

# The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. LII  
No. 1333

SATURDAY, JANUARY 13, 1945  
REGISTERED AS A NEWSPAPER

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P. 48/45/52

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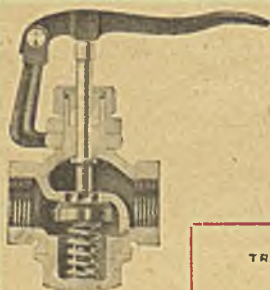
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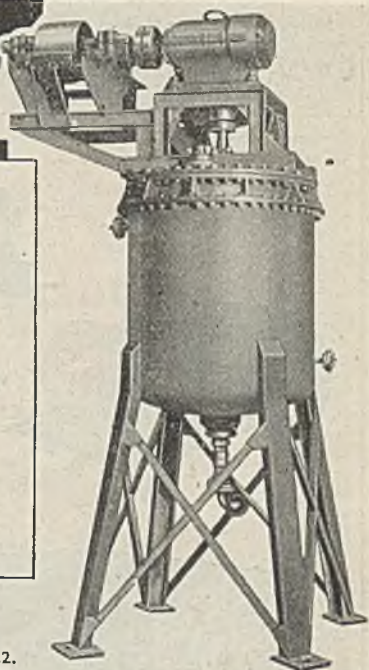
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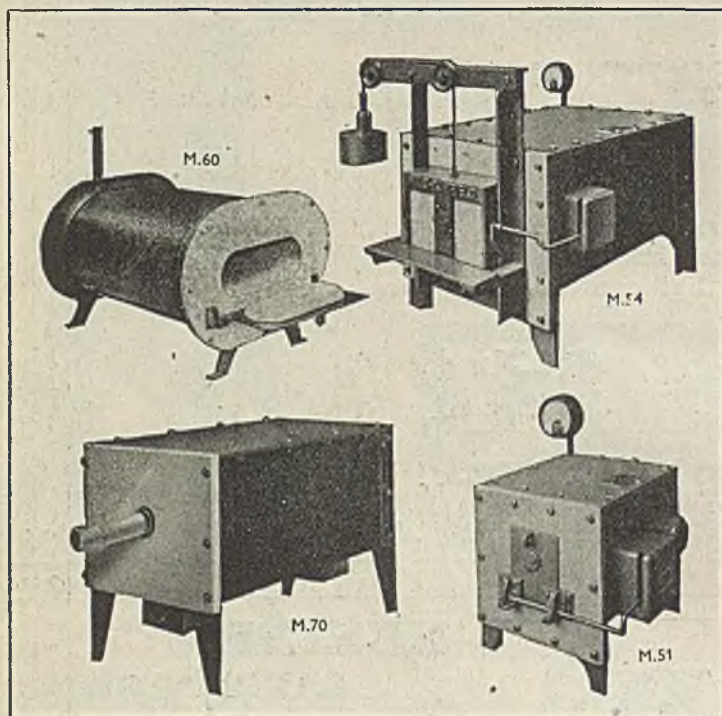
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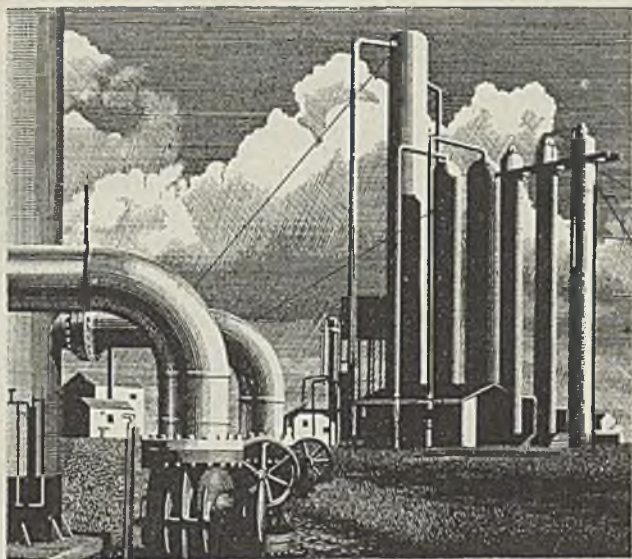
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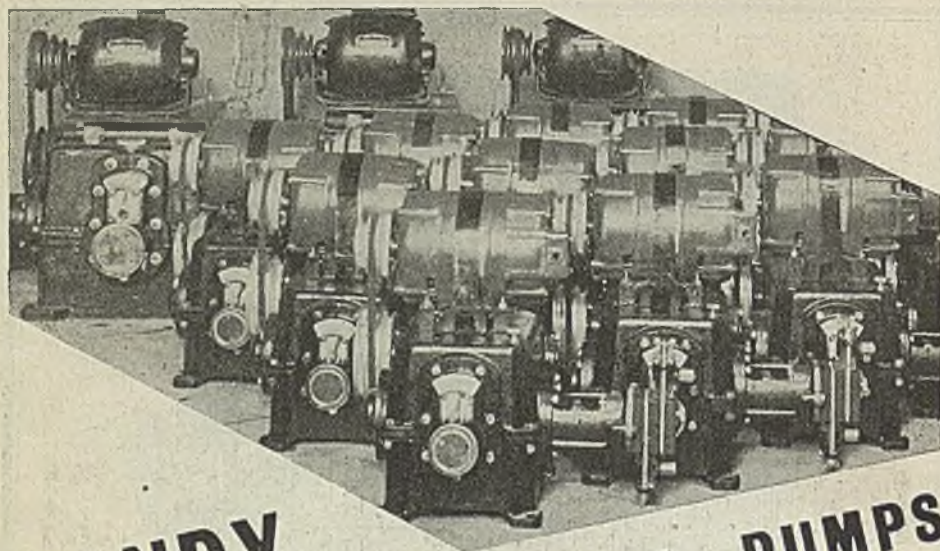


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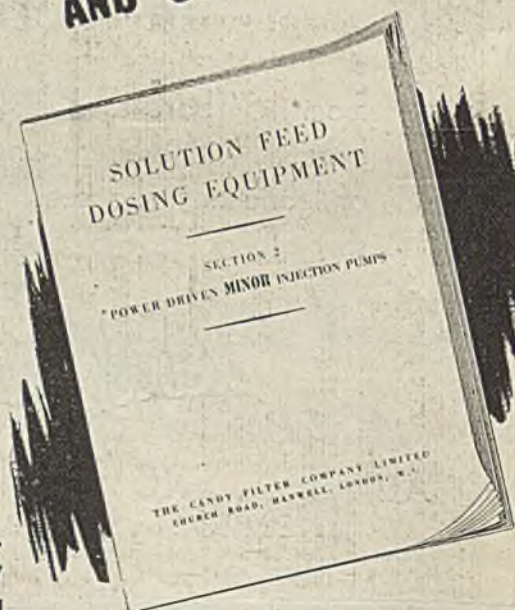
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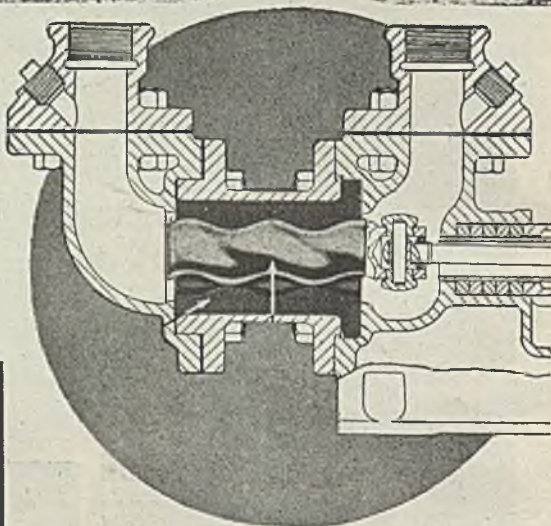
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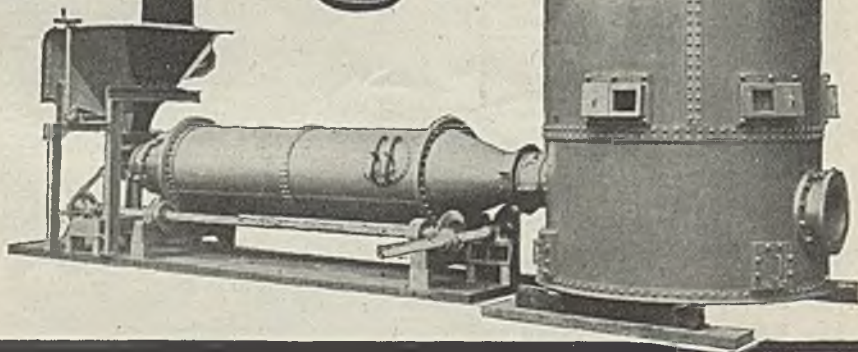
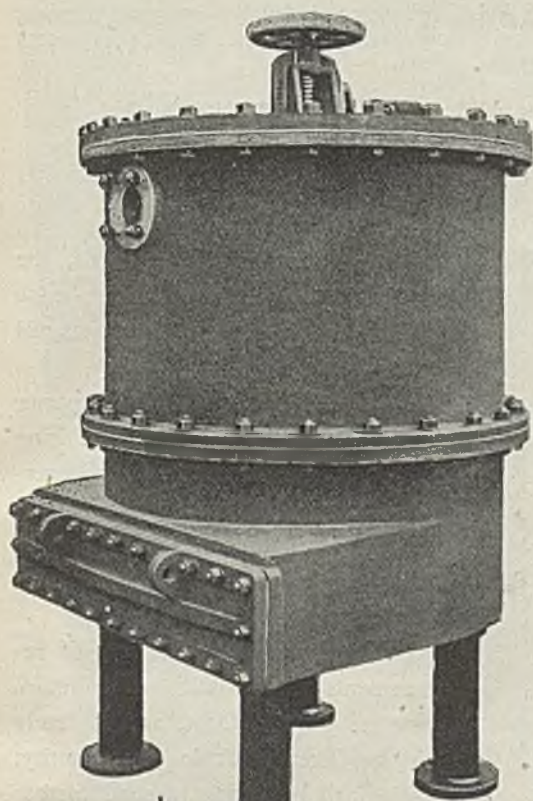


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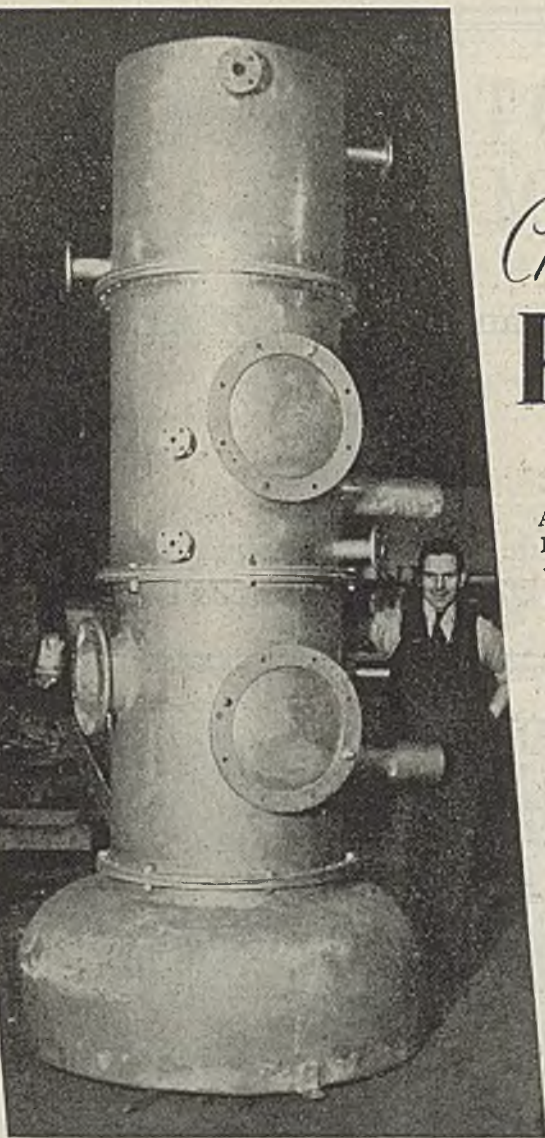


