finally chlorine at the highest potential. The solution is then concentrated and subjected to further electrolysis, yielding mannite and alginates.

Hydrochloric Acid and Salt Cake

Last year some of the problems connected with the heating of a mechanical salt-cake furnace were discussed. It was pointed out that it should not be necessary to use more than 2 cwt. of oil per ton of salt decomposed. Fig. 4 supplements the drawing furnished in the 1942 review, and shows diagrammatically the auxiliary provisions which have to be made in order to equip completely a mechanical salt-cake furnace. The provision of hot air for drying the salt is a necessity and for this purpose an interchange heater has to be provided. The interchange is between cold air and the fuel gases leaving the mechanical salt-cake pot.

The dry salt is elevated to the top of the furnace, preferably accummulated in a silo which has a capacity of six to eight hours' working, and is then conveyed to a volumetric measuring device, the volume of salt being controlled by a damper. The salt can be measured and weighed for a period of time, determined by a stop watch, and this has to be correlated with its chlorine content. Similarly, the 96-98 per cent. sulphuric acid has to be measured through a Rotameter and the two must be carefully synchronised.

Again, the hot salt cake being discharged continuously from the furnace must be crushed and cooled, and this is best effected by discharging it into a rotary drum and introducing cold air, counter-current, as the cooling medium. Lest there should be entrainment of the finer particles of salt cake, a cyclone has to be arranged for arresting the dust. The crushed salt cake is then elevated from the cellar to silos on the ground floor, and these are arranged for loading in bulk, or the filling of bags, as may be desired.

The production of hydrochloric acid, 28° Tw., in this country increased from 179,000 tons in 1939 to 236,000 tons in 1944. The quantity made electrolytically increased by slightly more than 4 per cent., and constituted about one-third of the total acid manufactured in 1944. About one-third of the total quantity of hydrochloric acid was used for the pickling of iron sheets.

The next use, in point of importance, is for the production of chemicals, and the

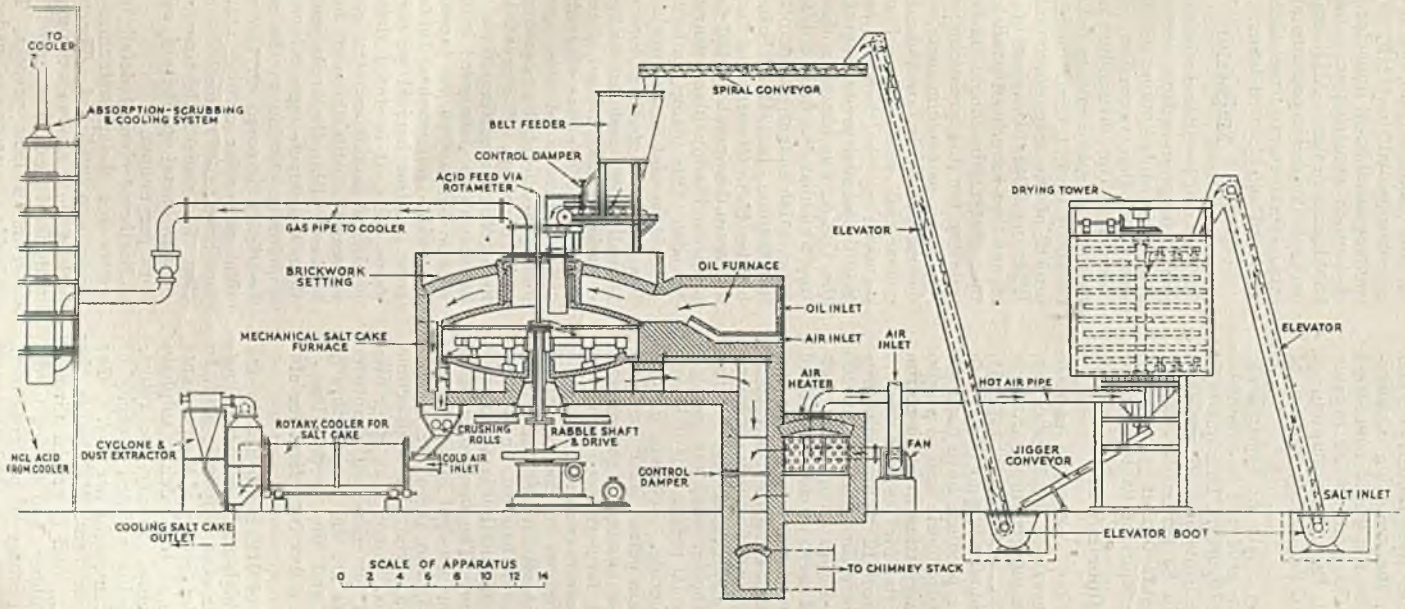


Fig. 4. Parrish type mechanical salt-cake furnace, with auxiliary equipment.

requirements of the dye industry stand third. Presumably, the reduction of nitrobenzene to aniline by the use of iron swarf and hydrochloric acid, and similar organic reductions, account for a consumption of about 10 per cent. of the total production of hydrochloric acid.

It is possible to calculate the approximate quantity of salt cake produced in this country from the above figures. This quantity, basing on salt cake containing 97 per cent. Na_2SO_4, and on an 85 per cent. recovery efficiency in the manufacture of hydrochloric acid, cannot be far short of 100,000 tons.

Hydrofluoric Acid

During the past few years, and particularly since the outbreak of the Pacific war, the fluorine products industry in the U.S.A.[13] has developed with remarkable rapidity. The chief factors contributing to this rise in demand for fluorine products have been the use of anhydrous hydrofluoric acid as a catalyst for producing alkylation aviation petrol, and as a raw material for the manufacture of the Freons. Freon-12 (difluorodichloromethane) has for some time been the principal product in the Freon group of refrigerants, but it gained new prominence about two years ago, when it was used for the first time as the propellant for aerosol insecticide bombs. About 8000 tons of anhydrous hydrofluoric acid were produced in 1944 for this purpose alone. Incidentally, the catalyst used in the commercial production of Freon-12 is antimony trifluoride. In the production of alkylation aviation petrol, AHF has been found to possess a number of advantages over sulphuric acid, formerly used as a catalyst. Higher temperatures can be employed, thus permitting the use of cooling water, and avoiding refrigeration. Further, there is no acid sludge to be handled, and the recovery of AHF by distillation is a comparatively simple matter. The first commercial AHF alkylation unit was put into operation in December, 1942, and there are now 27 plants in operation, producing high-octane spirit by this means. Among the other uses which have called for increased quantities of fluorine products are the manufacture of artificial cryolite and the preparation of lithium fluoride as a flux ingredient for aluminium welding.

The production of HF is effected by the decomposition of high-grade calcined fluorspar with 98-99 per cent. sulphuric acid. In the latest plants, the feeding of the reactants and the discharge of the calcium sulphate residue are continuous. Rotary steel retorts are used, each having a rated capacity of 6 tons of 80 per cent. acid per day. Gas containing 70-75 per cent. HF leaves the stills at 250-350° C., and is passed through a cyclone and scrubber, and thence to the absorption system, where 80 per cent. acid is produced. This aqueous acid is conveyed in tank wagons to another works, where it is concentrated to AHF. The distilling columns are 3 ft. in diameter by 10 ft. high, of copper construction, and conventional bubble-cap design. AHF boils at 67.8° C., under atmospheric pressure and it is necessary, therefore, to cool the condenser by means of refrigerated brine.

Magnesium

There can be little doubt that the production of magnesium from sea-water is one of the major contributions of the chemical industry to the war effort of the United Nations. The outstanding achievement of British enterprise in this field has been revealed by C. J. P. Ball[14] in his survey of the growth of the magnesium industry between 1924 and 1945. In view of the conflicting claims that have been published it is opportune that credit should be given to British industry for first producing, in any part of the world, magnesium metal from sea-water-derived magnesia, or indeed for the first commercial production of magnesia from sea-water by the dolomite process. Up to 1940 the annual production of magnesium in the U.S.A. was less than that of this country, which at the end of 1943 had reached a potential annual output of approximately 33,000 tons. In 1941, M.E.L. was requested by the U.S. Government to design, build, and train the operating staff for a magnesium metal and alloy plant near Boulder Dam, Nevada. This plant, the largest magnesium production unit in the world, was designed for an output of 50,000 tons of metal alloys annually, and produced its first metal in the remarkably short period of ten months from the day the site was cleared.

The pressure of the war period has greatly accelerated research in the development of alloys of increased strength and high purity, resulting in the production of metals which, compared with those available to industry in the pre-war years, show remarkable improvement in corrosion-resistance and mechanical properties. As regards costs, it is stated that alloys can be produced in this country at prices closely comparable with those of foreign competitors and within the limits required to enable them to compete on a volumetric basis with aluminium. Owing to the severe war-time restriction imposed on the sale of magnesium alloys for civilian use, markets will now have to be re-created and it is unlikely that, for some little time, the production of new metal in Britain will exceed 4000 tons per annum.

Further technical details of certain processes for the manufacture of magnesium have been published. The plant at Painsville, Ohio,[15] produces the metal by the electrolysis of fused magnesium chloride by the well-known Dow process. The magnesium chloride, however, is made from dolomite

as an adjunct of the ammonia-soda process, and the chlorine from the Dow cells is used to produce stable solid calcium hypochlorite. The plant was designed to take maximum advantage of existing ammonia-soda plant and technique to make use of the lime value of the dolomite in the alkali operations. The dolomite is first calcined so as to produce a tail-gas having a high (40 per cent.) CO_2 content. The dolomite lime is then hydrated and treated with ammonium chloride to form a slurry containing magnesium hydroxide, calcium chloride, and sodium chloride, the ammonia being driven off by steam and returned to the ammonia-soda plant. After removal of excess sodium and calcium chlorides, the slurry is carbonated by treatment with part of the tail-gas from the kilns. Further treatment, involving thickening and filtering to remove the precipitated calcium carbonate, results in a solution containing about 10 per cent. of magnesium chloride and some sodium chloride. Evaporation to a magnesium chloride concentration of 35 per cent. precipitates the sodium salt, and magnesium chloride after evaporation to dryness is suitable as a feed to the Dow cells.

Some idea of the magnitude of the operations involved in the production of magnesia in modern plants may be gathered from a description of the Dow cells, given to the (U.S.) Electrochemical Society.[16] These cells are rectangular steel pots, 6 ft. deep, 5 ft. wide and 11 ft. long, and contain approximately 10 tons of molten salts. In recent plants they have been arranged in pot lines, each containing 108 cells. Each line has a nominal capacity of 100,000 lb. of metal per day. The rated load is 60,000 amps. and at an electrode spacing of 1.5 in. the voltage is 6.3 v. per cell. The power requirement is 8 d.c. kWh per lb. of magnesium. One of the features of the Dow cell is the use of external heat to maintain the temperature of the bath at 700° C. The use of external heat provides a desirable flexibility where power is neither steady nor cheap.

A new process for producing magnesium chloride from Texas dolomite has been described.[17] Calcination of the mineral is followed by wet-slaking, to produce the hydrates of calcium and magnesium. The calcium hydroxide is then preferentially carbonated to calcium carbonate, thus allowing the magnesium hydroxide to be selectively neutralised by hydrochloric acid.

Manganese

A comparatively recent addition to the list of electrochemical industries is the electrodeposition of manganese and its compounds. The production of both metallic manganese and manganese dioxide by the electrolysis of manganese sulphate solution has been developed on a commercial scale during the war years, largely to meet the heavy demands for manganese dioxide in the manufacture of dry batteries. Although the simultaneous deposition of metallic manganese and the oxide at the cathode and anode respectively is possible, the optimum conditions for producing the metal are not the same as those for the production of the oxide if good current and power efficiencies are required. The commercial development of the two processes has therefore been carried on by unrelated organisations.

A process for producing manganese dioxide, with particular reference to anode corrosion, has been described by Storey, Steinhoff and Hoff.[18] The deterioration of the anode is a cause of some concern, as this constitutes a serious item of cost in the electrodeposition of manganese dioxide as now practised. The electrolyte used in plants now in operation contains at least 150 g./litre of manganese sulphate as originally prepared. The manganese sulphate content decreases and the H_2SO_4 content increases as electrolysis proceeds, and the spent electrolyte contains up to 50 g./litre of sulphuric acid. It is then necessary to restore the manganese sulphate content by the leaching of either manganese carbonate ore (rhodochrosite) or the lower oxide of manganese. Experimental work has been undertaken, using low-acidity electrolytes and varying current densities, with a view to minimising anode disintegration.

Nitrogen for Ammonia Synthesis

In the production of nitric acid by the catalytic oxidation of ammonia, the residual gas, after absorption of an economic proportion of nitrogen oxides, contains approximately 95 per cent. N_2, with 3-3.5 per cent. of O_2 and 0.3 per cent. NO_2. The removal of oxygen and nitrogen oxides by reduction with hydrogen produces almost pure nitrogen. Successful experiments along these lines led the Consolidated Mining and Smelting Co. of Canada, Ltd.,[19] to build a full-scale plant to meet an increased nitrogen demand, occasioned by war-time expansion of synthetic ammonia production. One of the most important considerations in using such a source of nitrogen is the possible corrosion of the ammonia synthesis equipment by nitrogen oxides. The plant has been in operation for three years, however, without the least evidence of corrosion beyond the burner. Copper, in the form of bundled heavy-gauge wire, is used as the catalyst, the optimum reaction temperature being 600-650° C. From 3 to 5 per cent. of excess hydrogen is used and the gas produced has the average composition per

cent.: N_2, 95; A, 1; H_2, 4; O_2, 0.1; NH_3, 0.01; p.p.m.: NO, 10; CO, 15; CO_2, 15.

Potassium Perchlorate

The production of potassium perchlorate by a continuous electrolytic method that has been in successful operation for over a year has been described.[20] The first stage in the process is the electrolytic conversion of sodium chloride to chlorate. This is effected in cells having graphitic anodes and steel cathodes. The cells operate at a temperature of 45°, with an anode current density of 30 amps./sq. ft. and a cathode current density of 50 amps./sq. ft. With an amperage of 2500 the voltage per cell is 3.0 to 3.5, and the current efficiency is of the order of 75 per cent. During the electrolysis the cell system is cooled and the *p*H is maintained by adding dilute hydrochloric acid. The liquor is circulated through the cell system by a pump, which is equipped with a proportioning device, the object of this being constantly to remove a portion of the liquor, equal to the volume of new liquor added to the system. The liquor so removed is withdrawn to a surge tank, where graphite particles, etc., are settled out. The supernatant chlorate liquor is then filtered and crystallised, the mother liquor being returned to the cells, together with fresh sodium chloride solution. The crystals are finally washed and dried and the product (99.5 per cent. sodium chlorate) stored in readiness for the second stage.

The perchlorate electrolysis system is similar to the chlorate system, although the volumes handled are much smaller and the cell characteristics somewhat different. Steel is used for the cathodes, but the anodes are of platinum. The optimum cell temperature is 65°, with anode and cathode current densities of 250 and 140 amps./sq. ft. respectively. The cell voltage is 5.5-6.0, and the amperage 2500, while the current efficiency is from 90 to 92 per cent. The concentrated sodium perchlorate solution from the cells is treated with filtered potassium chloride solution and the potassium perchlorate crystals thus precipitated are removed by centrifuging and washed. Sodium chloride is separated from the mother liquor by concentration in an evaporator, and this is returned to the first stage of the process. The washed potassium perchlorate crystals are finally dried to give a white granular product containing approximately 0.03 per cent. moisture.

Sulphur and Sulphur Materials

From time to time it is essential, in the interests of the nation's economy, and from the change of circumstances arising over a period of years, that a survey should be made of the raw materials used in certain basic industries, to determine whether some reorientation would not be desirable. Such a survey would be justified at the present time, as it is believed that certain metallurgical gases could be converted to sulphur suitable for contact sulphuric acid plants. This would reduce the quantity to be imported from Texas Gulf (U.S.A.), and generally would be a sound procedure when it is desired to avoid unnecessary purchase of dollars.