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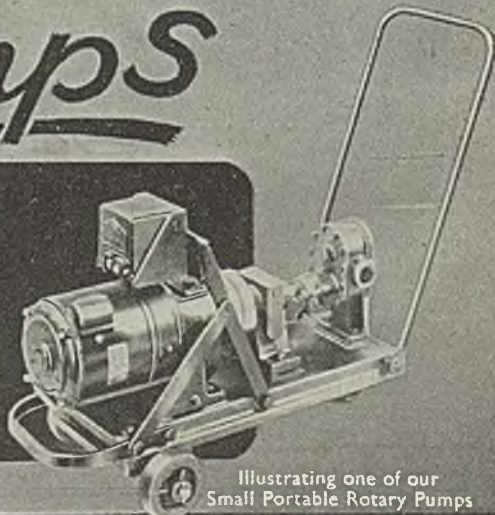


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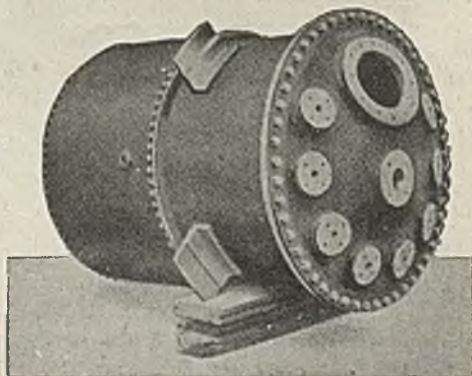
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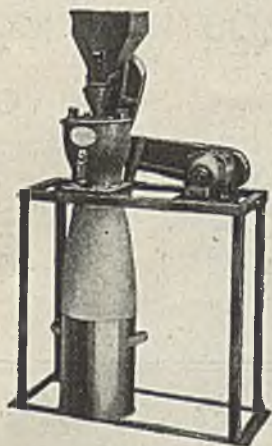
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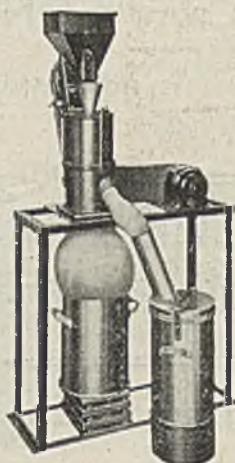


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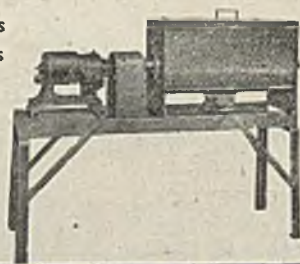
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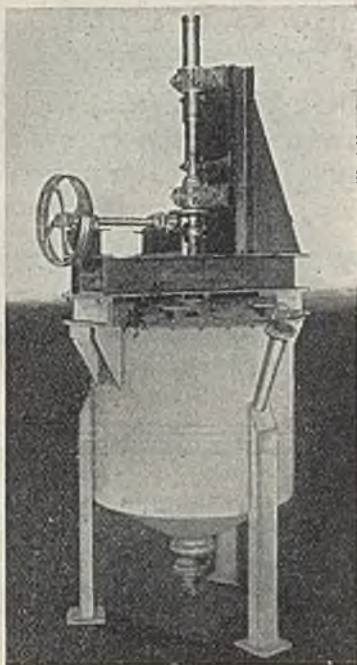
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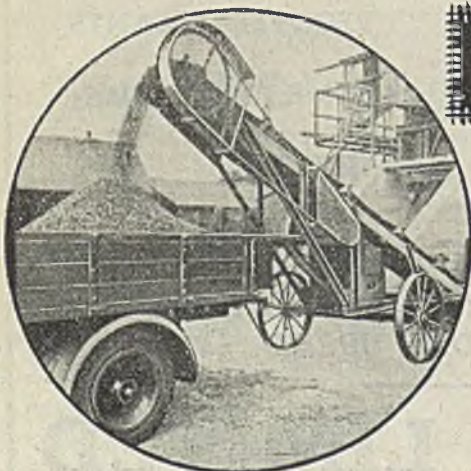
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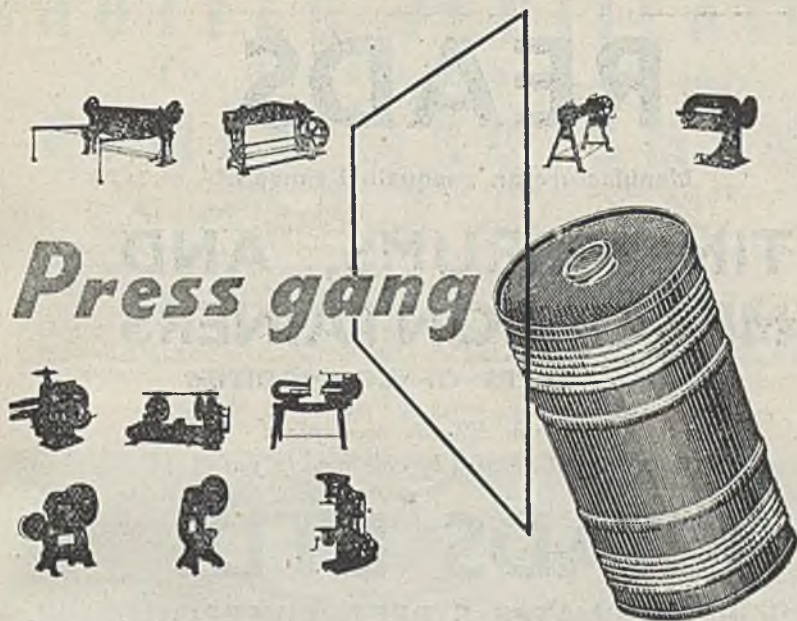
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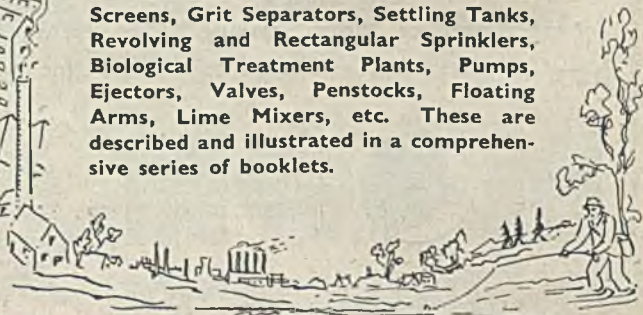
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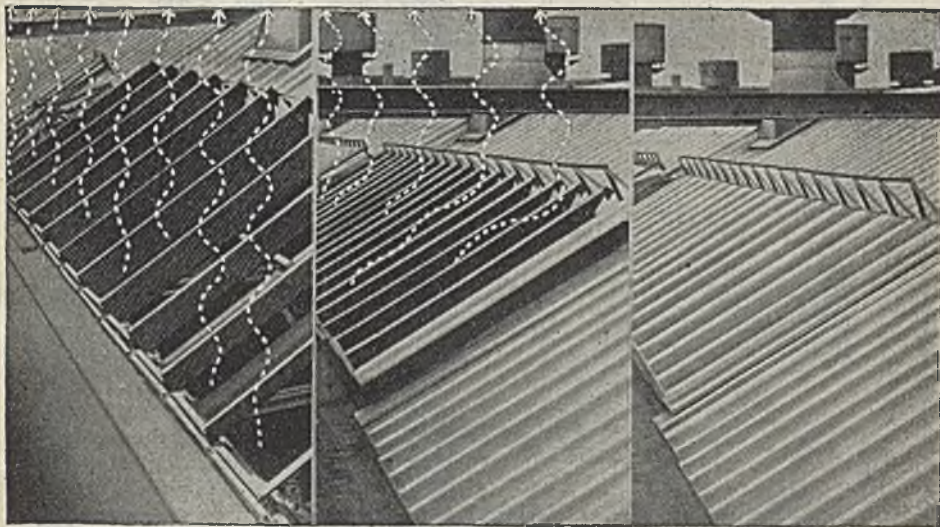
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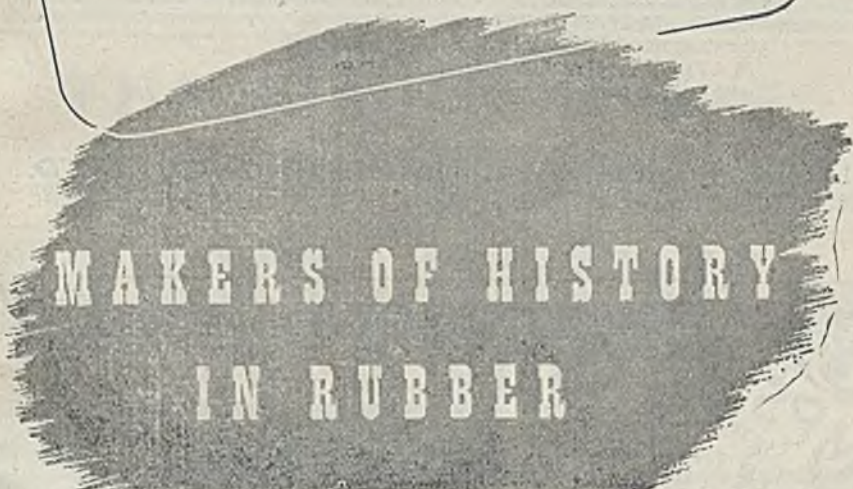


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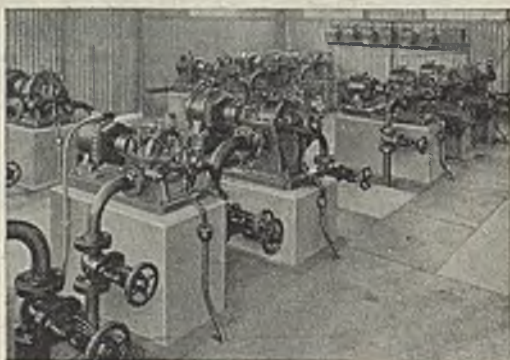
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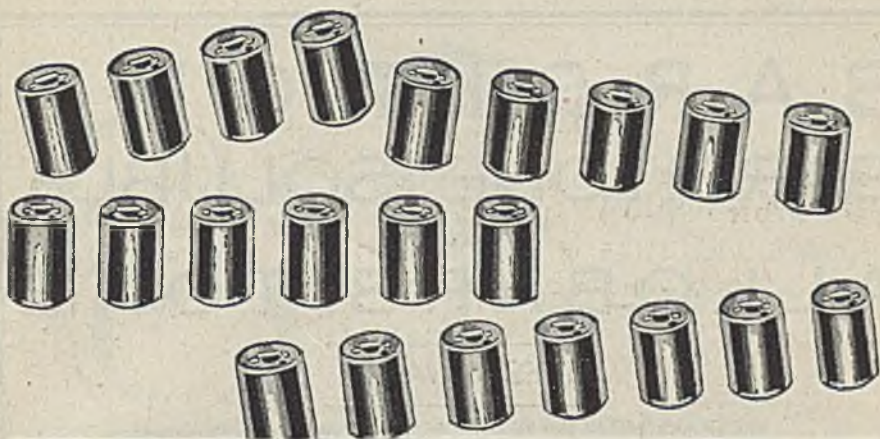
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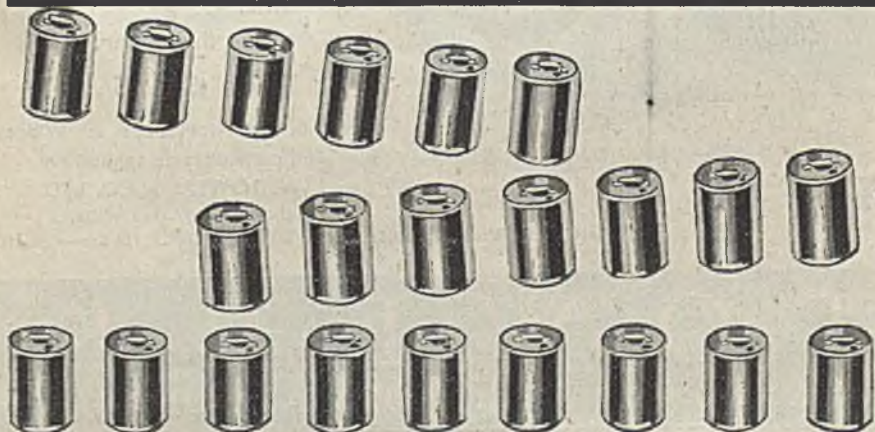
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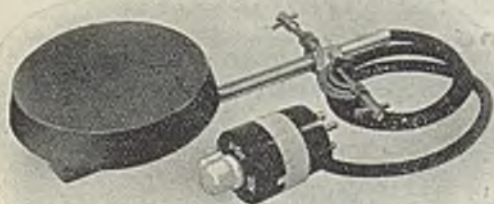
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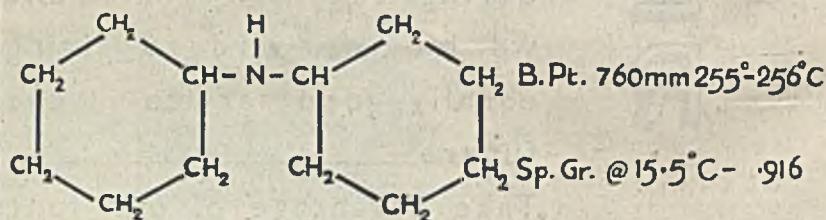
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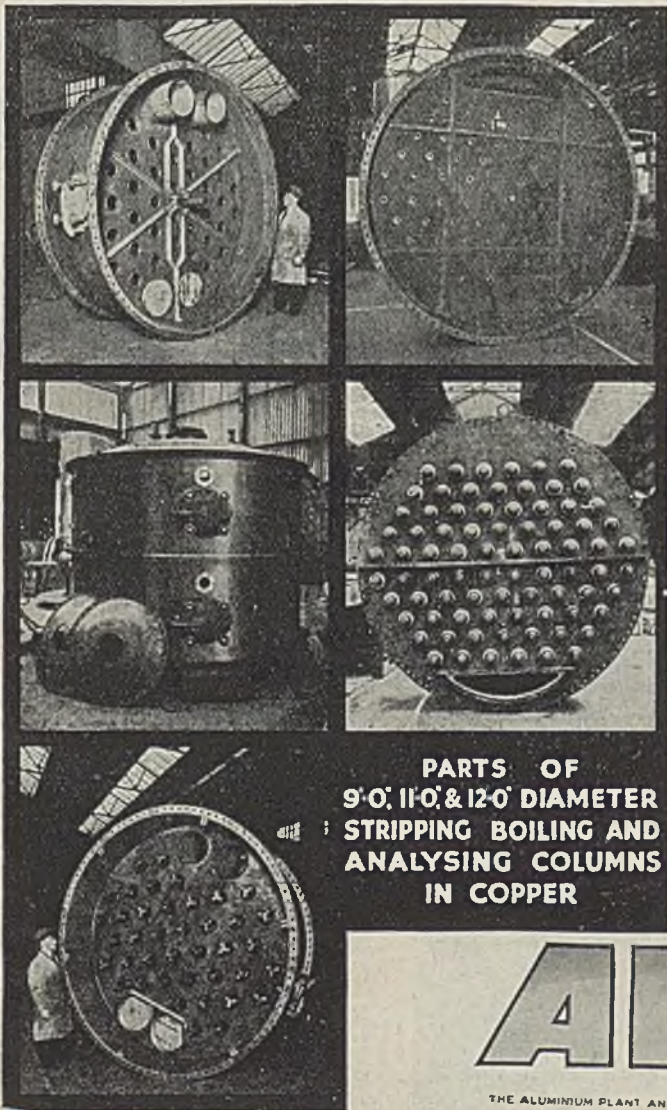
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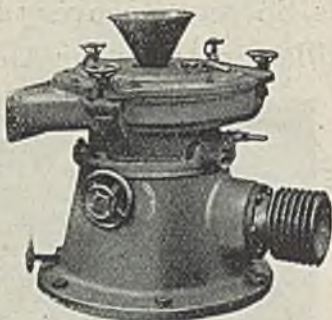
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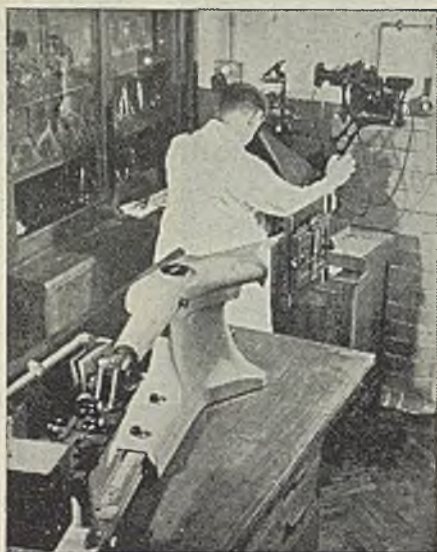
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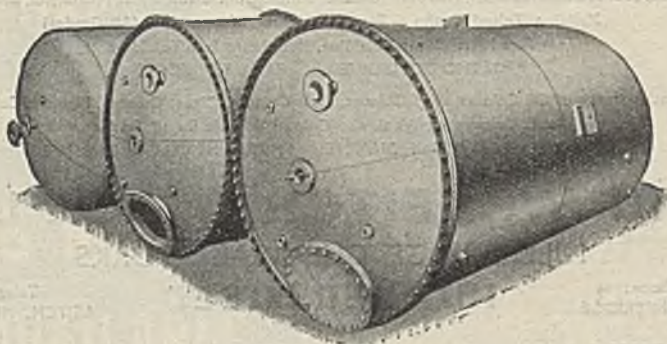
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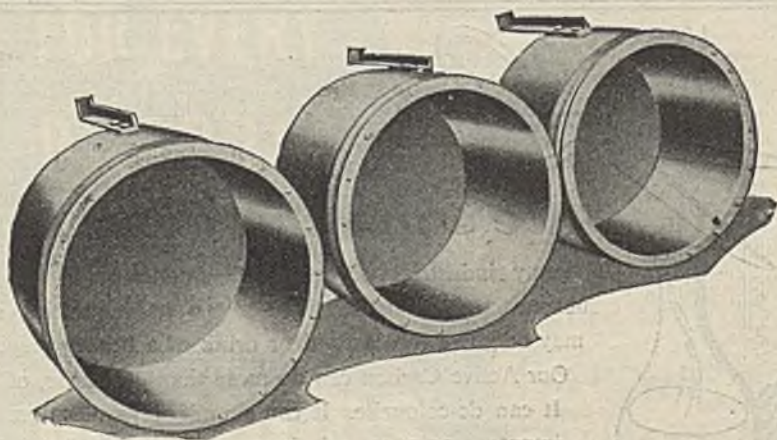
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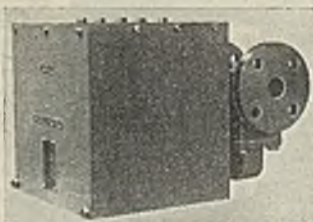
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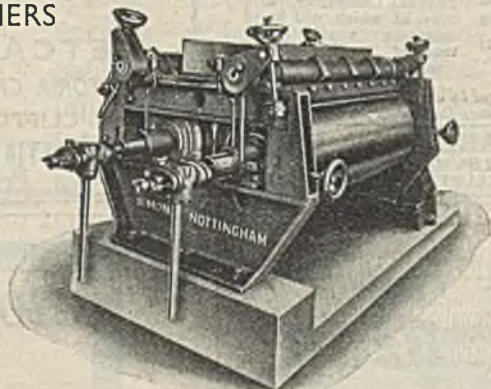
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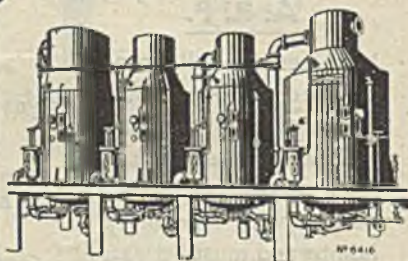
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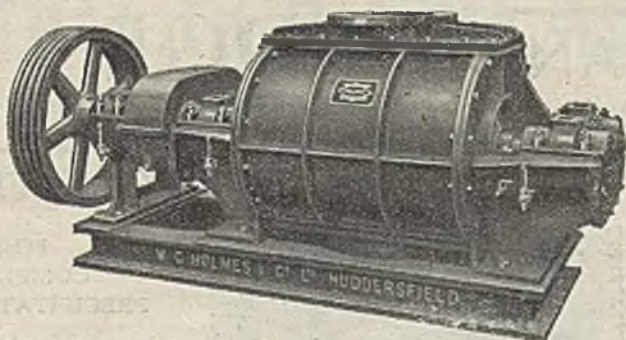
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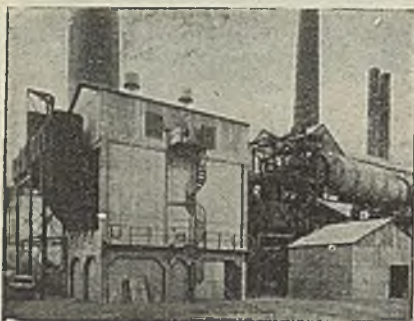
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# The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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THE CHEMICAL AGE offices are closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers Limited

VOL. LII  
No. 1333.

January 13, 1945

Annual Subscription 21s.  
Overseas 46s.

## British Chemical Plant Manufacture

AT the start of the war of 1914-18 it was recognised very quickly that we had sold our birthright for a mess of pottage. We had been slow to accept the responsibility of providing plant and research for the manufacture of many things that were vital to the waging of war. We had been offered them by Germany, and we had accepted the legend of the heaven-born scientific inspiration of the German chemists and industrialists. Consequently we found ourselves in Queer Street in regard to scientific glassware and fine chemicals—to mention only two items. Accordingly, when the war had shut off our supplies we went to work as we should have done years before. We trusted our technical men and gave them their head. Later, we assisted their efforts by a protective tariff.