I.C.I.-Boliden Process

The author referred briefly in his 1938 review in THE CHEMICAL AGE to several processes. The one which is now esteemed the most highly is the I.C.I.-Boliden process, where the SO_2-containing metallurgical gases, after being cleaned and cooled, are absorbed in an aqueous solution of basic aluminium sulphate. Generally, there are three or four absorbing towers arranged in series, and a countercurrent system is established. At the foot of each absorbing tower the liquor is cooled prior to recirculating to the next tower. All the SO_2 except 0.2 per cent. is arrested and the escape can be reduced still further by using a larger absorbing surface. The absorbent solution is prepared by precipitating gypsum from a solution of aluminium sulphate by means of ground limestone. Special instructions in the preparation of the absorbent solution have to be observed. The composition may vary over a wide range: a high degree of stability can be ensured if the recommended composition is arranged. Phosphoric acid is added as a stabiliser.

The SO_2-charged liquor is heated by interchange with the regenerated liquor and SO_2 is readily recovered. The SO_2 is reduced to sulphur by the Boliden process—essentially a direct reduction one. Fig. 5 indicates the general arrangement and speaks largely for itself. In the preheater the direct gas is preheated to 250-300°C. and the reduced gas is cooled correspondingly. The producer is of standard type, modified as regards certain features. The shell is of mild steel, lined with refractory brick, and a special inlet for by-pass gas is provided near the top. The preheated direct gas enters the producer through the rotating grate. The ash is discharged through a water seal, suitably constructed to deal with high gas pressure, and the coke bed is deeper than usual. Special coke-charging gear is provided, equipped to prevent escape of reducing gases into the producer gas. Hot gases leave the reducer through a large brick-lined pipe carrying a stack, closed by a flap valve. On addition of the by-pass gas the oxygen content of the latter is rapidly consumed and a sensible rise of temperature occurs before the gas enters the first catalyst chamber. There are two catalyst chambers, of similar construction, interconnected by a large vertical "U" to admit of some air-cooling of the

gas. Each catalyst chamber is divided into two sections by a division wall having a gas passage near the bottom. The catalyst, this is unfortunate, to say the least, because the first consideration should be to burn indigenous sulphur material, such as spent

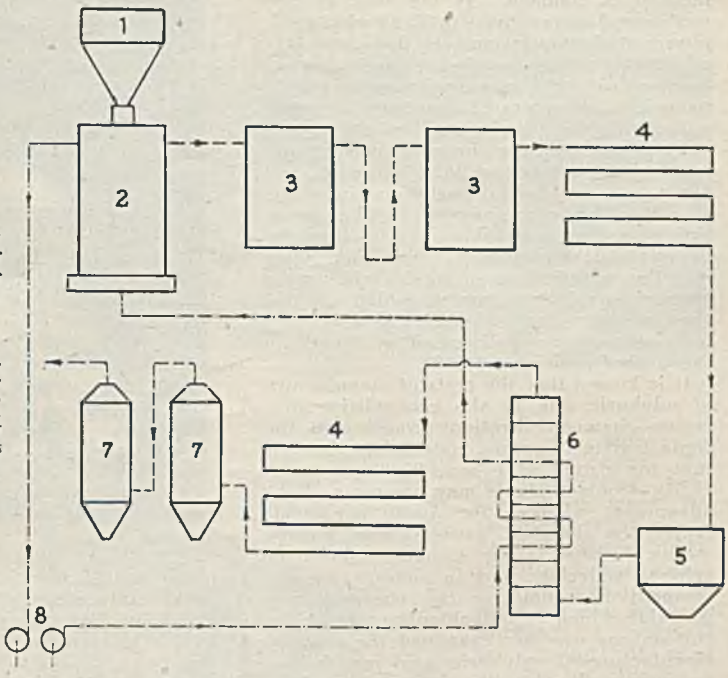


Fig. 5. Direct reduction of sulphur dioxide to sulphur (I.C.I.-Boliden process).

1. Coke hopper. 2. Producer - reducer. 3. Catalyst chamber. 4. Cooler. 5. Cyclone dust extractor. 6. Preheater. 7. Sulphur precipitators. 8. Fans

which is covered by a patent, consists of pieces of mixed ferric and aluminous oxides, arranged to form a chequerwork inside the catalyst chamber.

The gas temperature is reduced by means of air-cooling prior to entering the preheater. Dust-free coke should be used as far as possible. The gases are further cooled in a large sheet-iron serpentine cooler, and the separation of the liquid sulphur begins. Further cooling occurs in two electrostatic precipitators arranged in series. Almost complete separation of the extremely fine sulphur droplets is achieved in this way. Liquid sulphur from the cooler and from the precipitators flows to steam-jacketed catch-pots, from which it is discharged into small trucks. Automatic control of gas rates, composition, etc., is arranged and there is continuous analysis of the various gases.

Sulphuric Acid

It has been announced recently that before the war (1939) 37 per cent. of the total acid produced in this country was manufactured by the contact process, whereas to-day 50 per cent. of the acid manufacturing capacity resides in contact plants.

Practically all the contact plants use brimstone as the raw material. In these days oxide. It is a pity that this material should be accumulating at various points throughout the country. It is true that endeavours are being made to use spent oxide along with brimstone at certain contact plants, with a reasonable measure of success.

It might well be that some solvent process of extraction should be installed for recovering sulphur from spent oxide. Carbon bisulphide could be used, but the sulphur recovered would be dark in colour and would have associated with it hydrocarbons to the extent existing in the spent oxide. Dark-coloured sulphur could be used in existing burners at contact sulphuric acid plants without much disability. The tarry matter would possibly be partially burnt and partially volatilised; but if secondary combustion chambers were used, provided with plenty of incandescent brickwork, the volatile hydrocarbons, impinging, as they would, on the hot surfaces, would burn to carbon dioxide. The reduction in concentration of SO_2 by CO_2 would be relatively small, and poisoning, if any, by arsenic would be negligible. Indeed, the percentage conversion should not be sensibly affected.

Surprise has been expressed that the tonnage of sulphuric acid manufactured during the last six years constitutes only a relatively slight increase on the quantity pro-

duced in the pre-war period. The figures are given below (Table 1).

Clearly, two factors account for the small increase of tonnage. As far back as 1936 consideration was given to the nation's sulphuric acid requirements in the event of a major crisis. It was then agreed that all spent acids should be denitrated and subsequently concentrated in cast-iron pot stills. It was early realised that this method would ensure the most efficient and economical recovery of sulphuric acid, and obviate additional importation into the country of brimstone or other sulphur material, at a time when shipping was likely to be taxed to the uttermost. The other factor was the manufacture of nitric acid by the ammonia oxidation process, which avoided the necessity for sulphuric acid. Both these aspects were discussed at length in the author's review of 1939.

It is known that the costs of manufacture of sulphuric acid by the two existing processes—chamber nitration process and the contact system—approximate fairly closely: that for strong acid—say, 90-98 per cent. H_2SO_4—contact plants may possess a slight advantage, whereas for 70-80 per cent. H_2SO_4 the chamber process may possess merits, because it has a greater choice of sulphur materials, and in times of severe competition would use the cheapest raw material, which is undoubtedly spent oxide. But no one who has examined the costs of manufacture of sulphuric acid can fail to be impressed with the importance of so designing plant and arranging sales that maximum productive capacity is maintained at all times. In the five years 1935-39 inclusive, which may be regarded as normal years, the percentage of capacity in use was 77.36 per cent., whereas during the 5½ years of the war, for which figures have been given, it reached 78.8 per cent. Why should not a constant productive capacity of 90 per cent. be attained, and what a difference this would make to the cost of manufacture per ton!

It is important to note that anhydrite re-

placed sulphuric acid to the extent of approximately 458,500 tons of 100 per cent. H_2SO_4 in 1944. This is a computed figure, from information supplied by Lord McGowan.[22]

Imperial Smelting Corporation, Ltd., in 1942 produced over 239,000 tons of sulphuric acid, and 75,650 tons of zinc. This represents one of the largest—if not the largest—productions of acid in the country.[45]

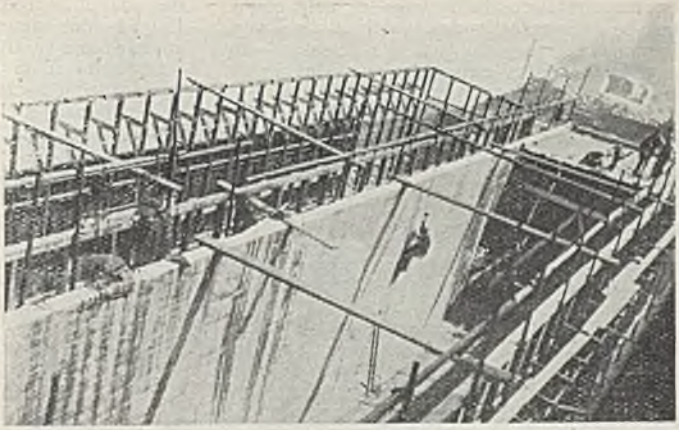
The manufacture of sulphuric acid during the last six years, particularly in the period September, 1940-April, 1941, and again from June 13, 1944, to March, 1945—the period of the flying bombs and rockets—was anything but an enviable task. All sulphuric acid plants (chamber type) are vulnerable: those with rectangular chambers cover a considerable area, and are partieu-

TABLE 1.[21]
PRODUCTION OF SULPHURIC ACID AND CONSUMPTION OF RAW MATERIALS (Tons)

Year	100 per cent. H_2SO_4			Pyrites and others*	Spent oxide	Brimstone and H_2S	Zinc concentrates
	Chamber and contact	Chamber only	Contact only				
1935	936,300	689,300	247,000	371,400	156,500	50,900	126,500
1936	1,043,100	734,500	308,600	404,100	161,200	61,200	160,900
1937	1,100,000	757,400	342,600	405,200	165,100	82,000	158,800
1938	994,700	651,400	343,300	364,900	146,200	74,500	141,600
1939	1,119,600	705,200	414,400	406,900	156,600	92,900	161,100
1940	1,235,400	771,200	464,200	426,400	164,300	125,400	154,200
1941	1,167,300	714,800	452,500	356,200	151,100	139,800	143,800
1942	1,213,500	703,800	509,700	340,800	154,500	145,000	195,700
1943	1,201,200	681,500	519,700	311,300	193,100	136,100	191,900
1944	1,221,300	674,400	546,900	303,400	191,800	146,900	184,100
†1945	604,100	335,900	268,200	152,200	93,600	78,300	70,700

* These figures include not only pyrites, but also the tonnage of anhydrite now consumed in this country in the manufacture of sulphuric acid after having been converted into the "equivalent" tonnage of pyrites.
† First six months.

Fig. 6 (opposite), and Figs. 7 (right) and 8 (below). Demolition of sulphuric acid chambers and their re-erection.



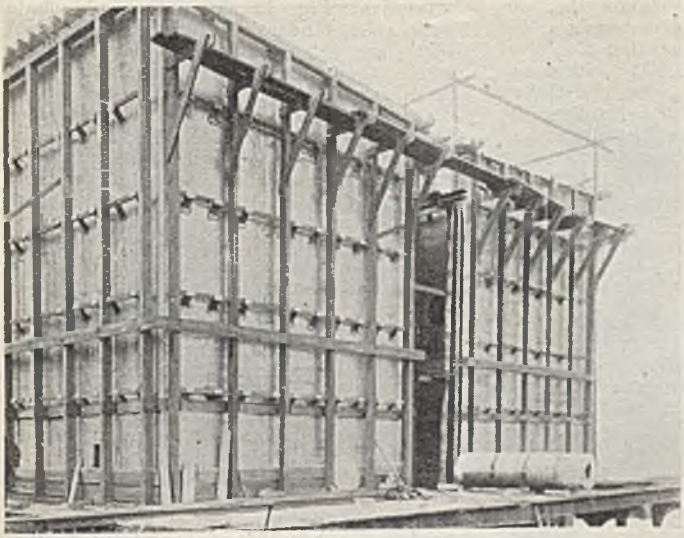


Fig. 6 shows a chamber after the leadwork has been cut down from the skeleton framework. Fig. 7 shows new chambers being reconstructed. A plumber can be seen burning a vertical seam, and the men on the top are busy with the fixing of two top sheets on the table. Fig. 8 shows the ends of the chambers, completely lead-lined, but the wooden brackets and staging have not been completely removed.

larly susceptible to aerial attack, blast, earth tremors, and excessive vibration.

The area in and around London was probably the worst in Great Britain, from the point of view of aerial attack, and it is little short of remarkable that it has been possible for metropolitan acid works to maintain production throughout the war. Few can understand the risks that were run, and the improvisations that were made, in order to ensure production. Despite the precautions taken at the outset of hostilities, in the shape of providing duplicate stock cisterns for acid circulation, in order that feeds could be maintained on Glover and Gay-Lussac towers during long periods of bombardment, it was difficult to foresee what damage would be wrought to sulphuric acid chambers, short of almost complete destruction, when hundreds of incendiary bombs were dropped within very short periods.

Invariably the incendiary bombs were the precursors of other and larger ones. Sometimes scores of incendiary bombs would enter a chamber or chambers and some would penetrate the lead floor; others would be arrested in the acid without severe damage being done. The writer arranged for plenty of finely screened lead ashes to be available on the top gangways of all chambers, so that any bottom leakages caused by incendiary bombs were sealed by the introduction of lead ashes at the points where the fracture of the top lead had occurred. Hundreds of leaks have been stanched in this way. Where the leakages from the chamber floors were more serious, the acid was collected in lead shoots, previously available, and directed to the stock

cisterns. Where the leakage of acid could not be satisfactorily dealt with in this way it was necessary to put the chamber—or chambers—out of circuit, exhaust the gases from the chambers by means of fans, enter them, dam off the acid at the points where fractures of the lead had occurred, repair the fractured lead and put the chamber—or chambers—into circuit again. On occasions these operations have been undertaken several times a month.

Again, at times the wooden framework of the chambers was distorted by blast, and one was compelled to improvise various measures for bringing the framework into a vertical position and restoring or patching the leadwork which had been buckled or fractured by the dislocation. Only in this way could production of acid continue.

In the demolition of chambers a predetermined technique has to be pursued (Figs. 6-8), in order to preserve intact the substructure and to economise materials as far as ever possible. The demolition of a steel skeleton framework (Figs. 9-11) with tower chambers 45 ft. high has to be undertaken with considerable care, and involves the removal of the lead, in the first place, and the dismantling, in suitable sections, of the steelwork. This is invariably done by acetylene burning. With several units of the metropolitan acid plant, not only was the superstructure seriously damaged and dislocated, but the substructure suffered a somewhat similar but less serious fate.

The Fertiliser Industry

It is doubtful whether the original basis of the calcium superphosphate industry will remain unchanged much longer. There are many evidences that water solubility has outlived its usefulness. Clearly, there should be some other test than water solubility, and it is felt that it will be necessary to introduce into our Fertiliser and Feeding Stuffs Act regulations such modified test, which will more accurately appraise the intrinsic value of a phosphatic fertiliser.

In America attempts have been made, more or less successfully, to remove fluorine from phosphate rock by heat treatment. Any process which will break down the molecule—calcium fluorapatite, $Ca_{10}(PO_4)_6F_2$—and leave alpha-tricalcium phosphate or monocalcium phosphate or calcium superphosphate, will render phosphorus available in growing plants.