The result is that, to-day, this country has nothing to fear from any nation in the world in these two fields of technical manufacture. The second German war has shown once again that British scientists and engineers are fully equal to those of any other nation, and has finally dispelled the claims that supreme skill in any technical field is the sole prerogative of any one nation. All

that is required is practice—the opportunity to gain experience, to put theory into terms of iron and steel, of non-ferrous metals, of stone or glass. We repeat, *all that is needed is the opportunity to acquire skill through experience.*

With that thought in our mind we turn to the export field. What shall we export in the future? We have deliberately undertaken a policy of full employment for all. That involves making the greatest possible use of our own raw materials and resources—both of materials and men. It also involves not exporting our raw materials, but of exporting goods of which the final cost comprises a high proportion of labour (including brains). The trend of exports can be seen from a quotation

dealing with the iron and steel industry from our contemporary, the *Iron and Coal Trades Review* (November 17, p. 767): "Since the beginning of the last war, British exports of iron and steel products—i.e., the actual production of the furnaces and mills—have declined in volume, and it is possible to read into the statistical record a history of the development towards self-sufficiency of many of our

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former customers. The decline is most marked in what may be termed the cruder forms, such as pig-iron which we used to export at the rate of a million tons per annum, but in the years immediately prior to this present conflict averaged less than one-fifth of this tonnage. A few more highly finished products did, however, show an almost equally big drop in volume. Galvanised sheets, which we used to ship at the rate of 800,000 tons a year, dropped to an average of less than 250,000 tons. The tendency appears to be to export more highly finished forms of steel in the shape of machinery, etc., and this tendency will become more marked, although the immediate post-war years may witness at least a partial return to the former types of export, in view of the destruction of producing plants in Europe and the long period which has elapsed since world trade flowed at all freely." There is the picture. It is clear and convincing; we may export "crude" semi-finished goods for a short time, but we shall be driven more and more to exporting only the most highly finished goods—machinery, for example, into which we put brains and workmanship in superabundance. Among the more important goods in this category stands *CHEMICAL PLANT*.

Let us now turn our attention for a moment to the Germans. What has been their policy? Obviously, to manufacture for Germany, and also to export German goods to the ends of the earth, by fair means or foul. Casting the mind back through forty years, we remember how the Briton would invent, the German would develop. The British manufacturer of consumer goods set his face against trying out anything new until someone else had got it over its teething troubles. His creed was very simple—and highly specious. "Why," he said, "should I spend my money in trying out new things and often burning my fingers when those foolish Germans will do it for me? I save my money and get from them a finished article which will work often cheaper than I could buy it here." This sounded very hard-headed and business-like, but it neglected one fact. The Germans, through their system of trial and error, were steadily building up a fund of experience and technical background which then, and

even more so later, they were able to put to good use. Ultimately, in the eyes of the world, they become the nation that did things; we were the copyists. We recollect, for example, how no one would think of designing a coke oven unless they had either a German firm who sent the designs or else German designers trained in Germany working in the British offices. In practice the Germans made just as many mistakes as we did, or as anyone else would have done; but they had put themselves in a position to profit by their mistakes: we had not.

So the time came in 1914 when the Germans made war. We had no chemical plant industry to pit against theirs. We muddled through somehow, but unlike what we had done in glass and fine chemicals, etc., we did not make it our business to build up a great chemical plant industry. Dr. Miall (*A History of the Chemical Industry*, p. 257) says: "The very rapid demand for unprecedented quantities of acids, explosives, and other chemicals induced several engineers who had not been much concerned with chemical engineering to enter this field between the years 1915 and 1919, and some of these remain available at the present time. The italics are ours. Why did the rest drop out? Was it because they received insufficient encouragement from chemical manufacturers who once again preferred the easy way of buying their plant abroad?

The Germans had a very different tale to tell. They regarded chemical engineering as a powerful tool in economic and later in military aggression—which, in fact, it was. German chemical plant became known all over the world and earned the raw materials which Germany needed. The Germans would build a plant to make anything in reason. The German chemical plant makers were tied up in amalgamations or in other ways with the chemical manufacturers. The German plant maker was able to build to his heart's content, and to see the results of his building. He was welcomed into the chemical works, and was consulted when his plant misbehaved. He got experience in the only sound way. He was supported by his Government. Through the assistance that he received, he built his plants all over Europe, he invaded South America; and he was found building busily in the



Far East. He built the Fischer-Tropsch plants for getting oil from coal; he developed the hydrogenation of coal; he erected huge works for the fixation of atmospheric nitrogen; he devised *ersatz* materials of many kinds which have enabled him to make war and to maintain his warlike posture for 5½ long years during much of which he has been cut off from external sources of supply. Unquestionably the Germans owe their ability to make war to their handling of the chemical engineering industries.

Are we going to allow this to continue? Shall they again build up their chemical plant industries so that they may again make war upon a defenceless Britain which had some chemical plant

makers, most of whom did not find it worth while to continue in business? Shall we build up great exports in this most highly skilled trade, or shall we be too "hard-headed" to try out new things? There is no need for us to summarise the lessons here, nor to say what should be done to encourage the growth of chemical engineering and of plant manufacture. It is in our power to step into the place that the Germans held before the war. We have the men and the machinery. But all must pull together to provide the opportunity and the experience. The lessons are plain for everyone to read in the history of the past 40 years.

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## NOTES AND COMMENTS

### Higher Appointments

A NY unbiased observer will agree that the organisation, classification and use of man-power, carried out, in spite of many hindrances, by Mr. Bevin's department, is not merely vital in winning the war, but represents one of the most significant changes that have lately taken place in this country. The recent publication, by the Ministry of Labour, of the findings of the Hankey Committee on Higher Appointments set up in July, 1943, "to consider arrangements to facilitate the employment after the war of men and women qualified to undertake responsible work in the professions or elsewhere, etc.," is a document that deserves to be closely studied by all concerned with the progress of science and the efficiency of industry. It is the Committee's belief that it will be a public need to avoid any waste of trained ability and they conclude that a nationwide, State-provided agency for employment in the field of higher appointments is essential. However, they quite rightly contend that the mere provision of yet another agency will not be enough. Men and women, in whatever walk of life, are now deeply concerned about their future careers, and it is impossible to overestimate the part to be played by a properly equipped Appointments Department, staffed—and this is important—with first-class men. Indeed, the Committee has put it on record that the task ahead "can only be done if it is

done supremely well." Only the future will tell whether or not the Department will have learned its lessons from the shortcomings of the Central and Supplementary Registers. If it succeeds in speedily putting into action the Committee's recommendations, there is hope of a fulfilment of Napoleon's saying "*La carrière ouverte au talent.*"

### Careers Research

THE Committee's main recommendations are that the scope of the Appointments Offices should be widened, while their number is to be reduced from 31 to 13. Vacancies for engineers and for scientists should be dealt with centrally. Advice on the choice of and training for a career should be provided, especially during the resettlement period. Another far-reaching proposal is that Appointments Offices should receive applications for grants under the Further Education and Training Scheme. It seems to us that the demand under this particular head may be so overwhelming that it will call for a separate organisation if the Department's other duties are to be effectively carried out. Information on trends of employment will be made available by various methods, including pamphlets and a handbook. A Careers Research Section has already been established to collect information on the professions. There are to be Standing Advisory Committees, including one for appointments abroad,

and there is to be close co-operation with the University Appointments Boards and with industry. These services may well place from 200,000 to 300,000 persons annually and will cost nearly £1,000,000. Nobody who has learned from the bitter experiences of the inter-war years and of this war will grudge this timely expenditure which, if need be, should be increased further so as to bring about conditions of full employment, the advancement of science, and the raising of industrial efficiency.

### U.S. Mineral Survey

IT appears apposite to review, at a time when we are reviewing our own chemical industry, something of the achievements of our American friends. The arrival of Mr. Ickes's survey of U.S. mineral developments in 1944 was thus particularly convenient, and its contents are well worthy of comment. During the period stated, minerals worth some 8500 million dollars were produced, compared with 8000 million dollars' worth in 1943—a rise of 6 per cent. To this total, however, mineral fuels contributed 5254 million dollars, compared with 4589 last year—an increase of 14 per cent.—whereas metals and non-metallic minerals fell by 5 per cent. and 6 per cent. Eight metals suffered drastic curtailment owing to changes in service demands and initial over-estimation of requirements; particularly striking is the drop of 54 per cent. in aluminium and its ores. Magnesium remained stationary, and pig-iron and steel production advanced by one per cent., though alloy steel demands fell by 7 per cent. Molybdenum production was down by one-third and mercury by 27 per cent., and lesser declines were recorded in copper, lead, and zinc.

### Oil Industry's Effort

MINERAL fuel, then, was almost entirely responsible for the aggregate rise, and the lion's share is due to the spectacular effort of the oil industry, in which the output of crude petroleum gained more than 11 per cent., at over 1600 million barrels. Natural gas was up 9 per cent., with 3,735,000 million cu. ft., while, despite shortages in labour and machinery, the output of bituminous coal rose by 30 million net tons to 620 million net tons. Other non-

metallics have given varied results: sulphur sales increased by 18 per cent. and pyrites output by 6 per cent. Bromine produced reached the remarkable figure of 103,000,000 lb., mainly because of the demand for anti-knock petrol. It would appear that the peak of mineral production, apart from fuels, has now been passed, and that this sector of America's commercial economy is aiming at a new balanced position. In the field of fuels, however, notably of petroleum, world demand is likely to call for yet greater substantial efforts.

### The Chemical Controller

THE award of a knighthood to Mr. Frederick W. Bain, the Chemical Controller, is an official acknowledgment of the manner in which he has carried out the multifarious and intricate duties attaching to that position. The honour done to him will be welcome to his many friends in the chemical industry, more especially as his department has recently been under the fire of criticism from an influential quarter (*see THE CHEMICAL AGE*, November 18, p. 479). We might almost go so far as to say that his knighthood can be regarded as a counterblast to any mephitic vapours that may lately have been surrounding the affairs of his department. It is to be noted, however, that even the most rigorous critics have never ventured to assail the department's just claim that they got their job done efficiently. No one who is conversant with Mr. Bain's record will be surprised at that, and the honour done to him should remove any lurking suspicion of partiality that criticism may have aroused. Indeed, Mr. Bain has merely carried on into Government service the principles by which he was actuated in commercial life. He has served with the United Alkali Company and with I.C.I. since the last war (in which he lost an arm on active service with the Gordon Highlanders), and it is in great part due to his insight and understanding of human problems that peaceful conditions have prevailed throughout the war in the company which he served as director. When the time comes for the turn-over of the chemical industry to peace-time conditions, it is to be hoped that the directive energy of Sir Frederick will still be available.



# The Heavy Chemical Industry in 1944

## Some War-to-Peace Problems

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

**L**AST year reference was made to the planning efforts of the chemical industry. In surveying the subject tersely it was observed that post-armistice planning differs little from the planning that every progressive industry has to undertake from its inception onwards. Assuming that the plans have been prepared, that the designs are mature, there are world factors, such as Lend-Lease and the Bretton Woods Final Act, which will influence post-armistice trade developments.

### Lease-Lend Supplies

In September, 1941, this country gave a unilateral pledge, not at the instance of the United States Government, that Lend-Lease supplies would not be used directly or indirectly for export. No one had occasion to cavil at it. We pledged ourselves not to use for export, material actually received from the United States. Equally, it was made clear that advantage would not be taken of the receipt of American material to divert similar British material into export products. Here is to be found an explanation why manufacturers who have never used or seen a ton of Lend-Lease material were ordered to curtail exports, because they were using material similar to Lend-Lease material supplied to some other manufacturers.

The position in this matter later in the year became acute, and it was a happy coincidence that Lord Keynes was in Washington, discussing the future of Lend-Lease, when the Prime Minister announced the successful conclusion of these negotiations. The new arrangement does not appear, on the face of it, to provide for any modification of the original principle. But its advantage lies in the assumption that after the defeat of Germany, Great Britain and the U.S.A. will be able to reconvert part of their resources to meet civilian needs. In the case of Great Britain, some measure of reconversion is urgent and justified, with a view (a) to rehabilitating export trade, and (b) for the relief of the civilian population.

In January, 1945, a number of articles—steel is one of outstanding importance—will be removed from the Lend-Lease list, and so from the 1941 ban. But apart from the above, there are important monetary problems looming ahead—problems arising from the Bretton Woods Final Act. This Act recognises our right to restrict capital movements into or out of the country. Next, it



Mr. P.  
Parrish.



confirms our freedom to devalue the pound, to correct a fundamental absence of balance, particularly if caused by internal economic policy. Thirdly, it protects us from competitive devaluation by other countries who cannot plead fundamental disequilibrium. Fourthly, it provides us with a new reserve of international credit, represented by our right to draw foreign currencies from the Fund up to the limits of our quota. Finally, it gives power to restrict dealings in currency which the Fund has declared scarce. This power can be exercised by us, regardless of any provision to the contrary in an existing trade agreement.

The F.B.I. has been wise, in an interim report, to support the Final Act of the Bretton Woods Conference, with certain reservations. Some doubt appears to exist about the proposal to form an International Monetary Fund, and the parallel scheme for an International Bank for reconstruction and development. These arrangements, surely, are complementary. The purpose of the Bank is to facilitate loans from the richer to the poorer countries. Countries with continued export surpluses will be encouraged to lend abroad. This will relieve pressure upon both the world's foreign exchange markets and the international monetary fund. Whether the charges imposed by the Fund for the use of its facilities are onerous, and whether the Final Act is still open to amendment by mutual consent, are aspects on which opinions differ.

Resentment is felt that further difficulties should be placed in the development of small businesses. One liberty after another has been culled. Is the control of capital issues (Capital Issues Exemptions Order, 1944), which came into operation on December 1 last,<sup>1</sup> the final straw? There may be justification for keeping a watchful eye on the powerful business combines, but there can be no grounds whatever for adding new difficulties to the mass of controls with which small businesses are hampered.

In earlier war reviews the author has spoken enthusiastically about American achievement, the prodigious Russian effort, and about the endeavours of the chemist and metallurgist.

### Britain's Achievement

Command Paper 6564,<sup>2</sup> replete with facts, figures and charts, was recently presented by the Prime Minister to Parliament. It is a tremendous tale of what people have been doing and enduring in and beyond this island, and to use the apt phraseology of a commentator, "Here, at length, is the arithmetic of blood, the chemistry of sweat, and the accountancy of tears." This Paper has been compiled for a purpose in the narrative style of a company report. The British are a formidable race, but they are reluctant to speak about their achievements. It is impossible to summarise this Paper in a few words, ranging, as it does, over casualties, man-power, mobilisation of woman-power, munitions, shipping, imports, clothing, houses and food, etc. The tonnages of dry cargo imported are given below (in million tons).

	Food	Raw material	Finished goods (incl. munitions)	Total
Pre-war average	22.0	26.0	7	55.0
1943 ... ..	11.5	12.8	2	26.3

(1) Production of wheat and potatoes has doubled. (2) We have doubled our production at home of low-grade iron ore, and used every bit of scrap. (3) Importation of pit-wood for mines has almost stopped, and we have reduced our normal timber supplies, used for houses, furniture, and a hundred other purposes, from 7 to  $1\frac{1}{2}$  million tons. (4) Paper-making materials have been cut to one-sixth of normal. (5) Textile materials (and therefore clothing) have been drastically reduced. (6) Very little material—or indeed man-power—has been available for our export trade, which has fallen to less than 30 per cent. of its 1938 volume. (7) The pattern of our food supply has sensibly changed. The consumption of flour, potatoes, and milk has increased; meat consumption is down by nearly one-third; butter is down by two-thirds, half of which is replaced by margarine; fruit, tea, and sugar are down by one-third.

As regards chemicals and chemical engineering, it is appropriate that something should be said about British achievement. Lord McGowan,<sup>3</sup> in February last, raised the veil on I.C.I.'s war effort. This organisation has now over 120,000 employees, in addition to some 15,000 on active service at home and overseas. The peace-time personnel was far smaller—about 70,000. The I.C.I., Lord McGowan remarked, looked big to British eyes, but it was relatively small, compared with the great firms in the U.S.A.

or Germany. The German I. G. Farbenindustrie employed about three times more people, while U.S. firms like United Steel and General Motors had over 200,000 employees each, and quite dwarfed his firm. The I.C.I. war effort started in 1935, and began with the erection, at a cost of about £3,000,000, of a large plant to produce petrol from British coal and tar, a decision carried in the face of strong opposition in Parliament and from the Press. The next landmark in I.C.I.'s war effort was in 1937, and had relation to the manufacture of cartridge cases for artillery and small arms. Probably the largest and most important contribution, however, measured in terms of man-power, was the erection of factories for the production of materials necessary for war. The I.C.I. had been responsible for building entirely new factories, involving the expenditure of £61,000,000; to make materials of which they either had manufacturing experience, or on which they carried out research. These factories belonged to the Government, but to I.C.I. must go the credit for having built them, and for operating them. Valuable service had been rendered in regard to drugs, textiles and plastics, new explosives, etc. They were considering their expansion in the years following the declaration of peace, and had been asked by the Government to do all they possibly could to ensure full employment. Plans were already laid for the expenditure of many millions of pounds over the next five years. This involved the replacement of plant worn out by continuous war pressure, extensions to existing plant, and new factories required for the manufacture of many new products which were now, after years of research and development, ready for production. There are many other impressive records—that of the gas industry and others—which cannot yet be told, because prudence demands reticence.

### Aluminium

Further reductions have been made in the American output of aluminium, owing to the accumulation of stocks, estimated to be sufficient for both military and essential civilian needs. The monthly production rate is now slightly over 90 million lb., as compared with the record of approximately 188 million lb. per month reached in the autumn of 1943. This restriction of supply also affects Canadian production, since scheduled exports to the U.S.A. have been curtailed drastically, and the delivery of 250 million lb. of Canadian metal under contract has been postponed indefinitely.<sup>4</sup>

In Great Britain it has not been necessary to curtail production to a comparable extent, but it has been possible to release increasing quantities of the metal for civilian requirements. Despite the reductions of American output, a new plant is expected



shortly to come into full operation at Harleyville (South Carolina), in which alumina will be extracted from clay for the first time in substantial commercial quantities. The process, which is described by its originators as a "lime-sinter method," consists of mixing the clay with ground limestone, calcining the mixture, leaching, purifying the solution, and recovering the alumina from the solution as alumina trihydrate. The final step is a continuous calcination of the hydrate to oxide or pure white alumina powder. Under close laboratory control the 45 per cent. of silica in kaolin is converted into an insoluble compound, so that the 40 per cent. of alumina present may be leached out as a solution. Until the plant has been in full operation for some months it is impossible to determine ultimate production costs, but it is confidently expected that the new process will be able to compete successfully with processes based on extraction from bauxite. Approximately 2.3 tons of limestone are required per ton of clay and 0.45 kWh of current is used to produce 1 lb. of alumina. An additional 10 kWh are absorbed to produce 1 lb. of aluminium from approximately 2 lb. of alumina.

In reviewing "War-Time Aspects of Australian Mineral Industry" recently, Dr. H. G. Raggatt gave some interesting facts concerning the distribution of bauxite in the Commonwealth. An alunite mud deposit of an unusual type, which occurs at Lake Campion, was also described. The alunite content of the mud (of which there is upwards of 10 million tons) is approximately 60 per cent. A plant has been put into operation for the recovery of a product containing 75 per cent. potassium sulphate and 25 per cent. sodium sulphate at the rate of 5000 tons per annum, and it is hoped to increase production substantially during the next few years. The residue from this plant contains about 46 per cent. alumina and 37 per cent. silica, and a pilot plant is being erected (using HCl generated in the potash plant) to determine whether alumina suitable for the manufacture of aluminium can be produced from this residue.<sup>5</sup>

### Magnesium

A remarkable rise in the rate of production of magnesium has been witnessed in the past two years. According to the U.S. Bureau of Mines the total world output for 1943 was 269,000 short tons—a figure nearly double that of the previous year, and more than eight times that of the year 1939, when Germany, Italy, and Japan were responsible for 60 per cent. of the world production. Some idea of the magnitude of the expansion of the industry can be gathered from a comparison of the annual rates of production in the U.S.A. for 1939 and 1943, viz., 3350 short tons and 183,600 short tons res-

pectively. In January, 1944, U.S. output reached its peak and was estimated at 246,000 tons. Since then the production has been gradually reduced and, at the present time, only a little over one-third of the possible production rate is being maintained. Needless to say, this reduction has been effected by either closing down or curtailing the output of the less efficient or, for other reasons, less economic factories. It will be recalled that at the beginning of the year the British output of magnesium was also reduced by order of the Ministry of Aircraft Production. Even further reduction may be necessary. The reason for these drastic cuts is, of course, the fact that output has so far outstripped demand that large stocks of the metal have accumulated. It is doubtful whether the post-war demand can, at least for some time, absorb more than a small part of the present potential supply. According to the U.S. Bureau of Mines the U.S. consumption of magnesium in 1943 was shared almost equally by incendiary bomb manufacture and the aircraft industry. In the latter case no less than 64 per cent. was accounted for by the production of aircraft engines. This fact gives reasonable grounds for the hope that after the war magnesium will find increasing employment in the machinery industry, particularly in the manufacture of engines for all types of transport vehicle.

As regards developments in the production of magnesium, an outstanding achievement of chemical technology is reported by P. D. V. Manning and S. D. Kirkpatrick.<sup>6</sup> By the ingenious use of phase rule data the potash industry of New Mexico has been enabled to utilise one of its by-products for the production of pure magnesium chloride. To meet the agricultural demand for potassium sulphate a method was evolved for reacting sylvite and langbeinite ( $K_2SO_4 \cdot 2MgSO_4$ ), under such conditions that most of the  $K_2SO_4$  could be removed by crystallisation. The mother liquors from this operation contain about 30 per cent. of dissolved solids, the system comprising  $Na-K-Mg-Cl-SO_4-H_2O$ . Based on the phase diagram for this system a complex method of evaporation and precipitation has been worked out, whereby magnesium chloride is produced of sufficient purity for use in electrolytic cells and at the same time potassium chloride and potassium sulphate are separately recovered. As the liquors are very corrosive and alloy steels are not readily available owing to war conditions, the evaporators are of steel with Pyroflex and acid-proof brick lining, the tubes and tube-plates being constructed of Inconel or Inconel-clad steel. The final pure magnesium chloride solution is spray-dried under such conditions that decomposition and consequent plant corrosion are reduced to a minimum.

An improved method of preparing mag-

magnesium oxide from calcined dolomite has been described by the American Zinc and Lead Smelting Co.<sup>1</sup> The process is a cyclic one, comprising the following steps: (1) Calcination of dolomite under such conditions that all the magnesium present is converted to  $MgO$ . (2) Suspension of the product in water and conversion to magnesium bicarbonate by passing  $CO_2$  under a pressure of about 4 atm. (3) Removal of calcium carbonate and other suspended matter by filtration. (4) Agitation of the  $Mg(HCO_3)_2$  solution under reduced pressure (approximately 16-in. vacuum) to remove the  $CO_2$  and precipitate  $MgCO_3$ . (5) Filtration and drying of the carbonate. (6) Calcination to produce pure  $MgO$ . The  $CO_2$  evolved is recycled. The vacuum method of removing the  $CO_2$  is an important feature of the process. Primarily, it results in the formation of a readily-filterable magnesium carbonate of exceptional purity. Furthermore, because of the use of a closed system, the by-product is a highly concentrated and pure  $CO_2$  gas.