It is conceivable that calcium superphosphate may be replaced by a citrate-soluble phosphate, i.e., dicalcium phosphate ($CaH_2P_2O_8$). This product may be made by treating calcium superphosphate in the ordinary way with basic slag, or perhaps some other reverting agent will be employed. Apart from this possible change in technique, it has been known for some time that soda ash may replace sulphuric acid in the manufacture of phosphatic fertilisers. Indeed, one new product has given very good results in the field, and is now being manufactured on a larger scale. Ground rock phosphate is mixed with sand, lime, and soda ash, and this mixture is subjected to heat treatment in a cement kiln, producing what can be regarded chemically as sodium silicophosphate. It is a mixture in solid solution of two molecules—calcium-sodium phosphate and calcium-silicophosphate. The product will contain 33 per cent. P_2O_5, and this is twice as concentrated as calcium superphosphate. It is a product not widely dissimilar to Rhenania phosphate, which was produced in Germany in 1914-18, when Germany's own low-grade deposits of phosphate were used.

But other modifications of technique may follow in the next few years. The blast-furnace process is becoming increasingly attractive. Fig. 12 shows that phosphate rock, coke, binder, and sand are used, and these are introduced to a blast furnace, where the phosphate rock is reduced to phosphorus. This last-named element is deprived of its associated dust, undergoes combustion, as is later described, then passes to a hydrator, and the resultant phosphoric acid is collected in an electrostatic precipitator. The blast-furnace process is one obviously calling for economy of heat, so as to reduce the quantity of coke used in the actual blast-furnace operation to a minimum. The phosphate rock and binder are briquetted and introduced with coke and sand to the blast furnace. The ferrophosphate and blast-furnace slag are tapped from the blast furnace at predetermined intervals. The introduction of two hot blast-furnace stoves with change-over valves is an important feature of the process, in that considerable economy of heat is effected. One of these stoves is in operation, burning the phosphorus vapour in air, and thus raising the temperature of the refractory brickwork, while air is being passed through the incandescent brickwork of the other stove, before being led to the blast furnace. Thus, apart from the phosphorus being burnt in the stoves in question, the heat arising from the combustion of phosphorus is conserved. Part of the phosphorus vapour is burnt with air under a steam boiler, and steam is recovered along with the P_2O_5 from the stove in a hydrator tower, which is irrigated with atomised water.

Phosphoric acid produced in this way can be coupled with ammonia to form either monoammonium phosphate or diammonium phosphate, or phosphate rock can be treated with phosphoric acid to produce triple superphosphate.

These products, in turn, may require to be treated with a reverting agent, in order

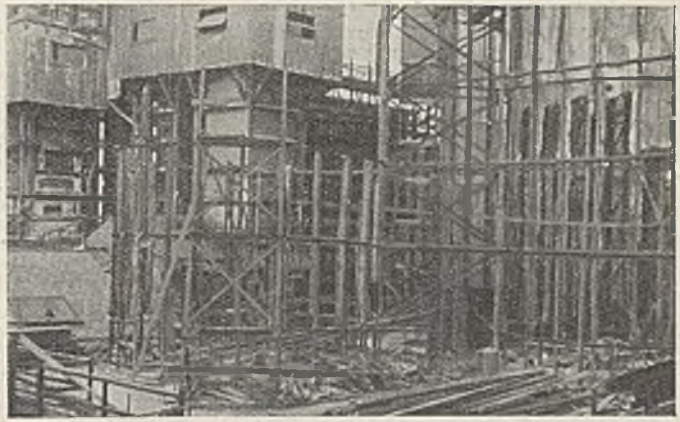


Fig. 9. Demolition of steel skeleton framework, in a unit of plant damaged by aerial attack.

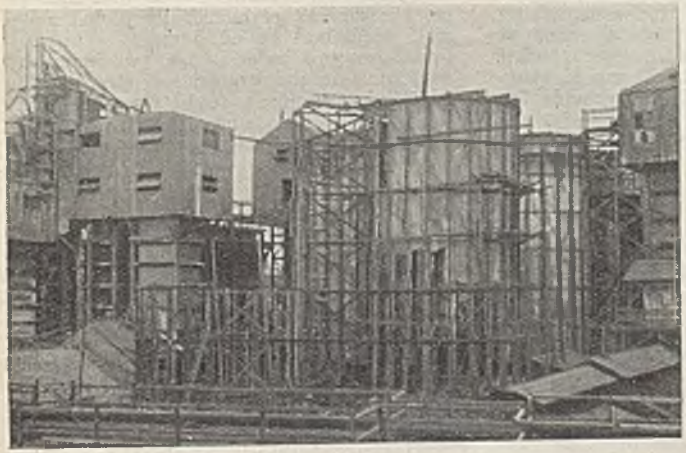


Fig. 10. A further stage in the demolition.

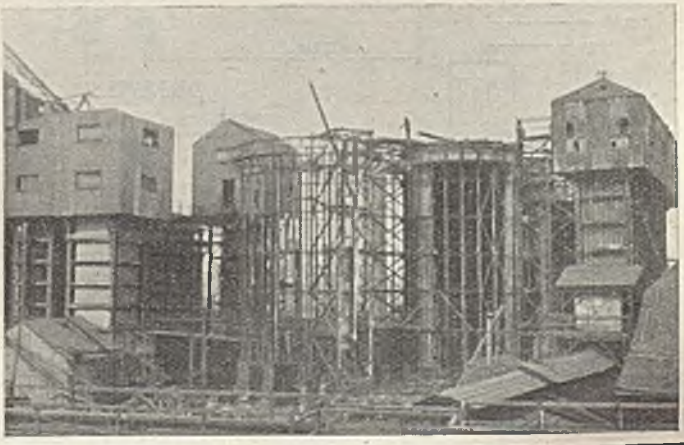


Fig. 11. Dismantling of the damaged plant still further advanced.

DISMANTLING OF ENEMY-DAMAGED SULPHURIC ACID PLANT.

to get the P_2O_5 in the best form for efficient utilisation by the soil. It may appear paradoxical to predict a change in the manufacturing technique of calcium superphosphate at a time when this industry is enjoying its greatest boom, but the next five years will, there is reason to believe, reveal the correctness of the prediction. At the present time it must be remembered that much of the European continent, and indeed many other parts of the world, are on the verge of starvation, and it is only to be expected that the demand for fertilisers in this country, for use here and for export to Europe, must be at its maximum.

Preoccupied, as the calcium superphosphate industry is bound to be, with the problems indicated above, the industry must not overlook the recent attack of the Howardists, and it must never cease to urge the necessity for ley farming, if a suitable physical condition of the soil is to be attained. The following oracular utterance by J. B. Abbott, of Vermont, should never be disregarded: "If all the accumulated soil-management wisdom of a hundred generations of master farmers were boiled down to just three sentences, one of these sentences certainly would be: provide for regular and frequent replenishment of organic matter in the soil."

Fertiliser salesmen should be taught that humus is not indestructible. When it becomes depleted, commercial fertilisers become less effective. This is a common farm experience. Soil fertility can never be stabilised and maintained unless soil humus is retained at a level normal for the origin and for the particular type of soil. Fertilisers, lime, and organic matter are undoubtedly complementary: each has a specific rôle to discharge: but it is the co-operative or combining effort that will lead to the big harvest.

Organic Manures v. Other Fertilisers. Dr. J. Crowther, F.R.I.C., head of the chemistry department at Rothamsted Experimental Station, Harpenden, published recently a pamphlet, No. 13, on the subject of "Fertilisers during the War and After."[24] In this he made clear that there is no conflict between using bulk organic manures and using fertilisers, as the two classes of material serve quite different purposes. Both aid plant foods, but bulk organic manures also furnish appreciable amounts of organic matter which may have immediate physical effects on the soil, and important secondary ones, thus increasing the amount of more fully rooted material, sometimes called humus. This colloidal group of materials plays an important part in maintaining good soil structure, in holding some plant foods in immediately available forms, and slowly liberating others. At the moment there is little to gain by ascribing the benefits from organic manures on agricultural land to "feeding the bacteria."

National Standard Fertilisers. In Great

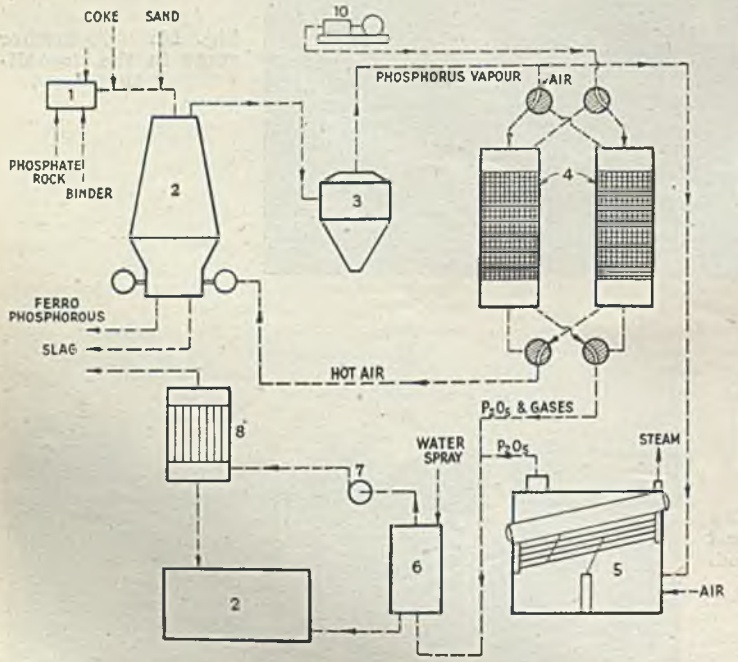


Fig. 12. Manufacture of phosphoric acid (blast-furnace process).

1. Press. 2. Gas into the blast furnace. 3. Cyclone dust extractor. 4. Hot blast stoves. 5. Steam boiler. 6. Hydrator. 7. Fan. 8. Cottrell precipitator. 9. Storage for the phosphoric acid, 90 per cent. 10. Air compressor.

Britain about half the plant-food was produced as "straights" and half as compounds, of which there was a large variety. The war has led to some simplification, and to the introduction of national standard compounds in 1942, to meet the needs of private gardeners and allotment-holders. National Growmore Fertiliser, with 7 per cent. N, 7 per cent. P_2O_5, and 7 per cent. K_2O, at a price of 25s. per cwt., is undoubtedly popular. To facilitate the national fertiliser rationing scheme in 1943-44, three national compound fertilisers were prepared and the recommended dressings to cover the ration were as shown in Table 2.

TABLE 2.

	N	P_2O_5	K_2O	March-June price per ton	Standard dressing per acre
	%	%	%	£ s. d.	
No. 1	7	7	12	11 5 0	10 cwt. for potatoes
No. 2	9	7.5	4.5	10 10 0	7 cwt. for sugar beet and mangolds
No. 3	6	12	—	9 2 6	4 cwt. for other roots

In 1944-45 the Fertiliser Permit allowed of 10 cwt. of a mixture supplying 0.7 cwt. N, 0.7 cwt. P_2O_5, and 1.2 cwt. K_2O per acre.

Sugar beet requires roughly equal amounts of the three plant foods, but less phosphate and potash, or even a nitrogen fertiliser alone, on dunged fields. For swedes, dressings of nitrogen should be kept down to the equivalent of 1 or 2 cwt. of sulphate of ammonia per acre. Illustrative of the effect of climatic conditions in most districts, 1 cwt. of sulphate of ammonia per acre may be taken as the upper limit for cereals and swedes. In very wet areas, *e.g.*, Northern Ireland, the nitrogen for potatoes should be kept down to 1-2 cwt. of sulphate of ammonia per acre, as heavy top growth may allow blight to spread more rapidly, and also delay ripening. The western counties of England use about half as much nitrogen for cereals, potatoes and swedes as the eastern ones, but nearly the same rates for sugar beet and mangolds, for which there is less objection to heavy growth of tops.

Sulphate of ammonia was produced in sufficient quantities throughout the war to make restrictions unnecessary, except for one short period at the end of 1942. Storage was the main difficulty. Factories must work at full pressure throughout the year, but farm demand reaches an acute peak in the spring. To overcome the inability of factories having to store the greater part of the year's production, and the impossibility of transport services delivering a vast quantity shortly before the farmers need it, a special Government Distribution Allowance was introduced in 1941. Each July a limited amount of sulphate of ammonia was offered at reduced prices for delivery at manufacturers' convenience, the rebate being 28s. per ton in 1941-42, and 15s. per ton in 1943-44 and 1945.

Fertiliser Consumption in European Countries, expressed as Plant Food Units. The question has often been asked: "What was the fertiliser consumption in European countries in 1936, expressed in terms of plant food units?" These figures have now been supplied in Dr. Crowther's review, and they are given in Table 3, because of their significance. It will be seen that the average rates of manuring varied sensibly from country to country, depending on the general intensity of farming and on the proportion of market gardening. The difference between countries would be less marked if it were possible to assemble data for the total consumption of plant food in all forms. Fertiliser practice in the six European countries listed in the accompanying table differed notably in the proportions in which the three plant foods were used. Great Britain used most phosphoric acid in proportion to nitrogen, and Belgium least. It is clear that as fertiliser practice develops with more intensive farming, the ratio of nitrogen to other plant foods will increase. War-time policy required maximum output of human food. Cereals, potatoes, and vegetables were given the highest priority among crops. Cereals increased very rapidly for the first two years of the war, and then more slowly. The main need of cereals is nitrogen. One cannot give accurate estimates of the ammonia used before the war, but in one survey of the manuring of potatoes and immediately preceding crops, it was found that two-thirds of the cereal crop throughout the country received no nitrogen fertiliser.

To demonstrate the increase to be obtained

TABLE 3.

FERTILISER CONSUMPTION IN EUROPEAN COUNTRIES, 1936, EXPRESSED IN PLANT FOOD UNITS.

	Total amounts in thousand tons			Cwt. per acre arable land				Plant food ratios		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	Sum	N	P_2O_5	K_2O
Holland	62	95	92	0.54	0.82	0.80	2.16	1	1.5	1.5
Belgium	50	55	46	0.42	0.41	0.35	1.17	1	1.0	0.8
Germany	483	623	961	0.20	0.26	0.40	0.86	1	1.3	2.0
Denmark	35	65	36	0.11	0.20	0.11	0.41	1	1.9	1.0
Great Britain	66	188	74	0.08	0.22	0.08	0.38	1	2.8	1.1
France	144	387	217	0.05	0.15	0.08	0.28	1	2.7	1.5

from a more general use of nitrogen, Crowther and Yates calculated that in Great Britain, in the years immediately preceding the war, about £1 million was spent on nitrogen fertilisers for cereals, resulting in extra crops worth £4 millions. If an average rate of 1 cwt. of sulphate of ammonia per acre had been used on the pre-war cereal acreage, the extra crop would have been worth £11 millions, for an outlay of £3 millions. For twice this rate the extra crop would have been worth £17 millions.

The Survey of Fertiliser Practice showed that in 1942 about 6 per cent. of the greatly increased cereal acreage received the equivalent of 1¼ cwt. of sulphate of ammonia per acre. Dr. Crowther is emphatic in asserting that "this great improvement on pre-war practice has been a major contribution to the country's food supply and the farmers' profit." Sulphate of ammonia necessarily increases the loss of lime from the soil, but the effect is fairly small (about one-third of the weight of the sulphate of ammonia) and is easily put right by regular liming. Sulphate of ammonia is very useful for shallow-rooted crops in wet districts, and especially for potatoes and oats.

No Simple Formula

Manuring for Quality. On the subject of manuring for quality, Dr. Crowther's *obiter dictum* may be thus summarised: there is no universal definition of quality and no simple formula for obtaining it by manuring. Compost enthusiasts argue by analogy from the known importance of vitamins in animal nutrition, and of hormones in plant and animal physiology, that similar material ought to be important in feeding plants. Biochemical research progresses rapidly and it is conceivable that some day there must be added certain complex organic molecules to the list of essention plant nutrients. Examples may possibly be found in which fertilisers and manures affect the vitamin content of crops. While these possibilities can be reflected upon and a search made for them, it is wrong to assume the results in order to advertise special practices. For the fodder crops, hay and straw, the principal factors are the proportions of protein, readily digestible carbohydrates, fibre, vitamins, and minerals, especially calcium and phosphorus. For sugar beet the quality depends primarily on sugar percentage, by which prices are fixed in this country. Two other factors may also influence the extraction and crystallisation of sugar in a factory. For barley the nitrogen percentage on dry weight is an important factor, and field experiments have shown that neither the price given by the skilled valuers nor the nitrogen percentage is appreciably altered by dressings with nitrogen fertilisers, which greatly increase yields.

Zirconium

An interesting review of recent developments in the production and uses of zirconium and its compounds has been contributed by M. Schofield.[26] Although the world production of ore is only 10,000 tons, and zirconium is still regarded as a rare metal, it is fairly widely distributed and is finding an increasing variety of applications in industry. For many refractory purposes natural zirconium needs little or no treatment before use. As a silicate it possesses the property of resisting molten slags, and its superiority in resisting any tendency to form a carbide renders it an invaluable refractory in constructing electric furnaces, steel furnaces, and glass kilns.

The oxide, ZiO_2, has the high melting-point of 2750°C. This property, together with its inertness towards acids, alkalis and slags, has led to its use for a number of special purposes. As an opacifying agent for enamels, zirconium oxide now rivals tin oxide. It is used both as a batch ingredient and as a mill addition. The glass industry also uses zirconium in the production of opal glasses, and for imparting high tensile strength in substitution for quartz glasses.

Zirconium metal may be prepared by electrolysis of the molten double fluoride with potassium or by calcium reduction of the oxide. It is a silvery-white metal, resistant to normal atmospheric conditions, and extremely hard. Its low ignition point (210°) and high heat of combustion were responsible for its application, in powdered form, as a starter in photo-flash bulbs, and in primers for ammunition. Zirconium is also largely used in the manufacture of vacuum tubes, valves and special lamps.

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Some Recent Work in Colloid Science

by W. H. BANKS, Ph.D.

Dr. W. H. Banks

Wetting of Surfaces

IT is well recognised that rough surfaces influence the spreading of liquids over them, but precise mathematical formulation of the effect is lacking. Thus Adam (*Physics and Chemistry of Surfaces*) states that if the liquid tends to wet the smooth solid (contact angle $\theta < 90°$) then roughening will increase the tendency, *i.e.*, θ will decrease. Wenzel (1936) showed that if 1 sq. cm. of surface had a real area f_1, then $\cos \theta'/\cos\theta = f_1$ where θ, θ' are the contact angles for smooth and rough surfaces respectively. Matters are different for porous surfaces and Cassie and Baxter have shown (*Trans. Farad. Soc.*, 1944, *40*, 546), for one composed of a single row of parallel fibres (as in a fabric) separated by an air space, that $\cos \theta' = f_1 \cos \theta - f_2$ where f_2 is the total air liquid interface in a unit plane area parallel to the rough surface. Clearly, when $f_2 = 0$, this leads to Wenzel's formula. The matter is of great industrial importance in waterproofing of fabrics, paper, and other substances. Cassie and Baxter explain on this basis the waterproof quality of birds' feathers.

Precise Zeta Potentials

Zeta potentials, as distinct from electrode potentials, have rarely been measured with any degree of precision because of the difficulty of preparing or even maintaining surfaces in reproducible condition as regards contamination and topography. These potentials depend on the composition of the electrical double layer at the interface and are thus sensitive to stray ions. Because their measurement depends on relative movement of the phases at the interface, irregularities comparable in size with the thickness of the double layer play a decisive rôle.

G. Jones and L. A. Wood (*J. Chem. Phys.*, 1945, *13*, 106) report what are probably the most accurate and critical series of measurements ever made on the interface between vitreous silica and aqueous solutions of potassium chloride by means of streaming potentials. After consideration of surface conductance corrections which in all but the most concentrated solution used (10^{-3} *N*) was negligible, they calculate ζ potentials from the equation of Helmholtz. The measurements were made under very precise null-point conditions (the current flowing never exceeded 10^{-11} amps.) with electrostatic shielding and insulation carefully considered. More than 1400 measurements were made on solution 10^{-5}, 10^{-4}, and 10^{-3} normal in KCl, leading to potentials showing average deviations from the mean of a few tenths of 1 per cent. for all solutions except the most dilute where deviations as high as 2 per cent. are recorded.

In spite of the precautions taken to cleanse the silica capillary tubes (they were finally heated to dull redness), progressive changes in ζ potential over one month were observed (*e.g.*, from 120 to 133 millivolts in 24 days). These changes were shown not to be due to disequilibrium between the silica and solution. One capillary showed regular changes while another showed irregular changes. In the reviewer's opinion the effect of heating in setting up strains in the silica surface, with consequent alteration of the surface profile as these strains dissipate, cannot be ignored.

Surface Tension of Salt Solutions

In 1937, Jones and Ray by a precise capillary rise method showed that the surface tension of very dilute salt solutions relative to that of water passed through a minimum at extreme dilution. These observations were not, however, confirmed by Long and Nutting (1942) using a precise bubble pressure mthod. This minimum surface tension is not predicted by the Debye-Huckle theory of strong electrolytes (Onsager and Samaris, 1934). Langmuir suggested (1938) that the minimum resulted from the fact that the capillary rise for dilute salt solutions will not correspond to the measured radius of the tube but to one slightly smaller, because of the presence of a wetting layer on the wall. The calculation of the thickness of this layer requires a knowledge of the ζ potential. G. Jones and L. A. Wood, using their measurements (discussed above), show that Langmuir's theory leads to wetting layers thick enough to be an appreciable fraction of the capillary radii used in their surface tension work. Thus, at 10^{-3} *N* it is 250Å thick

while at $10^{-3}N$ it is 516Å. Correction of the early data is shown to eliminate the minimum in the case of KCl solutions, but it remains to be seen whether this success is maintained with other salts.

Plasticity of Dispersions of Solids

Dispersions of fine particles in liquids (paints for example) exhibit plasticity under a variety of circumstances. This plasticity is usually expressed in terms of the minimum shear stress (yield value) necessary to cause flow. It is a matter of great importance and one immediately recalls to mind the potter's clay which must retain its moulded shape before firing, or the paint which leaves brush marks. The many factors leading to plastic behaviour are not always controllable, probably because their influence is not understood; nevertheless, speculation has been the rule and systematic experiment the exception. One factor which is always associated with plasticity in suspensions is the formation of aggregates (flocculation) and this has necessitated invoking attractive forces (usually Van de Waals!) between the particles.

The position has to a great extent been clarified by H. R. Kruyt and Miss M. G. Van Selms (*Rev. trav. chim.*, 1943, *62*. 415-426, 407-414) who measure the yield value of suspensions of glass beads of known dimension in liquids immiscible with water. They show that plasticity develops on introducing small quantities of a second liquid not miscible with the first. For example, additions of water increase the yield value to a maximum in the region of 2·4 per cent. of water by volume. The yield value is found to depend inversely on the particle size. The explanation is that when water is added the glass beads being preferentially wetted by water become surrounded by a film, and that when two beads approach sufficiently closely the water films coalesce, thereby joining them by a water meniscus. Clearly, the argument applies to more than two beads. On shearing such a flocculated suspension, extra work (*i.e.*, in excess of that in the absence of water) is expended in overcoming capillary forces, or, put another way, shearing will increase the interface between the water-immiscible liquid and the water, and the work done will be proportional to the new area of interface created. From the geometry of the system it will be obvious that the cohering part of the film is greater the larger is the amount of water present up to a critical amount beyond which no increase is to be expected. In consequence, no further increase in yield value will result. The theory is demonstrated to be perfectly general by showing that the addition of xylene to a dispersion of coal dust in water induces plasticity, because in this instance xylene wets coal in preference to water.

Tackiness

Tackiness is a property common to many industrial materials, but its precise definition and measurement is controversial. For this reason the recent symposium held by the British Rheologists' Club is of interest. The proceedings are published in *Paint Technology*, 1944, *9*, No. 106,211. N. A. de Bruyne considers that the early work of Stefan (1847) who measured the force required to separate two flat discs while immersed in a liquid can be made the basis of tack measurement. Calculation shows that this force (the tack) will be greater for smaller initial separations and for liquids of high viscosity. These variables thus act according to theory in a direction which agrees with experience. In this sense then, tack (if measured as a force) is a property of the system rather than of a particular substance. A further requirement, often forgotten, is that the liquid must wet the test surface in order to manifest any tackiness. Chewing-gum is tacky if tested between dry fingers, while it exhibits no tack between moist fingers. The one property of the liquid which enables it to show tackiness under the right conditions is the single property of viscosity, but de Bruyne wisely points out that it is doubtful whether the assessment of the tack of, for example, an adhesive, by rheological measurement alone is sufficient to judge its suitability for the complex conditions under which it will be used.

Much the same view of tack is adopted by R. F Bowles, who discusses printing inks, and by E. W. Mardles who discusses paints. Bowles defines a tacky solid as a gel in which syneresis occurs—a definition which, in the opinion of the reviewer, is too generalised. In theory, the surface tension of a liquid must contribute to any operation involving extension of liquid where the air/liquid interface is changing, that is, in all cases where tack is operating, but its contribution to the viscous forces is usually so small as to be negligible. Surface tension, on the other hand, is probably important in determining the stability of threads of liquid.

Novel Technique in Rheology

A plastometer based on the familiar wire cheese-cutter is described by L. J. Lyons and R. D. Vold (*Ind. Eng. Chem.*, Anal. Ed., 1945, *17*, 585). The velocity of movement of the stretched wire through the material in a direction at right angles to the long axis of the wire under a force is measured. Viscosity is calculated, using the theory of Lamb for the movement of an

infinite cylinder through an infinite liquid. The method is promising for highly viscous materials such as asphalt, for which substance the authors demonstrate its use; they report values in the region of 10 poises. It is also applied to soap, but here the results are less convincing because the Lamb theory concerns only Newtonian liquids; indeed, the authors admit that the wire leaves an open channel behind it as it travels through the soap.

An ingenious method of studying the viscosity of mineral oils over a range of shearing stresses in a single experiment is described by Derjaguin, Koussakov and Krim (*Acta Physicochemica U.R.S.S.*, 1945, *20*, 1, 35); mathematical theory by M. Koussakov, *ibid.*, 47). Air is blown at a measured speed through a channel of triangular cross-section, on the bottom horizontal wall of which is placed the liquid in a thin film. In the direction of the air flow the liquid is under constant shearing stress, but because of the triangular cross-section it is subjected to a stress which varies linearly across the direction of flow. The liquid piles up under the blast to different extents across the section, and this varying extent is shown up through the interference bands which result from suitable illumination of the liquid wedge. It is only necessary to photograph the interference picture and one has in effect a graph of shearing stress against velocity gradient.

For Newtonian liquids the interference bands consist of a series of straight lines radiating from the origin of the stress/strain diagram. Liquids having a yield point show the bands radiating from a displaced origin. Derjaguin finds that oils containing small quantities of aluminium stearate give anomalous diagrams; he attributes the anomaly to the presence of a layer of liquid adjacent to the wall having special properties. This view, that surfaces influence the properties of liquids to larger distances than classical theory can explain, is claimed in many of this author's earlier publications, but until more is known about the topography of solid surfaces the phenomena must remain inconclusive. In the latter connection it is worth recalling the recent demonstration by Tolansky (*J. Sci. Inst.*, 1945, *22*, 161) that the surfaces of freshly cleaved crystals, so favoured by the scientists as the standards of surface perfection, are, in fact, far from perfect.

Change of Surface Tension with Time

The change in surface tension with time of some solutions is an old phenomenon, and in instances of solutes consisting of large molecules (such as soaps and proteins) these changes may continue for days. We do, indeed, expect a fresh surface to occupy a measurable time for the molecules to take up their new arrangement, but so far the times to be expected from simple diffusion theory are not in agreement with observation. C. C. Addison (*J.C.S.*, 1943, 535; 1944, 252, 477, 1945, 98; *Phil. Mag.* 1945, *36*, 73) has developed the vibrating jet method of measuring surface tension first used by Bidone and explained by Rayleigh. By this means he has been able to measure the surface tension of aqueous solutions of long-chain alcohols when the surface varies in age from 0.001 to 0.1 seconds. It is important to deal with solutions of this kind in the first instance because they are simpler than solutions of micelle-forming soap and protein solutions.

In order to express the results in a manner which shows up the specific effects of the solute, Addison imagines a cylinder of unit cross-section extending to a small depth d below the surface and calculates from the measurements the time taken for all the solute, originally uniformly distributed through the cylinder, to collect wholly in the surface. From this is calculated the velocity of travel over the distance d. The sort of result obtained is illustrated by a 0.01 per cent. solution of sec. octyl alcohol in water, in which the distance of travel is 43×10^{-6} cm. and the velocity is 36×10^{-4} cm./sec. The migration distances decrease with concentration and the velocity of migration increases with increasing chain length of alcohol.

Sorption of Gases

R. M. Barrer and co-workers (*Trans. Farad. Soc.*, 1944, *40*, 195, 206, 374, 555) have shown that certain zeolitic minerals have marked occlusive properties for gases ranging from nitrogen to hydrocarbons. The important structural feature of these zeolites is the large interstitial space which in the hydrated state is occupied by water and the cations (they are the alumino silicates of alkali and alkaline earth metals). The size of the interstitial channels determines what sized molecules can be occluded and because of this they are referred to as molecular sieves. Their sieve action is very marked in the case of long chain hydrocarbons. For example, a zeolite which will occlude a normal paraffin will exclude the corresponding *iso*-paraffin. Barrer makes use of these properties to separate mixtures of hydrocarbons (*J. Soc. Chem. Ind.*, 1945, *64*, 130, 131, 133). That these observations are of more than academic interest is illustrated by one of the many examples given by Barrer. A mixture of *n*-heptane (20.7 per cent.) and toluene (79.3 per cent.) was completely resolved in 48 hours by treatment with chabazite at 200° C. in a sealed tube.

One characteristic of aqueous solutions of many detergents of the soap type is that the surface tension decreases to a minimum as the concentration increases. In many cases this minimum occurs in the region of

concentration where other properties (such as detergent power) also show turning points. Since this minimum generally corresponds to the critical concentration for micelle formation, it has been customary to connect the two phenomena. So far as the reviewer is aware there is no exact theory which ties these facts together. G. D. Miles (*J. Phys. Chem.*, 1945, 71) has recently questioned the reality of these minima and suggests that minima in surface tension concentration curves are due to the presence of impurities. He shows, for example, that solutions of pure (ether-extracted) sodium lauryl sulphate exhibit no minimum, whereas the presence of lauryl alcohol does introduce a minimum.

Surface Area of Powders

P. H. Emmett (*Chem. and Met. Eng.*, 1945, *52*, 210) determines the surface area per gram of some 86 powders by the low-temperature adsorption of nitrogen, employing the Brunauer-Emmett adsorption isotherm (1938), and finds that the results agree within 10 per cent. with the method of Harkins in which heat of wetting measurements are made (*J.A.C.S.*, 1944, 1356). This continued success of the adsorption method is difficult to understand in view of the uncertain theoretical basis of the Brunauer-Emmett isotherm (*see* THE CHEMICAL AGE, 1944, *50*, 63).

Langille, Braid and Kenrick (*Can. Journ. Res. B.*, 1945, *23*, No. 1, 31) have measured the surface area of crushed barium crown glass by adsorbing methylene blue on both the crushed and uncrushed glass. By assuming the area of the uncrushed glass they avoided the necessity of making any assumptions about the area occupied by the adsorbed dye molecule. Areas so obtained were then compared with those from a micro-projection method. The same order of magnitude was obtained although the agreement was not good: 682 cm.^{2}/gm. by dyeing, 568 cm.^{2}/gm. by projection.