An interesting new process, developed by the Mathieson Alkali Works<sup>2</sup>, involves the calcination of dolomite with natural gas and the treatment of the resulting oxides of calcium and magnesium with calcium chloride. The mass is then carbonated with  $CO_2$  evolved during calcination and the insoluble calcium carbonate separated from the magnesium chloride. Concentration of the magnesium chloride solution is then followed by electrolysis in a new type of cell, developed in co-operation with the Consolidated Mining and Smelting Company of Canada, Ltd. Experiments with this cell, known as the McMullin cell, were conducted at Trail, B.C., where a complete pilot plant was afterwards erected for the production of magnesium.

### Synthetic Rubber

The story has been told by S. D. Kirkpatrick<sup>3</sup> of America's war-time achievement in chemical engineering in the matter of synthetic rubber production. It is a fascinating narrative, which should be read by chemists, chemical engineers and technicians alike. It deals with the situation immediately following the Pearl Harbour attack on December 7, 1941, and the loss of 90 per cent. of the normal rubber supplies. How independence from enemy-controlled sources has been won, the pooling of patents and processes, the sharing of research secrets and operating techniques for the common good of all, constitutes a fascinating account. The most valuable asset was the specialised knowledge of synthetic rubber possessed by American chemists and chemical engineers. Interchange of technical information not only as regards the manufacture of synthetic rubber itself, but also in the produc-

tion of the basic raw materials, particularly butadiene and styrene, was fostered under the guidance of the Rubber Reserve Company.

Time was an important factor, and quick decisions had to be reached, following a free exchange of information. Later, there followed a standard design (Fig. 1), that allowed companies to operate the units so as to give a reasonably uniform product. Complications followed, there were controversy and debate, and in order to get at the relevant facts the Rubber Survey Committee of Baruch, Conant, and Compton was created. There is no need to say anything here about the findings of the committee. William J. Jeffers, as director, and Bradley Dewey as his deputy, formed a team peculiarly well qualified to energise and accelerate the programme through the five Deputy Rubber Directors who were appointed as heads of the following specific functions: (1) operational, (2) constructive, (3) rubber technology and specifications, (4) research and development of synthetic rubber, and (5) development of raw materials for synthetic rubber.

### The American Programme

There was ultimately developed a programme classified according to the type of raw materials, as represented below:

Buna S from butylenes	... 317,000	tons
Buna S from alcohol	... 253,000	"
Buna S from thermal cracking	83,000	"
Buna S from butane	... 82,000	"
Butyl from isobutylene	... 75,000	"
Neoprene from calcium carbide	40,000	"
Total for the programme	... 850,000	"

John L. Collier, president, The B. F. Goodrich Co.,<sup>4</sup> has observed that Americans, in the engineering and construction of 48 plants to produce the butadiene, styrene, and other materials, and to manufacture synthetic rubber, had undertaken a stupendous job. Synthetic rubber of all types has now been produced at the rate of nearly 700,000 tons a year, and during the last quarter of this year may reach 900,000 tons annually. Is there one basic factor upon which America's long-range rubber policy can be founded? In Mr. Collier's opinion there is: this factor is national security. The Americans have learned through bitter experience that they cannot afford to face the future without an adequate "insurance policy" in rubber.

**Styrene.**—The manufacture of styrene has been developed on a large scale in America by the Dow process.<sup>5</sup> Styrene (phenol-ethylene, vinyl-benzene,  $C_6H_5.CH:CH_2$ ) is the simplest representative of the olefine derivatives. The basic chemistry of the Dow process is: (1) alkylation of benzene with ethylene to form ethyl-benzene; (2) dehydro-



generation of purified ethyl-benzene to give styrene.

Gaseous ethylene and benzene are introduced to a tower at atmospheric pressure.

disfavour not less in this country than in America. What world—or should one say what United Nations—organisation shall be established, to regulate and control post-war

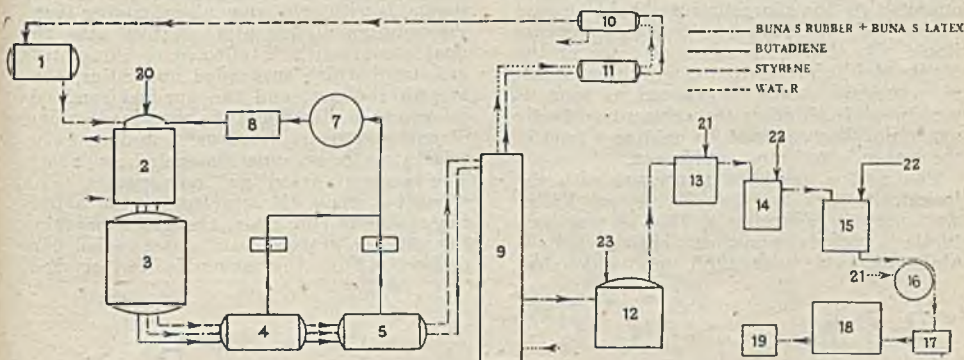


Fig. 1. Synthetic rubber flow sheet (standard design).

1. Styrene storage tank—2. Polymeriser—3. Blow-down tank—4, 5. Flash tanks—6. Compressors—7. Butadiene storage—8. Purifier—9. Stripping column—10. Decanter—11. Condenser—12. Latex blending tank—13. Creaming tank—14. Coagulation tank—15. Soap conversion tank—16. Vacuum filter—17. Disintegrator—18. Dryer—19. Baler and weighing machine—20. Soap solution, water, catalyst, modifier—21. Brine inlet—22. Acid inlets—23. Antioxidant.

By the aid of a catalyst, alkylation is effected and ethylene-benzene, diethylene-benzene, and polyethylene-benzene are formed. The crude ethyl-benzene thus formed is sweetened and distilled to yield pure ethyl-benzene. In addition benzene, which is recycled, and polyethyls which are returned for de-alkylation to ethyl-benzene, are separated at this stage. Ethyl-benzene is dehydrogenated over a fixed catalyst in the presence of steam to give styrene, together with small amounts of benzene, toluene, and tar. In the distillation stage these components are separated at reduced pressure to give recycle benzene, recycle ethyl-benzene, toluene by-product, and styrene of 99.5 per cent. or higher purity. The fractionation stage is a delicate one, 9°C representing the difference in the normal boiling-points of ethyl-benzene and styrene. Moreover, there is a distinct tendency of styrene to polymerise. By a dual arrangement of high-vacuum distillation technique and the use of suitable inhibitors, a routine operation has emerged from a very difficult problem.

## Synthetic Nitrogen

The world's increased production of nitrogen must inevitably call for some extension of the European nitrogen arrangement. Little wonder that Lord McGowan asked the Government the other day to state its attitude towards Germany, Italy, and Japan. The problem concerning the Allied Powers is a perplexing one, and some conception of its magnitude can be judged by the following information concerning the position in the U.S.A. Cartels are now regarded with

production of synthetic nitrogen, so that satisfactory prices and markets are ensured, is a matter calling for profound consideration.

Post-war utilisation of U.S. Government synthetic ammonia plants<sup>12</sup> is a subject which has received consideration at the hands of the Department of Agriculture. The plants owned by the Government furnish 19 to 24 per cent. of the estimated nitrogen consumption. Lower nitrogen prices are generally expected. They will be influenced by the general price level, Government price policy, and the international or world price of nitrogen fertilisers. It is conjectured that fertiliser nitrogen prices may be reduced to about 1934-36 levels, if one assumes good competitive conditions and no Government-subsidised production.

As regards the future, it is believed that the consumption of nitrogen by agriculture and industry will depend primarily on the level of national production and employment, the demand for farm products, and prices of nitrogen. The U.S. Government has invested more than £40,000,000 in nine synthetic ammonia plants. These have a combined capacity of about 750,000 tons of fixed nitrogen per year. The latter figure represents more than the United States consumption for all purposes in any one year. The plants are favourably located with respect to fertiliser markets. Granular ammonium nitrate, it is felt, should be produced at some of the converted war plants. Other nitrogen fertilisers that merit consideration are ammonium sulphate, urea, and sodium nitrate.

The findings of the Committee of the De-

partment of Agriculture recommend that: (1) the U.S.A. should be prepared to supply 1,200,000 tons of fixed nitrogen for civilian consumption; (2) plants of a combined capacity of 300,000 tons of nitrogen now operated by the Government should be converted to meet probable civilian consumption; (3) the conversion of some of the plants for the production of granular ammonium nitrate should be started as soon as possible; (4) all other Government synthetic ammonia plants should be held as a part of the nation's military equipment.

The author has been impressed with the technical work of the Tennessee Valley Authority in adapting a 1914-18 war synthetic ammonia plant at Muscle Shoals, Alabama, to a modernised unit, which has

holder and deliver it through six stages of compression for purification and synthesis. Water-scrubbing at 17 atm. removes  $\text{CO}_2$  and carbon monoxide, oxygen, and residual carbon dioxide are eliminated by scrubbing the gases with cold ammoniacal copper formate solution at 121 atm. At 350 atm. the final compression is effected. Circulating gas, from which suspended impurities, etc., are filtered out, and the purified synthesis gas are then mixed and the combined volume of new and recirculated gases undergoes refrigeration in an ammonia-cooled condenser. The ammonia-freed gas now passes to a separator, then *via* a heater to the ammonia synthesis converter, the gases emerging from which proceed to a water-cooled condenser. Now the ammonia is removed.

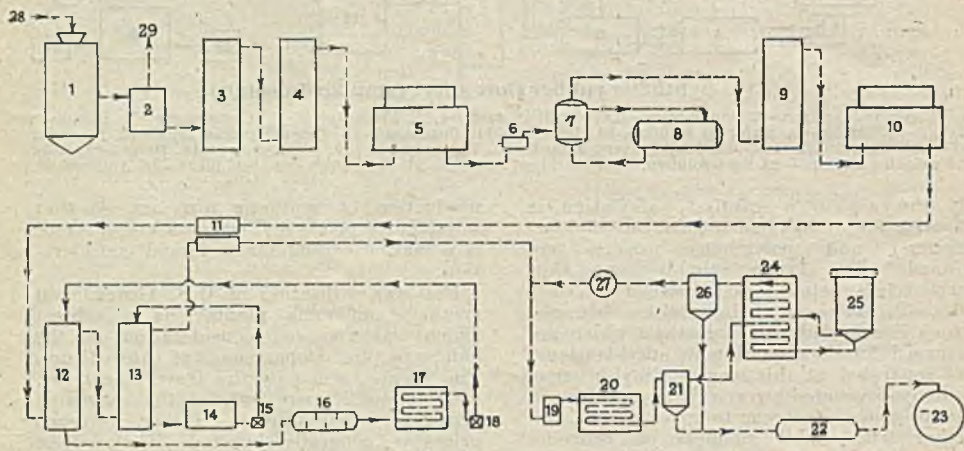


Fig. 2. Modernised synthetic ammonia unit (T.V.A.).