Sharratt, Van Someren and Rollason (*J. Soc. Chem. Ind.*, 1945, *64*, 73) employ the opacity of a suspension of opaque particles for the measurement of particle size (this is virtually an optical projection method if the particles are not too small) and show that the values differ from those obtained by the sedimentation method by a factor which is constant for a given material provided the particle shape is similar in all samples.

Recently, the U.S. cane-sugar refiners and bone-char manufacturers, in collaboration with the National Bureau of Standards (Washington) have published a bibliography of solid adsorbents (some 880 pages). The reviewer has not had the opportunity of seeing this book but recent reviews suggest that it is very complete, although it refers particularly to activated carbon.

Institution of Chemical Engineers

Nominations for Council

THE twenty-fourth annual corporate meeting of the Institution of Chemical Engineers will be held at the Connaught Rooms, Great Queen Street, London, W.C.2, on April 12, at 11 a.m.

To fill the vacancies on the Council caused by retirements in accordance with the Articles of the Institution, the Council has made the following nominations: *President*: H. Griffiths; *Vice-Presidents*: C. J. T. Cronshaw, S. Robson, D. F. Sandys Wunsch, S. J. Tungay; *Joint Hon. Secretaries*: M. B. Donald, L.O. Newton; *Hon. Treasurer*: F. A. Greene; *Members of Council*: Julian M. Leonard, J. Watson Napier, John A. Oriel; *Associate-Member*: A. Rees Jones.

Nominations from members in accordance with the provisions of Article 58 must be received at the registered office of the Institution, 56 Victoria Street, London, S.W.1, not later than March 1. In the event of there being no nominations from members, the nominees of Council will be declared elected at the annual meeting.

Royal Statistical Society

Industrial Applications Section

BEFORE the war there existed in the Royal Statistical Society an Industrial and Agricultural Research Section. The activities of this section were suspended at the outbreak of hostilities but the Society has decided that the section shall be reconstituted in the form of two separate sections, a Research Section and an Industrial Applications Section. The latter has grown out of the successful activities of the informally constituted Industrial Applications Group which held 17 discussion meetings in London from 1942 to 1945.

The section is concerned with the application of statistical technique to industrial research, development, and manufacture, including inspection. It is organised in local groups, which may be formed wherever sufficient support is forthcoming. Groups have already been formed in Birmingham, London, and Sheffield, and one is in the process of formation in the North-East Coast area. Membership of the section is open to all interested persons who are approved by the section committee. An annual subscription of 10s. is payable by non-Fellows direct to the Society, which in turn finances the local groups. Further information may be obtained from the Assistant Secretary, Royal Statistical Society, 4 Portugal Street, London, W.C.2.

News Events of 1945

JANUARY

PROFESSOR G. M. BENNETT was appointed to be Government chemist in succession to the late Sir John Fox.

* * *

The Place of Science in Industry formed the subject of a two-day conference convened by the British Association.

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The report of the Hankey Committee on Higher Appointments was published.

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A " Wealth from Salvage " exhibition of the Ministry of Supply demonstrated the importance of the utilisation of industrial by-products and scrap.

FEBRUARY

The Red Army entered Germany's Eastern Arsenal, Silesia.

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The creation of a comprehensive industrial health service as an essential part of the National Health Service was urged by a special committee of the Royal College of Physicians.

* * *

India's aluminium production from domestic bauxite was surveyed by a special correspondent.

* * *

Cambridge University accepted a gift of £435,000 from the Shell group of oil companies for the establishment of a School of Chemical Engineering.

* * *

The production of DDT and food yeast was taken up in South Africa.

* * *

Sir John Anderson, Chancellor of the Exchequer, in his Budget, made allowances for expenditure on buildings, plant and machinery, as well as on patents and research expenditure.

* * *

A stirring appeal to scientists to fit themselves more for the work of government was made by Professor Harold Laski in a lecture arranged by the British Association of Chemists.

MARCH

The Distribution of Industries Bill, presented by Dr. Dalton, President of the Board of Trade, and passed shortly before the General Election, is an important instrument for the planning of the location of industry.

* * *

The Association of Scientific Workers held a conference on " Science in Peace."

The application of films in chemical industry and research formed the subject of a paper by Dr. A. J. Rathbone.

* * *

Chemical education was discussed at a joint conference of the Royal Institute of Chemistry, the British Association of Chemists and the Association of Scientific Workers.

* * *

It was revealed that polythene, a polymer of ethylene, a great British discovery, made Radar possible.

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The invention of the insecticide Gammexane was announced by I.C.I.

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The Royal Society elected the first women Fellows since Queen Victoria's *ex-officio* presidency.

Dr. G. M. Bennett.

Courtaulds, Ltd., decided to endow a Chair of Chemical Engineering at the Imperial College of Science and Technology, University of London.

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Mr. C. S. Robinson was appointed head of the chemical industry branch of the Allied Control Commission for Germany.

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I.C.I. announced its discovery of the selective weed-killer Methoxone.

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The Allies captured the centres of the chemical industry in Western Germany.

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Mr. Richard Bertram Pilcher retired from the office of Registrar and Secretary of the

Royal Institute of Chemistry which he had held since 1900.

APRIL

A motion on enemy patents was brought forward by Lord Vansittart.

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The Bessemer Gold Medal of the Iron and Steel Institute was awarded to Mr. Harold Wright.

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The report of the Ayre Committee on Hydrocarbon Oil Duties was published.

Mr. Harold Wright.

Mr. H. Griffiths was elected president of The Institution of Chemical Engineers.

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The progress made in the British scientific instrument industry was surveyed in a special number of THE CHEMICAL AGE.

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Sir Ambrose Fleming died in his 96th year.

MAY

Mepacrine, packed in polythene, has played an important part in the battle against malaria, it was announced.

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Sir Frank Smith delivered a series of three Cantor Lectures on Chemicals from Petroleum before the Royal Society of Arts.

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Important recommendations contained in the Reid report on the coal industry were announced this month.

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Germany surrendered unconditionally to all Allies.

JUNE

I.C.I.'s war record was surveyed by the chairman, Lord McGowan.

THE CHEMICAL AGE published a series of pictures showing the state of some German chemical plants.

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Operations "Fido" and "Pluto" were disclosed.

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A group of 21 British scientists attended the 220th anniversary of the formation of the Academy of Sciences of the U.S.S.R.

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The House of Commons discussed cartels and monopolies.

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The Select Committee on National Expenditure published a report on "Research and Development: War-like Stores."

JULY

Dr. Cecil H. Desch delivered the inaugural Harold Wright Lecture at Middlesbrough.

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I. G. Farben placed under military control.

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Professor E. K. Rideal was again nominated president of the Society of Chemical Industry.

Mr. Richard B. Pilcher.

The achievements in adversity of scientists in the U.S.S.R. were described by the British scientists who visited the Soviet Union.

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The report of the Swan Committee on changes in the Patent Acts was published.

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The birthday honours list contained many names of interest to science and the chemical industry.

The five-year plan of the steel industry was made public.

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A Research Secretariat was formed by the Federation of British Industries.

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I.C.I. offered a group of Research Fellowships to the Indian Institute of Sciences.

AUGUST

A Labour Government was elected with a clear majority in the General Election.

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The Board of Trade announced the formation of seven new trading estates, the expansion of existing estates and the conversion of four R.O.F.

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The Gas Light & Coke Company made a number of new research appointments.

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The British Iron and Steel Research Association was formed in London as a central research body for the industry.

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The atomic bomb was released on Japan.

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The Potsdam conference made important decisions on the future of German industry.

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A plan for the erection, near Watford, of a new central research station of the D.S.I.R. was announced.

Dr. F. W. Aston.

The war ended on August 15.

SEPTEMBER

Lend-lease ended.

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Progress of chemistry in the Colonies was reviewed.

President Truman urged upon Congress the early adoption of a Federal Research Agency to promote scientific research.

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The reorganisation of the Scientific Civil Service was proposed in a White Paper.

Mr. L. P. O'Brien.

Developments in industrial plant in glass were surveyed.

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Professor R. P. Linstead was appointed Director of the Chemical Research Laboratory in the D.S.I.R.

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The development of DDT and the part it played during the war were surveyed.

OCTOBER

The Petroleum Warfare Exhibition demonstrated the rôle of oil in war.

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A second Anglo-American oil conference was held in London.

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War-time developments in the German chemical industry were reviewed.

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Death of Sir David Milne-Watson.

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Mr. L. P. O'Brien was elected chairman of the A.B.C.M.

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The formation of tripartite working parties, to make recommendations for increasing the efficiency of certain British industries, was announced by the President of the Board of Trade.

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Centenary of the Imperial College of Science and Technology.

The Chancellor of the Exchequer, in the first post-war interim Budget, announced a number of tax reductions.

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The Melchett Medal for 1945 was awarded to Professor C. H. Lander.

NOVEMBER

Jubilee celebrations of Röntgen's discovery of X-rays on November 8, 1895, were held by many learned bodies.

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The announcement was made of the discovery of a new anti-malarial drug—Paludrine—by I.C.I. chemists and biologists.

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Professor Roger Adams received the Davy Medal of the Royal Society.

Dr. E. F. Armstrong.

The Royal Society held its first post-war conversazione.

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The Nobel prize in chemistry for 1945 was awarded to Professor Artturi Wirtanen, of Helsinki.

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Details were published of the final scheme for a National Chemical Laboratory in India.

DECEMBER

The inaugural meeting of the Institution of Metallurgists was held in London.

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Dr. F. W. Aston died at Cambridge, aged 68.

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The annual report of the Chief Inspector of Factories registered a decline in the rate of accidents and made reference to welfare and safety measures in the reconstruction period.

Sir Robert Robinson was elected president of the Royal Society.

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I.C.I., Ltd., announced a £10,000,000 five-year project for the manufacture of heavy chemicals from coal or oil on the Tees.

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Professor D. M. Newitt was appointed to the Courtauld's Chair of Chemical Engineering at the Imperial College.

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The British Association held a two-day conference on "Scientific Research and Industrial Planning."

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Dr. E. F. Armstrong died in London, aged 63.

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The Coal Industry Nationalisation Bill provided for the appointment of a National Coal Board.

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Sir John Anderson was elected president of the Parliamentary and Scientific Committee in succession to Lord Samuel.

ETHYL CELLULOSE FILMS

The terpene hydrocarbon, menthyl phenol, is a white opaque semi-crystalline solid. It has been discovered that it possesses the interesting and important property of improving the ageing characteristics of ethyl cellulose even when used in quite small amounts. Ethyl cellulose films containing about 3 per cent. of menthyl phenol are more flexible, show less surface cracking and less change of colour, and take longer to become brittle than films from which this stabiliser is absent. The optimum amount to use is about 2½-3 per cent. calculated on the total solids in the mixture. No advantage is gained by using over 3 per cent., and amounts less than 1 per cent. do not stabilise efficiently. (H. Courtney Bryson, *Paint Technology*, 1945, *10*, p. 232).

CARBON-13

A report from New York states that the Sun Oil Company and the Houdry Process Corporation, with the collaboration of a group of scientists, many of whom worked on the atomic bomb, have developed methods for the production in substantial quantities of Carbon-13, the heavy isotope of carbon, which occurs in natural carbon in the proportion of 0.7 per cent. The radioactivity which this isotope of carbon shares with a number of rare isotopes of the lighter elements, will, it is hoped, enable it to be used as a tool of medical science, allowing the biochemist to follow its chemical reactions within the human body.

Notes on the Progress of Research in the Food Industries in 1945

by FRANCIS H. BANFIELD, M.Sc., Ph.D., F.R.I.C.

Dr. Francis Banfield.

THE limitations of space available make it impossible to present a complete review of the papers and articles dealing with the food industry which have been published during 1945. The reviewer therefore attempts to select those which he thinks will have the most general appeal. At the same time it is inevitable that the personal interests of the writer will tend to influence him in his selection.

Studies in Famine

The physical condition of prisoners of war and the inmates of certain concentration camps, and the state of a proportion of the Dutch population were so poor following their treatment by the Germans, that special arrangements were made to supply them with suitable food. Robinson[1] has described the development of protein hydrolysates or "F" food ("F" for famine) since 1913 when the initial experiments on the maintenance of the nitrogen equilibrium by the injection of amino acids into animals were made. The hydrolysis by acids is shown to destroy the essential amino acid tryptophan, while the use of alkali results in the loss of methionine and cystine and the production of optically-inactive amino acids which are incapable of being used in the body. Much work on the enzymic hydrolysis of casein, the protein mainly used, has resulted in a hydrolysate containing about 60 per cent. of amino nitrogen. Fortunately, it was not found necessary to use the material on a large scale; the liberated people being able to take a milk diet. The research has not been in vain, since the material is useful in certain cases where loss of protein has occurred following disease or operation.

The distress among the poorer sections of humanity, in many places aggravated by the war, has resulted in the study of the production of yeast in a form suitable for eating. Thaysen,[2] in a recent lecture before a section of the Royal Society of Arts, has outlined the experimental work preceding the construction of a pilot plant capable of producing 100 to 150 lb. of food yeast per week. Some idea of the success of the experiments may be judged from the fact that the fourfold increase in the weight of the original inoculum in the case of bakers' yeast has been raised to 64-fold in the same period of time. The product, dried on rollers to a moisture content of 5 per cent., has a pleasant nutty flavour said by some to resemble meat. The nutritional value is high, the protein content being 40-45 per cent. and phosphorus 2 per cent., while the whole range of the B vitamins are present in balanced proportions. The experiments in human nutrition are still in progress, so that a full appreciation of the advantages of the utilisation of food yeast cannot yet be given. It would appear, however, that the authorities are convinced of the value of the material, since a plant has recently been completed in Jamaica for the daily production of 12 tons. This location of the factory was decided on account of the abundance of the raw material in the form of sugar or molasses.

Digestion of Fats

The popular belief, so long prevalent, that the presence of fats incorporated in foods by cooking renders them difficult to digest, is receiving some attention. Killian and March[3] have published their first paper of a series concerned with a study of the digestion and absorption of fats by human volunteers. The subjects, after a fast for 12 to 15 hours and the removal of the gastric residuum, were given test meals. At regular intervals the gastric contents were examined by removing samples for analysis. The findings indicate that "moderate amounts" of fat incorporated into foods by frying or baking showed no relationship between the fat content and the time taken for the elimination of the food from the stomach. Two other interesting facts which emerge are that properly-fried potatoes take no longer for digestion than boiled potatoes, and doughnuts no longer than the equivalent amount of fat as butter on bread! The presence of excess fat in fried potatoes did, however, prolong the time of digestion.

The problems associated with vitamin deficiency in foods vanish when the consumers have an adequate income and access

to the components of an adequate diet. It does not follow, of course, that a vitamin deficiency will not occur owing to an ignorance on the part of the housewife in selecting a balanced diet for those in her care. Those concerned with the manufacture of foods are therefore at pains to ascertain whether their products contain any of the essential vitamins, whether the manufacture or exposure for sale results in their destruction, and sometimes whether there are any advantages to be gained from the fortification of these products by the addition of certain of the vitamins. The statement by Drummond and Moran[4] a year or so ago that a not inconsiderable amount of riboflavin was present in tea has resulted in a more detailed examination of tea from various sources by Hughes and his collaborators.[5,6] They found that for 19 samples of tea from various places the amount of riboflavin varied from 6 to 11 μg per g. and of pantothenic acid from 14 to 40 μg per g. Seven samples, on being examined for nicotinic acid, gave figures ranging from 56 to 94 μg per g. Coffee, too, contains appreciable amounts of nicotinic acid according to Teply, Krehl, and Elvehjem,[7] who point out that there is no pellagra in Brazil among a people whose solid diet is quite low in nicotinic acid.

Work on Vitamins

The fortification of foods with vitamins has been discussed at length in various journals. Whatever one may think of the uncontrolled addition of vitamins to foodstuffs in peace-time, there is everything to be said in time of war for the addition of certain vitamins to certain articles of the diet. For example, Siemers[8] has computed that the average American Serviceman eats 110 lb. of sweets each year, and on this basis he suggests that it is reasonable, following the lead given by the authorities for the enrichment of flour, for foods essentially carbohydrate in character to contain "an appropriate amount of the vitamins associated with carbohydrate utilisation." He then suggests the amounts of various vitamins to be added to restore that lost during processing and storage. The addition of vitamins to chocolate has received attention by the authorities in this country both for the Services' requirements and for the relief of distress on the Continent. Activated, no doubt, by similar motives, but without giving any estimate of the amount of liquor consumed by either the public or the American serviceman, Younger and Harvey[9] report on the stability of added vitamins in beer. They argue that as improved malting and brewing methods will result in an increased content of the B-complex vitamins, it is essential that the effect of storage on their stability should be studied. They show that light and heat are responsible for the destruction of some members of the group, while others are completely stable for at least six months.

Pork is rich in thiamin and it is therefore natural that, until the mechanism of the loss of this vitamin during the cooking of the meat has been thoroughly worked out, studies on the subject will continue. In recent years it has been shown that thiamin in natural products is considerably more heat-resistant than it is in aqueous solutions. Rice and Benk[10] have studied the kinetics of the thermal destruction of thiamin in small (5 g.) samples of minced lean pork at various temperatures from 50° to 120° C. They find that above 77° C. the destruction is proportional to temperature and at any one temperature the rate of loss is constant. They suggest that an hydrolysis takes place. Below 77° C. the speed of the reaction is faster first than it is later, when it again becomes monomolecular. They intend to continue their studies, but point out meanwhile that their results explain why smoked hams (held at 63° C.) retain so much more vitamins than roast pork.

It is interesting to note how the methods of vitamin assay have changed with the years. First we had the rat growth method, then the purely chemical method with its complication of interfering substances which became of smaller importance as the chemistry of the vitamins became better known. Now it would seem that the cycle is complete, at least for certain vitamins, since the biological assay with its tedious and exacting system of records has become the microbiological assay using decinormal caustic soda. The latter method is, of course, not so simple as the last sentence would indicate. Barton-Wright[11] has discussed the microbiological assay of the members of the vitamin-B complex, three of which, aneurine (thiamin), riboflavin, and nicotinic acid, are of interest to food manufacturers under the new labelling order. He describes in detail the basal media required for the various micro-organisms and details for the computation of the results obtained. It remains to be seen how the average analytical chemist accustomed to purely chemical work will adjust himself to this type of analysis.

Moisture in Cereals

"It must be acknowledged that the determination of moisture, while a fundamental part of any analytical scheme, remains one of the most empirical of procedures." With this sentence Fosnot and Haman[12] introduce their paper on the application of the Fischer reagent to the determination of moisture in cereals and cereal products. Quite apart from the difficulties associated with volatility of compounds other than water, the time taken over the drying process and the necessity for at least two weighings add

considerably to the labours of the factory chemist. The Fischer reagent, introduced in 1935, is specific for water although the reaction between the iodine, sulphur dioxide, pynidine, and the solvent methanol has not as yet been worked out satisfactorily.

The actual determination may be electrometrically controlled, so that coloured materials may be examined without interference with the end-point which is brown to colourless. The material to be tested is added in a weighed amount to the solvent and allowed to stand for a period before the addition of the reagent. Apart from some deterioration of the reagent and the necessity for working with the apparatus protected from atmospheric moisture, the method lends itself to the routine testing of samples with a saving of time and labour. These authors quote results for a number of products with a moisture content of 10 per cent. or less, but they also include malt syrup (20 per cent.) and condensed skim-milk (73 per cent.) as examples of products which may be examined by this method.

A further paper by Johnson[13] describes the application of the method to the examination of comparatively dry products. This author is concerned with the effect of the soaking time and of the size of the particles on the result obtained. He shows that for some products higher results are obtained with a prolonged soaking period and with further grinding. The vacuum oven method, which is standard practice for the determination of moisture in certain products, has been modified by a patented process[14] involving the use of dielectric heating. In the apparatus described the material is placed in a quartz crucible inside a vacuum desiccator. The high-frequency current (about 112 megacycles) is passed between the two electrodes. Analysts will await further details of the process before passing judgment.

Metallic Impurities

Only those who have the task of analysing numerous samples of foods for metallic impurities will appreciate the real significance of the paper by Strafford, Wyatt, and Kershaw.[15] These authors describe in detail their scheme for the photometric determination of traces of arsenic, copper, lead, zinc, and iron on a single 2-g. sample of the material. They state that a senior assistant, using the Society of Public Analysts Metallic Impurities Committee's methods, was originally able to test 12 samples of organic medicinals. Using the proposed scheme, this number was increased to 20 and, if zinc was omitted, the figure could be raised to 30. The method briefly consists in the wet oxidation of the sample, followed by the selective solvent extraction of the metals as metallo-organic complexes. The final determination of each of the metals is carried out using the Spekker photo-electric absorptiometer. For those who do not enjoy the arsine stain methods for the determination of arsenic, there is a new solvent extraction method given with an accuracy claimed to be ± 0.5 p.p.m.

Crude fibre, which is the indigestible part of foodstuffs, consisting of cellulose, lignin and water-insoluble hemicelluloses, is generally estimated by treating the sample successively with dilute sulphuric acid and sodium hydroxide. It is generally agreed that this treatment does result in the "solubilisation" of some of the fibre. A very rapid modification of the method has been proposed by Whitehouse, Zarow, and Shay,[16] in which a mixture of glacial acetic acid, nitric acid, and trichloracetic acid in water are used. This method would appear to have the same disadvantages as the original. A more logical method is the enzymic digestion first used in 1931. Woodson and Mackenzie[17] have further examined the enzymic method, using a preparation isolated from the pancreas of hogs. This material requires 96 hours as against the 8-day digestion necessary with the enzymes originally recommended. A sample of corn meal which showed 1.8 per cent. crude fibre by the chemical method showed 8.2 per cent. by the enzymic method.

Oxidation of Fats

The development of rancidity in fats and its prevention by the presence or addition of antioxidants is generally studied by the determination of the peroxide value of the material from time to time under controlled conditions. The test consists essentially in the addition of potassium iodide to the sample dissolved in a suitable solvent, and the volumetric estimation of the iodine liberated. It was originally described in 1931 by Lea and has since been modified. Stuffins and Weatherall[18] have recommended that the reaction be allowed to proceed at room temperature in the absence of daylight and atmospheric oxygen. These modifications, they claim, will prevent oxidation of the reagents giving erroneous results. Where the stability of a fat against oxidation is being examined, it is necessary that peroxide values be determined at fairly frequent intervals. This work may be simplified if advantage is taken of the suggestion made by Chirgwin.[19] This author has studied the change in the refractive index of an oil with increasing peroxide value, and he finds that changes in the slope of the peroxide value curve are followed by similar changes in the curve relating the refractive index to the duration of the test. Where antioxidants are being examined, it is only necessary to carry out one set of peroxide value tests on the fat being used, the refractive index also being determined. Thereafter, as long as the same fat is being used, it is only necessary to determine the refractive index,

a much simpler operation and one requiring a very small amount of fat.

The manufacturer of foods may prepare a very satisfactory article with universal appeal, but if there is insufficient protection during transport to the home or during storage in wholesalers' premises, the deterioration may set in with considerable loss of appeal. If, also, the product is subject to control under a Ministry of Food Order in regard to composition, unsatisfactory packaging may materially affect the results obtained on analysis and cause the sample to become the subject of a prosecution. Fairbrother[20] shows that storage of self-raising flour at relative humidities of 70-100 per cent. and temperatures of 52-85° F. may result in the total CO_2 falling from 0.548 per cent. to 0.380 per cent. in three months, unless precautions are taken to select suitable forms of package. Breakfast cereals deteriorate if the moisture from the atmosphere penetrates the outer package or the liner. Manufacturers obviously would prefer not to point out on the label the fact that the contents may be restored to their original crispness by being placed in the heated oven for a short time. Felt and co-workers[21] have compared the shelf-life of certain packaged cereals under actual field test with the shelf-life expected from a consideration of the nature of the contents, the moisture permeability of the materials of the package, and data from the weather bureau of the locality where the product will be stored. Of twelve places in the United States selected for the test, the observed shelf-life agreed quite well with the calculated shelf-life in all except one where the effect of temperature heavily outweighed that of humidity. In view of the desire to increase the export trade from the United Kingdom and the necessity to reduce the weight of the package to the utmost consistent with safety in transport, it is inevitable that manufacturers should concentrate on this type of development work in conjunction with the manufacturers of wrappers and packages.

High-Frequency Heating

Two examples may be taken to illustrate the attempts made to apply more modern methods of tackling certain stages of the manufacture of foods. The blanching of potatoes, hitherto effected in steam, has been successfully accomplished by the use of high-frequency inductive heating. Now that high-frequency heating has been used to defrost frozen foods and to grill certain types of meat, it is natural that other uses should be sought for this type of equipment. The use of the dielectric form of high-frequency heating was found by Schade[22] to result in the charring of the skins due to the necessity for using a high voltage across the plates to pass enough current through the potatoes to raise the temperature at a sufficient rate. He found a more satisfactory method was to immerse the potatoes in a dilute salt solution of suitable electrical resistance and to pass a high-frequency current (250,000 cycles) through the liquid by means of flat electrodes. Rapid and uniform heating of the potatoes was found to take place, particularly if they had previously been peeled. Whether this process will find application commercially depends upon the question of the initial cost of the equipment and the costs of running and maintenance.

The softening of water by the ionic exchange process is well known, although the application of the same principle to other materials is not so well known. A example of such an application to apple syrup is given by Buck and Mottern.[23] In place of the use of lime to remove the malic acid, which results in the bitter flavour of calcium malate, the authors have used the ionic exchange process with success. They find that not only does a single onion exchange treatment remove 80-90 per cent. of the malic acid, but it is also possible to remove the arsenic and lead derived from sprayed fruit. The process must, of course, be under adequate scientific control, but when this is available the results are said to be very satisfactory. The authors were able to use the ionic exchangers for as much as 75 cycles without detectable loss in capacity.

Transport of Fruit

The satisfactory transport of fresh fruits to this country is a subject which will appeal to all who have missed them during the war. The attack by green mould on citrus fruits is well known and the results are extensive and unpleasant. The use of volatile fungicides impregnated in the paper wrappers was investigated by the Food Investigation Board[24] prior to the war. It was found that both diphenyl and *o*-phenylphenol were effective in preventing the growth of the mould. The question of the toxicity of these compounds has now been examined by Macintosh,[25] who finds that pharmacologically diphenyl appears to be inert as far as animals are concerned, even when using doses far greater than would be consumed by human beings according to the data recorded by Tomkins.[26] The application of a carefully selected wax coating has been found in America to be of considerable advantage in delaying decomposition and drying out of fruit in storage. Kalmer[27] has described the commercial application of such a protective covering to tomatoes, oranges, and cucumbers, and illustrates the differences between treated and untreated products after storage.

Those who are familiar with the process of kippering herrings will know how much the success of this operation depends upon the skill of the operator. The fish are split and the roe or milt removed. After washing

they are immersed in a salt bath and then hung up in a smoke kiln. The operation of such a kiln is considerably affected by the humidity and temperature of the ontside air, with the result that unless the operator of the kiln is thoroughly skilled the final products vary considerably in their flavour and keeping qualities. In some cases it was necessary to immerse the herrings in a dye bath before smoking to produce a colour which should be developed in the kiln. It is therefore satisfactory from the consumers' point of view to find that the art of kippering may now become a science as far as commercial practice is concerned. The principles underlying the process have been worked out largely at the Torry Research Station of the Food Investigation Board and have been described elsewhere. The commercial application has now been described and illustrated.[28] The kiln used is simple in design and continuous in operation, the fish entering at one end into an area of lowest temperature and highest humidity, and passing through controlled zones to emerge properly kippered. The development of this process, coupled with the present successful mass quick-freezing of herring at the landing port, will enable districts far removed from the coast to receive fish in good condition at moderate prices and may also help to improve the general quality of this type of fish at places inland.

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Overseas Trade

Disappointing November Results

BRITISH exports in November have failed to show an improvement; in fact, they are the lowest of the three full peacetime months, a development which has nothing to do with the docker's strike, as the dockers had returned to work on November 5, involving a loss of only 2½ days in the preceding week. The total of £29.9 million was £2.1 million below the average for the first ten months. Exports of relief goods were below normal, shipments of food to countries in liberated Europe amounting to 1.8 million, against an average of 2.3 million for the previous quarter. Exports of coal amounted to £732,219, compared with £1,007,106 in October, machinery exports receded sharply from £4,015,266 to £2,116,255, but the major reduction took place in cotton and rayon goods, exports which fell by nearly 50 per cent. to £2,237,154. As a result both of the decline in exports of machinery and cotton goods, exports of chemicals, drugs, dyes, and colours head the list with £3,087,933, that is, a maintenance of the ten-monthly average of £3,081,825. Exports of oils, fats and resins at £323,138 show an increase over the average of £240,429.

The value of imports was also lower than the previous average, the reduction being £3.8 million, and the November figure £90.2 million, and there was also a reduction in re-exports. The decline was due wholly to smaller imports of manufactured goods, which fell from £27.6 million to £14.4 million—one-quarter smaller by value than in 1938 and about three-fifths lower in volume. The major reduction as compared with earlier months was in refined petroleum, imports of which, valued at £6.4 million, remained over two-fifths of the recorded total, and did not differ materially from those in the two preceding months. Imports of raw materials show an expansion from £24.4 million to £30.4 million. Imports of chemicals, etc., were at £1,049,836, substantially below the ten-monthly average of £1,616,718.

LOUGHBOROUGH COLLEGE

A request for the admission of a considerable number of Indian students to be trained with British engineering methods and familiarised with British Engineering products, is one of the problems now facing Loughborough College, according to a survey made by the principal, Dr. Herbert Schofield.

The college is one of the few civil establishments giving practical training in metrology. The new metrological laboratory is an underground windowless room specially kept free from even the slightest vibration, illuminated by fluorescent tubes, and having a constant air temperature of 68° F. the college has been certified by the N.P.L. as a testing centre for instruments and gauges. Closely allied with this faculty is the research department of the Institution of Production Engineers.

Physical Society's Exhibition

Some Apparatus of Interest for the Chemist

AMONG scientific instruments and apparatus demonstrated at the first post-war exhibition, held with great success a few days ago by the Physical Society at the Imperial College of Science and Technology (*see* THE CHEMICAL AGE, January 5), a Mullard-B.T.L. potentiometric titration apparatus of Baird & Tatlock (London), Ltd., deserves attention. Its outstanding feature is the incorporation of an electron-beam indicator in place of a needle galvanometer. Not only does the "Magic Eye" enable the point of balance to be ascertained more rapidly, but it is also possible to make the closing of the "eye" coincidental with the end-point of the titration. Other exhibits included a grease-testing apparatus, an apparatus for determining water resistance and loss on rotation, and a U-tube viscometer bath, primarily intended to meet the stringent temperature-control requirements of the Institute of Petroleum. Both "Unity" and "Industrial" models of the B.T.L. electrolytic analysis apparatus were also on view; these have been designed to produce adaptable units which, by addition of slave units to the original unit, can be built up into a multi-test outfit.

Di-electric Heating

An apparatus on view publicly for the first time was the Ferranti-Wild-Barfield high-frequency di-electric heating equipment, manufactured by Wild-Barfield Electric Furnaces, Ltd., Watford, Herts. It may be applied in the pre-heating of plastic moulding powders and pellets, the drying of timber and textiles, the glueing of plywood and joints, the curing of rubber, and for other similar processes. The company exhibited also a Spekker photo-electric absorptiometer, in use for metallurgical work, as well as a Wild-Barfield Resilia pyrometer-testing equipment. An air-damped balance and a high-vacuum pumping unit were exhibited by J. W. Towers & Co., Ltd., Widnes, Lancashire. Exhibits of Townson & Mercer, Ltd., Croydon, included a precision thermostat tank, a Turbinia stirrer, viscometer mountings (cemented into laminated plastic plaques at right angles), and a "strip-action" still, an all-glass multi-surface condenser of small size, which fractionates dirty steam and produces distilled water of good quality from normal steam mains at a rate of one gallon per hour from normal steam.