1. Water gas generator—2. Waste heat boiler—3. Scrubbing tower—4. Sulphur removal tower—5. Gas holder—6. Gas pump—7. Heat exchanger—8. Hydrogen converter—9. Gas cooler—10. Gas holder—11. 6-stage compressor—12. Carbon dioxide removal tower—13. Final removal tower—14. Caustic tank—15. Caustic solution pump—16. Copper solution regenerator—17. Copper solution cooler—18. Pump—19. Filter—20. Ammonia-cooled condenser—21. Separator—22. Degasser—23. Storage tank—24. Water-cooled condenser—25. Converter—26. Separator—27. Circulator—28. Coke—29. Steam.

rendered signal service in the present war. Fig. 2<sup>13</sup> shows the method employed for producing synthetic ammonia: it is one which has aroused considerable interest. Virtually, there are six essential stages, namely, semi-water gas manufacture, hydrogen conversion, gas compression, gas purification, ammonia synthesis and ammonia storage. Graded coke (with fines removed) is fed to the semi-water gas generators. These supply the nitrogen in the blow-run gas. Water-gas and blow-run gas are mixed and scrubbed with water. Sulphur is subsequently removed and the gas is passed to a storage holder. Additional hydrogen is produced catalytically by the action of the carbon monoxide of the mixture with steam. Synchronous motor-driven compressors withdraw the gas from the converted gas-

which is condensed, and the remaining gases pass into the recirculating system by way of the circulator-compressors. The separated liquid anhydrous ammonia passes through a pressure reduction valve into elevated tanks, where it can be weighed and delivered to spherical tanks for conversion to nitric acid or for the manufacture of ammonium nitrate or other ammonium compounds.

A new type of cell for the electrolytic production of hydrogen has been described by B. P. Sutherland, of the Consolidated Mining & Smelting Co., of Trail.<sup>14</sup> While it is not claimed that finality in design has been reached, it is believed that a great advance on other and older types has been achieved. A characteristic feature of the new cell is the concrete top supporting the electrodes, asbestos diaphragms, asbestos



collecting skirt, feed-water pipes, and bus-bar and gas main connections. The gas chambers for hydrogen and oxygen and the narrow inverted trough-like collecting bells are also disposed in the concrete cover. When this assembly is fitted on to the steel cell tank it forms a complete unit. The

constituted of bismuth oxide, distributed over sintered iron oxide as a carrier. This process was never fully developed because more interesting methods were evolved. "B" and "C" are simple types which the author has used, one arranged for a vertically-supported gauze, the other for a gauze

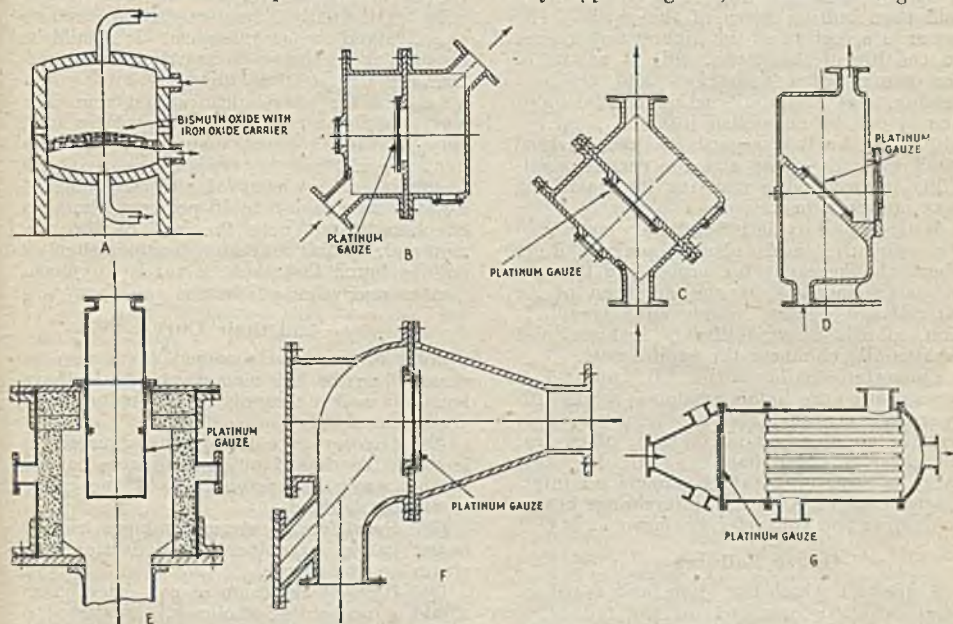


Fig. 3. Various types of ammonia oxidation converter.

cathodes are of mild steel plate, and the anodes are nickel plated. A current density of 67 amp./sq. ft. is employed. Carbonation of the KOH electrolyte is said to be very small compared with open top cells. The cost of the plant is only about half that of older types, and the effective life is upwards of six years.

As chemical engineering and certain of its applications depend on a cheap supply of electrical power, the contribution on "Hydro-electric Development and its Influence on Chemical Industries,"<sup>15</sup> by Sir Alexander Gibb, F.R.S., etc., merits careful study.

#### Ammonia Oxidation and Nitric Acid

From time to time the author has been asked for information about the various types of converter which are used in ammonia oxidation units and nitric acid plants, where ammonia is oxidised to nitrogen oxides or recovered as nitric acid. Fig. 3 has been prepared with a view to illustrating certain types. "A" is merely of historic interest, representing one of the original converters of the Badische Anilin und-Soda-Fabrik, when using a catalyst

placed at an angle of 45°. With the arrangement of converters in question, the front plate can be removed for the insertion of the gauze, and this operation can be readily effected. The only disability with this type of converter is the fact that the lighting port is not placed centrally, and therefore some slight difficulty to tyros may be experienced in the lighting of the gauze.

Emphasis recently has been placed on the necessity for stream-line flow of the ammonia-air mixture to the gauze, and it is conceivable that in this respect converters "B," "C," and "D" can be improved. "D" represents the Wyld type of converter, which possesses the merit of allowing ready removal and replacement of the gauze, and its construction is lighter than that which the author has developed. "E" is an American type, largely used, it is believed, by the Du Pont Company. The gauze is cylindrical, with a fused silica plate to close the bottom of the cylinder. It is clear that it cannot be replaced as readily as the gauze in the Parrish and Wyld types. It has a mild steel shell, and hence a fire-brick lining is a necessity. "F" represents a new type, developed by the author. This

embodies several features which may be regarded as meriting adoption. (a) It has a centrally placed lighting port. (b) It provides for stream-line flow of the ammonia-air mixture. (c) The carrier plate is recessed and the holding ring is provided with a spigot, thus allowing of central placing and even bolting down of the gauze. The latter is a feature of the highest importance in the life of the gauze. (d) It admits of the gauze being withdrawn and replaced readily. (e) The construction can be light, and it can be enamelled inside if need be, although, having regard to the vertical placing of the gauze and the remote possibility of iron oxide reaching it, enamelling may not be a necessity.

Where small oxidation units are concerned for sulphuric acid plant, opinions differ about the necessity for preheating the ammonia-air mixture by the adoption of an interchange heater, which adds complication, affords a possibility of leakage, and incidentally enhances the capital cost.

Converters similar to the "B" and "C" types, with pure liquor ammonia, work with unerring accuracy, and are relatively free from hitch of any kind. Where, of course, the gauze is larger than, say, 8 in. diameter, there is something to recommend an interchange heater. One such interchange heater combining the converter is shown at "G."

### Gauze Failures—

A question which has often been asked is, what are the reasons for the failure of gauzes? Failures may be due, in the author's opinion, to the following causes.

(1) Rupture of gauze due to explosion during lighting.

(2) Straining of gauze due to explosion, which decreases the mechanical strength, so that the life is thereby reduced. This damage may not be visible, and the early failure of the gauze is apparently inexplicable.

(3) Ammonia oxidation gauzes are distorted by the differential pressure over the gauze, the deflection sometimes amounting to almost a quarter of the gauze diameter. This, again, seriously strains the gauze and reduces the diameter of the wire. The differential pressure over the gauze is increased by the choking of the mesh with: (a) salts deposited on the under-side from liquor entrained from the pipe-line; (b) deposit on back of gauze from chamber gases—only during lighting, or when gauze is not alight; (c) deposit of rust, etc., from the converter box on the back of the gauze.

(4) Irregular clamping of the gauze, due to corroded jointing rings, insufficient holding bolts, etc.

(5) Irregular feed of ammonia and air—particularly the latter. The tendency, to prevent the gauze from becoming extinguished, is to work with insufficient air, and

hence an excessive gauze temperature. Liquor deposits in the pipe-line cause oscillating flow, which results in alternating stresses on the gauze: with red gauzes this causes rapid depreciation.

(6) Natural "aging" of the wire. This results in progressive embrittlement of the wire, until finally it has insufficient strength to withstand the gas pressure. It should be noted that the gauzes giving the longest service are always those which have the minimum number of relightings and removals. Very fragile gauzes can be used for a long time if they are not disturbed, but such gauzes could not be replaced or relit. It is estimated that removal and relighting of a gauze may take 5 to 10 per cent. from its effective life. Where the lead of the ammonia-air to the converter gauze is short it will be found that there is rarely any occasion to remove or relight the gauze.

### —and their Cure

Some of the defects named above may be remedied in the following ways: (1) Uniform ammonia and air supply, and freedom from oscillating flow.

(2) Greater care in lighting gauzes. It is estimated that if no damage were caused in this way, the average life of one gauze would be doubled.

(3) Provision of strengthening wires of larger gauge, to reduce the deflection and strain on the gauze.

(4) Possibly re-design of converter boxes would improve the efficiency.

Much of what has been said so far relates to the gauzes and converters of ammonia oxidation units in connection with sulphuric acid plant. As regards gauzes for nitric acid plants, the average life of a platinum gauze, according to continental experience, is 20,000 lb. of ammonia. If the production is forced, as is the case at many of the works manufacturing nitric acid, one cannot expect the same quantity of ammonia to be converted. The writer's experience of small installations at sulphuric acid plants, where production is less intensive, is that the life of the gauzes averages 50,000 lb. of ammonia.

There are two methods of working on the Continent. One is to preheat the ammonia-air mixture as efficiently as possible, and the other is to use oxygen. European practice with gauzes which are used for the manufacture of nitric acid provides for three superimposed gauzes to be placed horizontally. The gases can be passed up or down. Where a gauze is placed vertically, and it is operated at high temperatures, say, ranging from 800° to 1050°C., there is not much mechanical strength. Technicians have emphasised that gauzes should be placed horizontally, and that the preheater tubes should be below the gauzes, in order to keep iron oxide from them.

Some experts assert that platinum-



rhodium allows one to work at higher temperatures; in other words, allows of intensive production of nitric acid. If platinum alone is used there is abnormal loss when working intensively—that is, when working at high temperatures. At one time on the Continent a number of 1-metre diameter gauzes were in use. Now there has been a change from 1-metre to 2-metres diameter. Usually, there are three separate gauzes, two platinum-rhodium gauzes and one platinum. The platinum gauze is used at the back of the platinum-rhodium gauzes, but it is suspected that it does relatively little work. It is, however, in reserve.

Some technicians recommend two gauzes, 80 meshes per linear inch, thickness of wire 0.0024 in., and one layer 150 meshes per linear inch, thickness 0.0016 in. Others recommend two layers, 80 meshes per linear inch, thickness 0.003 in. With small gauzes it is generally conceded that one need not hesitate to use 10 per cent. rhodium: for larger gauzes 5 per cent. of rhodium is satisfactory. I. G. Farben use gauzes with 10 per cent. rhodium, and it is understood that they use nothing other than platinum-rhodium.