Optical glass produced by melting in platinum pots, optical glass lens mouldings, and a Flamemaster hand torch are products of Chance Bros., Ltd., and Austinlite, Ltd., Smethwick, Birmingham, which were also on view for the first time. The hand torch has been designed as a universal burner for all flame processes and gives a wide variety of flames when using either gas/air or gas/oxygen mixtures. Quickfit & Quartz, Ltd., King's Norton, Birmingham, show some of their well-known products: there is an all-glass still with a 100-litre steam-heated vessel, and 15 sq. ft. surface condenser, a steam-heated boiler and heat exchanger, capable of operating under steam pressure up to 50 lb./sq. in., and a reflux or distillation condenser.

Vitrified enamel scales and graduations on glass were exhibited by Johnson, Matthey & Co., Ltd., London, E.C.1. The markings are in the form of vitrifiable enamels fired on to the glass, forming a permanent design which is resistant to abrasion and highly resistant to corrosion. The minimum line-thickness is 0.005 in. and the limit of accuracy ±0.5 per cent. Negretti & Zambra, of London, W.1, exhibit a range of their well-known instruments, and Griffin & Tatlock, Ltd., London, W.C.2, demonstrate their anti-vibration balance table. Their G. & T. "Tep-meter" which fills an urgent need in the carrying out of routine chemical analysis, because the employment of physico-chemical methods, which can be operated by junior assistants, dispenses with the employment of trained analysts. The latter instrument is also based on the "Magic Eye" as an indicator, thus avoiding sensitive galvanometers. Changes of potential of suitable magnitude cause the eye to open and to indicate the end point of a reaction. Furthermore, it announces the approach of such an end-point, due to the addition of the titrant, by opening and closing repeatedly ("winking") when the equilibrium point has been nearly reached. An electro-chemical analysis apparatus, a five-unit model, has been designed to meet the demand of the non-ferrous metals industry during the war, when the shortage of trained personnel necessitated the introduction of more rapid methods of accurate alloy analysis. A specific surface apparatus for measuring the surface of powders, a new model of the G. & T. Ford cup viscometer, and the sulphur-in-steel determination apparatus were also on view.

The first deliveries of rubber to Italy by the Allies have just arrived. They comprise 836 tons of synthetic rubber, 555 tons of synthetic rubber products, and 81 tons of natural rubber. The Pirelli plants have been charged with the distribution of these products to Italian industry.

Metallurgical Advances in 1945

Phenomenal Progress

by A. G. AREND

METALLURGICAL advances during 1945 have been of so striking a character as to be justly described as phenomenal; at no time previously have improvements been developed, and fresh avenues opened up, of such a basic and fundamental disposition. While most of this relates to the practical implementation of atomic researches, other associated studies are likely to have equally far-reaching effects. As recently as the beginning of the war, proposals for the transmutation of metals were regarded as little better than the prophecies of the ancient alchemist, but in 1945 this reached actual fruition. From another aspect, pre-war electronic applications were concerned rather with simple devices for automatic starting and stopping or counting mechanisms, and had little apparent bearing on the prodigious advancements made this past year. Literally all these electron emissions depend on selected metallic oxides coated on cathodes, using electrodes of specially made and fabricated metals, under different tube conditions. As almost all of the common base metals, besides many of the rare metals, have enjoyed further applications or improved treatment, omissions must not be accepted as errors in a description within limited space.

It would almost appear that some form of telescoping of subjects is required nowadays so that the main features of advancements may be picked up at a glance. Abstracts are frequently apt to be too abstract, to lack clarity, and to fail to give a clear picture of what it is intended principally to convey. It has been suggested elsewhere that more numerous illustrations, and (following American practice) the use of colour printing, could make difficult concepts clear. After all, what is wanted is a ready appreciation and assimilation of a subject, without the necessity for devoting most attention to interpretation and translation of fresh expressions and nomenclature.

Spectrographic Improvement

When the spectrograph was first introduced, it was considered an appreciable advance that quantitative analysis of numerous metallurgical products could be completed in about half an hour. Briefly, this involved the developing and fixing of a photographic plate, followed by measuring the bands which appeared on the spectrogram by a microscope, to ascertain the percentages of the respective metals. When the war started, an improvement on this comprised the use of a device which automatically ran over the surfaces of these bands and registered the percentages on a recorder. While this was an advance, it still necessitated the development of the photographic plate, etc., although efforts were made to apply the measuring microscope directly. During 1945 a marked advancement was made by the application of the electron multiplier tube, which is claimed to amplify the bands as they appear, for immediate measurement. What electrons are projected bounce off the plate in a considerably multiplied number. If, as is suggested, this is fully ratified in all ways, it

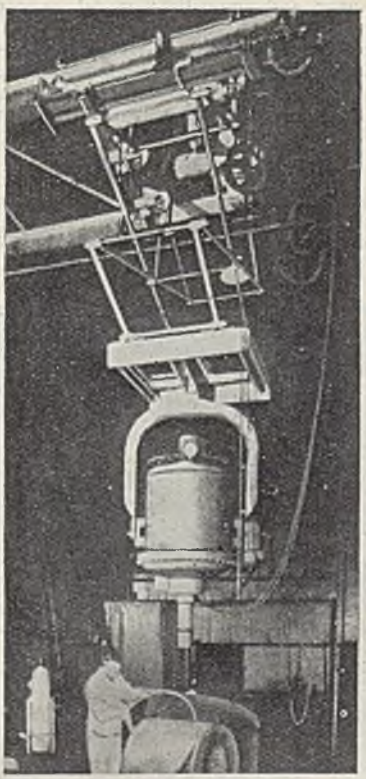

Fig. 1. Million-volt X-ray apparatus mounted on overhead travelling crane, used for examining inclusions in heavy metal parts. (GENERAL ELECTRIC X-RAY CORPORATION, CHICAGO).

means that the familiar developing and fixing, followed by measuring, can be obviated, since the bands can be made to appear directly on a calibrated screen, for the eye to see the percentages the moment the sample has been placed within the miniature arc. A stack of ten 67.5-volt batteries giving a total of 675 volts is engaged for this electronic amplifier, so that it is possible to get an output 20,000 times greater than is possible with the ordinary photo-tube. Thus, even the smallest proportions of metallic contents should appear for easy and immediate visual conception in actual percentages. It is intended, of course, to apply this system in numerous other ways, such as the instant measurement of X-ray diffraction patterns, chemical analysing devices, and other similar recording equipment.

Micro-radiography

An advancement of corresponding importance was again seen in 1945 in the introduction of micro-radiography, or the micro-radiographic application of X-rays in metal-

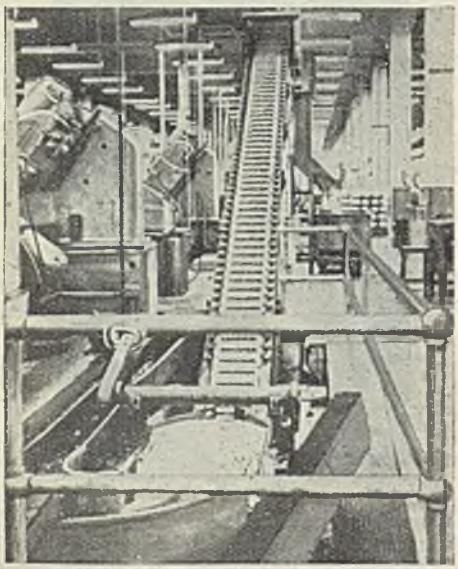

Fig. 2. Apron conveyor with vibrating screens for rapid automatic handling and de-oiling of aluminium chips from engineering-shop floors. (LINK BELT CO., PITTSBURGH).

lurgy. The ordinary study of metallography was frequently suspected of being in error, since internal crystalline structures as thrown up from the surfaces of samples could scarcely be regarded as a true criterion of the interior. During the war, X-ray studies of metals still persevered with the initial investigation of fissures, voids, blow-holes, etc. This has now been supplemented by the ability to acquire the desired three-dimensional contours of the metal structure, by which means the exact distribution of the different phases, and any lack of homogeneity, is clearly portrayed. A certain restriction of advancement was apparent with the earlier system of obtaining the shadowgraph or radiograph (the method still mainly adhered to) because the method of acquiring the contrast allowed of no latitude, and was fixed and definite.

With the recently improved system, the emission from the X-ray tube comprises two parts of different wavelengths, one superimposed on the other, and the contrast from these is imprinted on a special photographic emulsion. This in turn is magnified optically, 100 or more times as required, and reveals the interior structure with the greatest precision. Samples of metal are cut and polished in the usual manner, thin specimens being preferred. To make this matter of obtaining the maximum contrasts clear, one wavelength depends on the voltage applied, while the other is not affected by the voltage, but by the material of the X-ray target used. While on the whole the micro-structures as revealed by ordinary optical microscopic examination were fairly correct, the improved system soon revealed errors in the presumed distribution in different alloys.

In view of the vast amount of theoretical details which have been lavished on metallography, this modern study should act as a deterrent to those who only follow up existing practice, and add voluminous hypotheses without making provision for improvements. Much of this micro-radiography has already been applied in forging, rolling, extrusion, and other methods of fabrication, and particularly to discovering the structures which give the best machining properties. Metallography in colour is a study which was somewhat restricted by the war, but which also showed great promise of assisting easy discrimination.

To facilitate and expedite the work of the engineer, a number of instruments have been evolved this past year for measuring the hardness of microscopic areas of metal surfaces. For studying metal-to-metal impact behaviour, ultra high-speed cameras have been developed to ensure appropriate photographs. Researches of the creep strength of metals of the long-time order necessitate months for completion, and are considered of primary importance for alloy steel units, turbine blades, and other parts exposed to heated conditions.

In order to make a certainty of following plastic flow with precision, a number of new constant strain-testing machines, and high-speed tension machines have also been evolved. The latter cause extremely rapid

plastic deformations, approaching those of an explosion, to be produced, where an inch-long tension bar can be broken in 0.001 second. Such instruments have been applied alike to thin light-metal sheets, to ship steel, and to armour plate.

Since accurate alignment and perfect shaping became so essential in assisting direct rapid mass-production of metal sections during the war, the need for a true record of the exact roughness of surfaces became apparent. The electron microscope, photo-cell reflecting light recorders, and specialised optical microscopic methods were at first used, but in 1945 automatic surface analysers were introduced. These obviated the need for the human element, as a diamond stylus point was caused to ride automatically over the surface giving an exact record of the surface irregularities, without being interfered with by any wavy disposition on the part of the metal itself. It will thus be gathered that instruments have played an increasingly important function in linking up the work of the metallurgist with that of the engineer.

The great penetration of the betatron, which represents the most powerful form of X-ray machine, and gives an accurate conception of what lies well below the surface of metals in a manner not previously possible, was introduced earlier than 1945 and cannot be described amongst the latest developments. Its 20-million-volt X-ray beam, however, has had its uses still further extended, while it is understood that a 100-million-volt machine is in the course of construction. In other directions, shrinklits using liquid oxygen, and other specialised refrigeration methods, have now made it possible to connect metal parts within tolerances which formerly were not thought possible.

Developments with Common Metals

A brief review of some of the individual metals which have enjoyed improvements during 1945 is herewith appended in short detail. Information has come to light on the improved final stages of the Pidgeon magnesium process which requires neither a large electric power supply, nor a raw material of high magnesia content. Magnesia as contained in dolomitic limestone is reduced by ferro-silicon in the form of briquettes in externally-heated vacuum retorts. Modern mechanical handling has evidently made a marked improvement in the continuity of this process, and 20 furnaces are, each equipped with 20 individual retorts, operated in rotation. Each reaction cycle occupies approximately 10 hours, when the retorts are opened to permit the magnesium to be removed from sleeves contained within the condensers; the material is claimed to be of 99.9 per cent. purity. The retorts are operated at high vacuum and high temperature, and the product is pressed to crown-shape in presses, before being dispatched to the melting and alloying department where the ingots are cast. The light metals so produced have involved more intensive study in respect of their varying physical properties than probably any other alloys.

Aluminium has not reached such prominence recently, but one of the improved processes this past year consists of constructing a special elevator and screen arrangement for more or less automatically removing all chips from engineering-shop floors. These are de-oiled in such a manner that several barrels of oil are recovered per week, while the clean particles continuously pass to briquetting machines for continuous remelting (*see* Fig. 2).

Tin has been less prominent, with the absence of supplies from the Far East, but

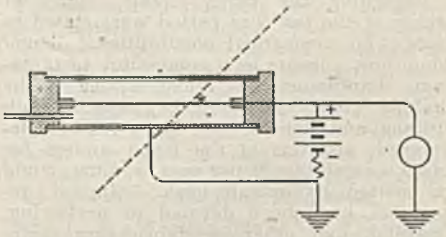

Fig. 3. Arrangement of a Geiger-Müller counter, portable makes of which are to-day used for instant detection of the presence of uranium deposits.

every effort has been made to improve the recovery of what tin was available. During the war, the task was to find suitable substitutes for tin solders and bearing metals, and this revealed only too clearly how valuable was the virgin metal. The most economical de-tinning process has proved to be a mechanical handling one, rather than the best scientific one. This latter, a patented process using sodium hydrate electrolyte and copper oxide depolariser, permitted a full regeneration of the reagents used, and a recovery of the tin at the cost of current alone, but it could not compete favourably with the ancient chlorine system. It has been found that great accumulations of tins, cans, and boxes of all kinds are more easily charged and discharged for chlorination by modern mechanical handling systems, and this form of reclamation has thus turned out cheapest.

Improvements in the making of lead screws and other fabricated parts have been introduced, while the oxides, red-lead and litharge, are to-day produced by automatic means. The use of lead metal as a screen in isotope separation processes must not be forgotten. Zinc is faultlessly prepared for process plates for the lithographer by improved methods of

surface treatment, using the instruments previously referred to. A special cheap zinc alloy has been introduced for templates, etc., while there has been a revival of electric smelting of zinc ores. Copper by itself, as an alloy, and also in the form of beryllium-copper, has been put to a comprehensive list of fresh uses, and in the U.S.A. has apparently reached some prominence for roofing purposes.

Antimony pigments have proved successful as flame-resisters as well as being good heat-resisters, while a number of fresh type-metal compositions have been tried with the metal itself. In steel-making, the latest attempts comprise efforts at operating the process on an automatic basis, which up till now has not been thought possible.

Advancement with Rare Metals

Regarding the rarer metals, many of which at the last war period were stated to have "no commercial possibilities," columbium now appears as a competitor to tantalum. Lanthanum has found service in the making of special optical glasses. Both lithium and indium have been further developed, and one of the latest solders for glass, containing 20 per cent. indium, could be melted by human heat. Special researches have been devoted to perfecting, drawing, and otherwise fabricating tantalum, between each stage of which specialised vacuum annealing is now under the closest automatic control. Rhenium is at present being tried out as being the metal with probably the highest melting point. The most prominent use of tungsten during the year was in the making of tungsten-target type X-ray tubes. The oxides of cæsium, rubidium, molybdenum, and a host of other metals are now utilised in the construction of electron tubes.

Lastly, reference should be made to uranium, a metal which until the present time enjoyed only very fluctuating fortunes. A failure as a competitor to tungsten steels during the last war, of limited value for colouring glazes and in photography, too expensive as a cigarette lighter, and the first large-scale catalyst used for synthetic ammonia production, uranium has now reached great prominence in atomic studies. One of the simplest metals to test, qualitatively, by its radio-activity (although this is extremely weak compared with radium) and by wet methods, taking advantage of its unusual property of possessing a soluble carbonate, but a distinctively precipitated hydrate, it offers practical difficulties for accurate quantitative determination. This is to-day simplified by poloragraphic estimation with the dropping mercury cathode.

The fact that palladium was made by transmutation during 1945 is sufficient evidence of what is to happen to other precious metals in the near future.

Personal Notes

MR. H. W. CREMER has been appointed a joint honorary secretary of the Society of Chemical Industry as from January 1.

MR. J. M. LEONARD has been elected vice-chairman of the Chemical Engineering Group, S.C.I.

MR. L. SHUTTLEWORTH has been appointed manager of the distillation and by-products department of Dorman, Long & Co., Ltd.

PROFESSOR I. M. HEILBRON, F.R.S., has been awarded the Priestley Medal of the American Chemical Society.

DR. R. C. HOATHER is the new Principal of the Counties Public Health Laboratories, Gidea Park College, Essex, as from January 1.

DR. J. P. BAXTER, of I.C.I., has been awarded the O.B.E., in the second part of the New Year honours list, for his chemical research work in connection with the development of the atomic bomb.

MR. G. F. A. BURGESS has been released from his duties as Mica Controller, and the new head of the Mica Directorate is MR. G. H. TIPPER. The Directorate will operate from the same address as the Control: Euston House, Eversholt Street, London, N.W.1.

By the retirement, on January 1, of LIEUT.-COL. G. P. POLLITT, D.S.O., M.Sc., Ph.D., I.C.I. lose one of their original directors. Distinguished as a soldier, research chemist and farmer, Col. Pollitt was responsible for the construction of the largest chemical works in the British Empire, at Billingham-on-Tees, the importance of which to the national security was so amply proved in the war just ended.

Obituary

SIR FRANCIS SAMUELSON, Bart., who died on January 3, aged 84, was president of the Iron and Steel Institute in 1922-24 and became a director of Dorman, Long & Co., Ltd., when his firm, Sir B. Samuelson & Co., Ltd., was acquired by that company. He resigned from the board about ten years ago, when Dorman, Long was reorganised.

MR. EDGAR PAM, a director of the Mond Nickel Co., Ltd., and president of the Institution of Mining and Metallurgy, died on December 20. He joined the Mond Nickel Co. in 1928 as consulting mining engineer and in 1945 he was appointed a member of the board. He was closely concerned with the company's operations in the Petsamo area of Northern Finland down to the time of the outbreak of war there.

General News

The parcel post service to Czechoslovakia has been restored.

The first batch of German scientists and technicians who are to work in this country was landed at Barrow-in-Furness on Friday last week.

DTD Specification 31 CC, "Soft Aluminium Alloy Tubes" (suitable for oil, petrol, gas starters and general low-pressure purposes) supersedes DTD 31 OB.

The European Coal Organisation, provisionally set up last May to promote the supply and distribution of coal and certain types of mining equipment, was formally established in London on January 4.

The Minister of Food announces that there will be no changes in the existing prices of *refined* oils and imported edible animal fats allocated to primary wholesalers and large trade users during the eight-week period January 6 to March 2.

During 1944 the paper-making industry in Ireland used 845 tons of chemicals, valued at £25,384, compared with 929 tons (£21,925) in the preceding year, according to a census of industrial production report just published by the Eire Department of Industry and Commerce.

An interesting new catalogue of "Benn Books" published by Ernest Benn, Ltd., was issued on January 1. Chemists will be interested to see that Sir James Dewar's study of Professor Armstrong is available, as well as some important works, great and small, on chemistry and chemical engineering.

A new shaft is being sunk by B. A. Collieries, Ltd., at Calverton Colliery, Notts, the first sod having been turned on January 11 by Col. C. G. Lancaster, M.P., chairman of the company. The shaft will be sunk 1800 ft. to the top hard seam, and the pit is expected to be opened in 1948.

Penicillin treatment for Salford school children has now been introduced in the city's clinics. The treatment is being given for certain kinds of skin infection and defacing skin conditions, and brilliant success had been achieved in a number of instances. Conditions normally requiring months to clear were cured in a matter of days.

The report for 1945 on the Vacation Work Scheme of the Imperial College Union records that 467 students were placed with 230 firms (in 1944, 477 with 214). Among additional companies which have prepared I.C.U. leaflets detailing the schemes in operation for students' benefit are the following: British Industrial Solvents, Ltd.; Kodak, Ltd.; May & Baker, Ltd.; Shell Refining and Marketing Co., Ltd.

From Week to Week

On and after January 15 an air-mail service for letters and postcards will operate between Great Britain and Eire. In addition to the ordinary inland postage charge, a special air fee of 3d. for each 8 oz., in the case of letters, or 3d. for each postcard must be prepaid.

Dr. P. B. Moon, Reader in Atomic Physics at Birmingham University, is to deliver a lecture on Atomic Energy at Cadbury Brothers Works on January 16. The lecture, which will be followed by a discussion, will deal with the constructive aspects of atomic energy rather than its use as a destructive agent.

For the current rationing period ten additional clothing coupons, "The Industrial Ten," are being issued to a wide range of manual workers in industry and agriculture. The categories of worker eligible are substantially the same as in the 1944/45 ration period. Part-time workers will be able to apply if they work 22 hours or more a week, and supervisory workers if they are exposed to exceptionally hazardous conditions.

Mr. J. H. Wootton-Davies, of Liverpool, M.P. for the division until his defeat in the General Election, has been adopted prospective Conservative candidate in the Heywood and Radcliffe by-election. Mr. Wooton-Davies is the principal of a well-known Aintree soap firm. He joined Messrs. Lever Brothers as an apprentice chemist and became chief chemist and technical adviser to their foreign companies. During the 1914-18 war he was technical adviser to the Ministry of Munitions concerning glycerine production.

Forthcoming Events

January 14. Royal Institute of Chemistry (Leeds Area Section). Chemistry Lecture Theatre, Leeds University. Dr. F. M. Lea: "Research on Building and its Materials."

January 14. Association of Austrian Engineers, Chemists and Scientific Workers in Great Britain. Austrian Centre, 69 Greencroft Gardens, Hampstead, London, N.W.6. 7.30 p.m. Dr. F. Singer: "Modern Ceramics."

January 16. Royal Institute of Chemistry (Belfast and District Section). Physics Lecture Room, Royal Academical Institution, 7.30 p.m. Mr. D. Lindsay Keir: "The Influence of Science on Civilisation."

January 16. Institute of Fuel (Midland Section). James Watt Memorial Institute, Birmingham, 2.30 p.m. Mr. R. Scott: "Some Aspects of Tar Distillation."

January 16. Institute of Physics (South Wales Branch). University College, Aberystwyth, 2.30 p.m. Dr. J. H. Shaxby: "The Eye and Colour." Visitors will be welcome.

January 16. Institute of Welding (N. London Branch). Fyvie Hall, The Polytechnic, Regent Street, Londuon, W.1, 7.30 p.m. Mr. R. R. Sielifant: "Submerged Arc Welding."

January 16. Institute of Fuel (Yorkshire Section) and **Coke Oven Managers' Association.** Royal Victoria Station Hotel Sheffield, 2.30 p.m. Dr. J. G. King and Dr. F. J. Dent: "The Utilisation of Waste Heat in the Carbonising Industries."

January 16. Royal Institute of Chemistry, British Association of Chemists and **Association of Scientific Workers.** London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, 6.30 p.m. "The Present and Future Rôles of the Technical Press."

January 16. Society of Chemical Industry (Food Group). Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1, 6.30 p.m. "Science and Tea." Introductory remarks: Sir Frank Engledow. The following papers will be presented: Dr. L. H. Lampitt: "An Historical Survey," and Dr. A. E. Bradfield: "Recent Developments in the Chemistry of Tea."

January 16. North-Western Fuel Luncheon Club. Engineers' Club, Albert Square, Manchester, 12.30 p.m. Mr. Harold Moore: "The National Economics of British Petroleum Refining," followed by a visit to the Manchester Oil Refinery, Trafford Park, by invitation of Dr. F. Kind.

January 17. Chemical Society. Burlington House, Piccadilly, London, W.1, 5 p.m. Professor E. D. Hughes: "Substitution" (Tilden Lecture).

January 17. Society of Chemical Industry (Road and Building Materials Group). Gas Industry House, 1 Grosvenor Place, London, S.W.1, 6 p.m. Mr. P. Good: "The Presentation of British Standards."

Company News

At a recent extraordinary general meeting of **Evans Sons, Lescher & Webb, Ltd.,** it was resolved to alter the name to **Evans Medical Supplies, Ltd.**

United Metal Industries, Ltd., report a net profit, for the year to October 31, of £12,623 (£12,475). A deferred ordinary dividend of 33⅓ per cent. (same) has been declared.

English Clays Lovering Pochin & Co., Ltd. report a net profit, to September 30, of £132,320 (£94,227). An ordinary dividend of 3½ per cent. (2½ per cent.) has been declared.

The Power-Gas Corporation, Ltd., has made a group trading profit, in the year ended September 30, of £74,533 (£115,063). An ordinary dividend of 10 per cent. and a bonus of 2½ per cent. (both same) are being paid.

Turner & Newall, Ltd., report a combined trading profit to September 30, 1945, of £4,095,779 (£4,445,860). The parent company's net profit is £629,462 (£545,665). A final ordinary dividend of 8¾ per cent. makes a total distribution of 12½ per cent. (same).

With the retirement of Mr. H. A. Brassert, chairman of H. A. Brassert & Co., Ltd., in order to concentrate his activities in New York, the engineering business of that company has been transferred to a new company, under the name of **John Miles & Partners (London), Ltd.** The directors of the new company are: John Miles (chairman and managing director), T. Thomson, A. G. E. Robiette, J. R. Thring (secretary), and T. Rudkin. John Miles & Partners will act as consultants on the same lines as H. A. Brassert & Co. on the lay-out, design and construction of plant and equipment, and on the methods and processes of operation in all branches of heavy engineering, particularly in the fields of coal carbonisation, iron and steel manufacture and rolling of steel products. They have also opened a new department for consulting in the non-ferrous metal industry. The registered office of the new company is Granite House, Cannon Street, London, E.C.4.

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.)

NORTH BRITISH ALUMINIUM CO., LTD., London, E.C. (M., 12/1/46.) December 8, disposition by Mrs. Bee Cullen, or McLellan, with consent granted in implement of a Trust Deed dated September 12, 1934; charged on land with Glenburn, Grange Terrace, Fort William, and other buildings thereon. *—. March 27, 1945.

Satisfaction

BRITISH DIESEL OIL & PETROL CO., LTD. (formerly L. T. C. DISTILLATES, LTD., London, S.W. (M.S., 12/1/46.) Satisfaction December 13 of debenture registered April 4, 1938, to the extent of £6000.

Chemical and Allied Stocks and Shares

BUSINESS in stock markets has been on a broader scale, with strength of British Funds the outstanding feature. The rise continued under the lead of long-dated stocks, among which 3½ per cent. War Loan became more prominent, and extended to shorter-dated stocks, notably 3 per cent. Savings Bonds. Demand partly reflected reinvestment of year-end interest payments, but the main stimulus was the prospect of new developments in the Government's cheaper money plans, and also talk of prospects, in the next Budget, of a further reduction in income tax. Rise in gilt-edged tended to influence markets generally, but leading industrials continued in demand on export trade prospects and hopes that E.P.T. may be abolished; although elsewhere colliery shares remained subdued on compensation uncertainties. South African gold mining shares reflected profit-taking, but there was demand for base-metal shares on expectations of pending increases in lead and zinc prices, and Rhodesian copper shares were better on the industry's contract with the Ministry of Supply.

Imperial Chemical at 40s. 9d. were well maintained, while Turner & Newall strengthened to 81s. on the full results and annual statement. Dunlop Rubber have been firm at 52s. 6d., and outstanding in a generally quiet textile section were Courtaulds with an advance to 56s. 7½d.. Firmness following the higher steel prices gave way to a slightly easier tendency among steel shares, the disposition being to await the forthcoming report on the industry, upon which it is expected the Government will decide whether nationalisation is to be proposed. Guest Keen were 42s. 9d., Dorman Long 25s. 7½d., Hadfields 30s. 6d., and Stewarts & Lloyds deferred 57s. 7½d. Colvilles at 24s. 3d. were higher on balance, also United Steel at 25s. 4½d. Thomas & Baldwins 6s. 8d. shares at 11s. 9d. lost part of the further rise which followed the increased tinplate prices. John Brown at 27s. 10½d., and Firth Brown at 55s. were firm on the group's export trade plans.

In other directions, Lever & Unilever were in request up to 50s. 6d. and, in anticipation of the big field for re-equipping the steel industry, General Refractories 10s. shares strengthened to 17s. 4½d. Ruston & Hornsby rose further to 57s. 3d., but Allied Ironfounders lost ground at 54s. Gas Light & Coke eased to 21s., while on uncertainty as to the effect of coal nationalisation, Low Temperature Carbonisation 2s. shares receded to 2s. 3d., and British Benzol and Coal Distillation to 43s. A good rally to 33s. 9d. was recorded by British Plaster Board, Goodlass Wall 10s. shares have been firm at close on 25s., while Wall Paper Manufacturers deferred kept steady at 44s. Nairn & Greenwich were 81s. 3d. on the unchanged 12½ per cent. dividend.

B. Laporte were firm at 83s. 9d., Burt Boulton 26s., Cellon 5s. ordinary 27s., and W. J. Bush 80s. Greeff-Chemicals Holdings 5s. shares remained in better demand and further strengthened to 10s. 6d. Monsanto Chemicals 5½ per cent. preference were again 23s. and, among plastics, De La Rue were £10⅛, with Erinoid 5s. ordinary higher at 12s. 3d., and British Industrial Plastics 2s. ordinary 6s. 10½d. Reflecting the companies' participation in export trade plans, Boots Drug further strengthened to 56s. 4½d., British Drug Houses were firm at 49s. 6d., Evans Medical Supplies 6s. 8d shares were quoted at 16s., and Vitamins 1s. shares more active up to 8s. 3d.

British Oxygen were a good feature, steady demand raising the price to 85s. 6d. while British Aluminium were little changed at 39s. 6d. In other directions Bradford Dyers improved to 26s. 4½d. on the prospect that the company will benefit from important war-time developments in the dyestuffs industry. Oil shares were uncertain and, where changed, slightly lower on the Persian uncertainties. There is talk of the end of petrol rationing this year and also the ending of "pool" petrol.

British Chemical Prices

FAIRLY active conditions have prevailed in the London general chemicals market during the past week. The volume of home trade inquiry has been on a good scale while deliveries under existing commitments are being taken up promptly. In the export field the flow of orders has not diminished. The potash and soda products remain in good demand with prices firm and values in other sections continue steadily. Acetic acid controlled rates are £2 per ton higher for quantities less than 10 wt., and £1 per ton higher for lots of 10 cwt. to less than 1 ton. Deliveries of less than 4 cwt. are not subject to a maximum price.

The demand for the coal-tar products has been steady with rather more interest than during the previous week. A good export inquiry for xylole, solvent naphtha and toluene is reported, and the demand for naphthalene exceeds available supplies.

MANCHESTER.—Trading conditions on the Manchester chemical market during the past week have been reasonably satisfactory and a full recovery seems to have been made after the recent holiday dullness. Home trade industrial users are specifying for steady deliveries of the alkalis and other leading "heavies," and fair numbers of new inquiries covering a wide range of materials are being dealt with. Export

prospects are regarded hopefully and actual shipments are on a fair scale. Trade in fertilisers is showing a seasonal expansion in several departments, while a steady movement into consumption of many of the principal tar products has been reported during the week.

GLASGOW.—In the Scottish heavy chemical trade business was very quiet during the past week owing to the New Year holidays, a number of the larger firms only resuming work on Friday. Prices remain firm, with a tendency to advance at the beginning of the year. Export inquiries are more numerous.

Price Changes

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