Recent practice at M.O.S. Factories has been to provide converters with a nest of gauzes, 25 in some cases, and up to 36. At one works there is a converter operating with a gauze about 7-ft. in diameter. Those responsible for the working of this converter would prefer a number of smaller gauzes, rather than one large one. What is important is that the air for the ammonia-air mixture should be deprived of all suspended matter which it entrains, and too much attention cannot be given to this aspect.

### Capacity of Converters

Converters have a capacity for ammonia oxidation as indicated below:—

- No. 1 gauze 5 in. dia. (4½ in. effective)—  
4½ lb. ammonia/hr.
- No. 2 gauze 7 in. dia. (6½ in. effective)—  
9 lb. ammonia/hr.
- No. 3 gauze 10 in. dia. (9½ in. effective)—  
18 lb. ammonia/hr.

Some manufacturers of gauzes base on the conversion of 7 to 8 lb. of ammonia per sq. in. of gauze, but this represents very intensive working, and is not to be recommended in the case of small ammonia oxidation plant for sulphuric acid units. It is found that where a 6½ in. dia. effective gauze is converting about 9 lb. of ammonia per hour, a life can be obtained equivalent to the conversion of 50,000 lb. of ammonia. With gauzes of 7 in. diameter and above there should be crossed reinforcing wires, and they should preferably be of rhodium-platinum or platinum-rhodium, 4-ply, 80-

mesh, 0.003 in. dia. wire, welded selvedge edges, spot-welded in the centre.

### Hydrochloric Acid

Last year some details of the Laury mechanical saltcake furnace were afforded, but manufacturers may be tardy in adopting a process of this kind. They may regard it unfavourably, because the products of combustion from oil find their way with the gaseous hydrochloric acid evolved, and thus demand larger condensers of the Vitreosil S-bend type than are necessary with a muffle furnace.

Instead of the heavy cast-iron pot and cover which were a usual equipment of the Mannheim furnace, it has latterly been the practice to build a refractory hearth, either of radiused double-rebated tiles, or tiles combining a rebate and tongue and groove, providing a heat-transmitting carborundum arch.<sup>16</sup> To give stability to the skewbacks from which the arch is sprung, the furnace is encased in a 5/16-in. steel plate, securely braced, and access doors at various centres are provided for the top and bottom flues, in addition to the muffle.

Firing of the muffle can be effected by solid fuel, producer gas, or oil. Where solid fuel is used, the consumption of coal of 12,500 B.Th.U./lb. represents about 5½ cwt. per ton of salt decomposed. This is regarded as too high a figure. In this connection it has to be remembered that for the second stage of the saltcake process (i.e.,  $\text{NaHSO}_4 + \text{NaCl} = \text{Na}_2\text{SO}_4 + \text{HCl}$ ) a temperature of about 580° C. is needed. Taking the temperature head into consideration, this represents in the top flue a temperature of 830° C., and, despite the travel around the muffle, the emerging products of combustion in the main flue to the chimney will be of the order of 550°-600° C. It is clear, therefore, that in the absence of some system of regeneration, the fuel consumption must be high. There is much to recommend the use of oil or producer gas. Indeed, with oil having a calorific value of, say, 16,000 B.Th.U./lb., given a system of regeneration, it should not be necessary to use more than 2 cwt. of oil per ton of salt decomposed. Further, part of the sensible heat of the products of combustion can be used to dry the salt and thus render it reasonably mobile, overcoming difficulties which otherwise may arise by "holding up" in the hopper.

This latter difficulty may be avoided by providing the hopper with a reciprocating feed, or if the salt is fed to an adjustable weir arrangement on a continuous belt, before discharge to a positive worm feed placed at a lower level, an opportunity for volumetric measurement is afforded, of which it is desirable to take advantage.

The use of oil or producer gas, or even powdered fuel, raises the question of the

relation between the combustion chamber and the rate of fuel fired. It is a question on which the author has been approached for information on a number of occasions, where oil fuel for the concentration of sulphuric acid and for the production of activated carbon has been contemplated.

A word or two at this juncture may be of interest. The relation in question varies widely, depending on the type of furnace, the fuel, and the method of firing. In powdered fuel furnaces, Kent recommends a rate of heat release not greater than 20,000 B.Th.U. per cu. ft. of furnace volume per hour, with refractory furnaces in continuous operation. For oil fuels, an accepted figure is 30,000-100,000 B.Th.U./cu. ft./hr. for industrial furnaces, although in special cases the heat release is as high as 250,000 B.Th.U./cu. ft./hr. The range of heat release for gas is particularly wide.

The shapes of combustion chambers must obviously vary with the fuel, and in a lesser degree with the method of firing. This is an aspect that cannot be pursued here, except to say that long single-direction combustion chambers for oil and gas fuels are usually highly inefficient, with a considerable part of the heat released in the flue, as revealed by high stack temperatures and a low rate of heat transfer. In addition to conventional types of combustion chamber, many special types are used for gas. These may be classified as muffle type, radiant and immersed tubes and various applications of surface catalysis.

### Temperature Recording

To aid the control of a Mannheim mechanical furnace, it is desirable to keep continuous records of the temperatures in the top and bottom flues, and in the muffle, and the temperature of the gaseous hydrochloric acid (about 380°C.) passing to the condensers. Given uniformity of feed of dry salt and sulphuric acid, and reasonably uniform temperatures at the points indicated, it should be possible to maintain maximum production with a minimum fuel consumption.

An improvement yet needed is a method of fixing the arms to the shaft and the rabblers to the arms, so that replacements can be effected without any prolonged period of cessation of the normal manufacturing operation.

The movement of the salt under treatment with sulphuric acid in a mechanical furnace assists decomposition. Fresh surfaces of salt are presented for attack by the sulphuric acid and the rotation should bring all the material in contact with the medium responsible for the attack. In the Mannheim furnace no attempt is made to propel the salt undergoing decomposition, by the rabblers. The forward angle at which they

are set is almost negligible. To compute the time during which reaction occurs in the pot one must base on the effective cubical capacity of the pot and the displacement which occurs. The time of contact ranges from 4 to 5 hours, according to the speed of rotation, etc. The finer the salt, the greater the surface, but the size can be too fine, leaving practically no voids for the penetration of the acid. The salt bed should not be impervious, but on the contrary should allow of satisfactory penetration.

The chemical composition of the saltcake must necessarily depend on the quality of the salt. Some qualities contain too much magnesium chloride, and some too great a quantity of calcium salt. But the physical texture and granularity of the saltcake depend on the movement of the salt that is undergoing decomposition, and on the maintenance of a satisfactory temperature of decomposition. Relative freedom from iron is a desideratum for the manufacture of certain qualities of glass.

The Ministry of Supply (Sulphuric Acid Control) is now regulating the production and sale of hydrochloric acid. Saltcake is likely to be required to an increasing extent for glass manufacture in the post-armistice period.

### Sulphuric Acid

In this country we continue to manufacture the equivalent of about 2 million tons annually of sulphuric acid, 70%, of which about half is produced by the contact process and the balance by the nitration, or chamber process. Essentially, imported sulphur is the raw material used by the firms operating the contact process. One firm, however, employs pyrites and one uses anhydrite.

After five years' intensive demand for sulphuric acid, several units of plant have needed extensive repairs, and some have been renewed. Transport of sulphuric acid has been a problem at times.

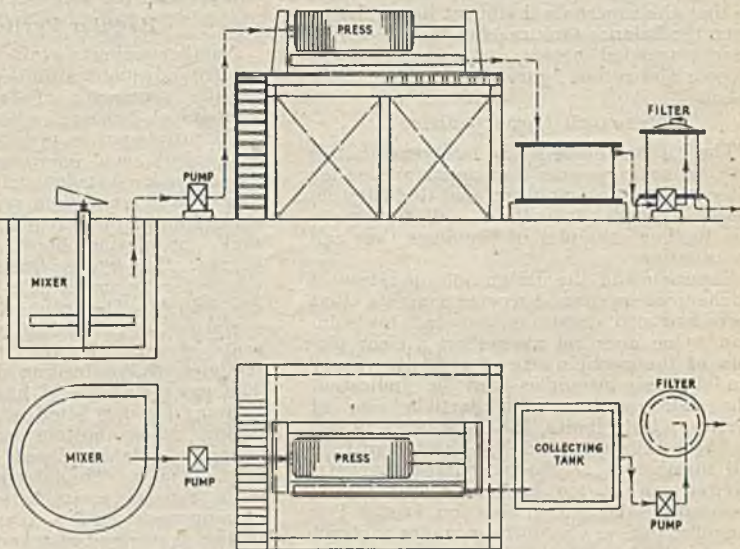
Spent oxide is being produced at the rate of about 200,000 tons per annum (say, 90,000 tons of sulphur), against a pre-war figure of 150,000 tons. There are accumulations of spent oxide in some parts of the country, and it cannot be doubted that pyrites will be displaced very shortly if the present disequilibrium of stocks continues. Large quantities of ferric oxide ash resulting from the combustion of spent oxide are being converted to gas-purifying materials, in some cases by new processes, which produce synthetic bog ore unapproached in quality and uniformity of characteristics by any natural material. Other quantities of ferric oxide ash are reaching the blast furnaces. Pyrites companies will need to look to their laurels, especially as spent oxide is capable of producing acid commercially free from arsenic,



whereas most pyrites are arsenic-containing. Many cupreous pyrites cinders contain zinc, which during the chloridising-roasting process and subsequent leaching is found in the copper liquors. Recovery of zinc from such spent liquors has been the subject of

orifices staggered. The second, or "collector" group, consists of three plates having orifices 1/12-in. diameter, not staggered. The plate separation is again 1/8 in. The separation of mist particles is effected by the centrifugal force exerted upon them dur-

Fig. 4. Plant for precipitating soluble iron salts from waste pickle liquors, producing simultaneously an innocuous effluent liquor.



experimentation for many years. A. G. Arend<sup>17</sup> has dealt with the problem in some detail. By evaporating the liquor following the separation of the iron salts to a Twaddell concentration of 64-72° in the cold by a vacuum evaporator, it is claimed that Glauber salts are crystallised out, and that there remains a practically pure solution of zinc chloride. This liquid, when evaporated, can be utilised for a wide range of industries, for soldering fluxes, vulcanisation, wood preservation, etc. Attempts at direct electrolysis of the waste solution have been unsuccessful. When the sodium salts are crystallised out, at preferably 0.5°C., diaphragm cells, with revolving disc-shaped cathodes, can be used at 9 amp./sq. ft., with a voltage representing 3.6 volts, and zinc of 99.9 per cent. purity is produced.

The Calder-Fox scrubber was originally designed as a means of reducing the acid content of the exit gases from sulphuric acid concentrators. It consists essentially of a casing of acid-resisting material (usually lead), with stream-lined gas entrance and exit connections, and containing a number of perforated plates, usually arranged in two groups. The first group, known as the agglomerator plates, comprise an "orifice" plate, perforated with 1/8-in. diameter holes at approximately 1/2-in. pitch, and an impact plate with 1/8-in. diameter holes at the same centres. The plates are set 1/8 in. apart, with

ing their zig-zag path through the scrubber. There are several factors influencing the performance of these scrubbers, apart from those inherent in the design of the scrubber plates. In a paper<sup>18</sup> read before the Institution of Chemical Engineers in November, G. Lowrie-Fairs discusses the theoretical considerations, as well as the practical aspects of design and performance.

Plant has been evolved for the treatment of waste pickle liquor,<sup>19</sup> either sulphuric acid-containing, or hydrochloric acid-containing, by which solutions of ammonium sulphate, or ammonium chloride, or magnesium chloride are produced. These solutions can be evaporated to yield attractive commercial products. By this method of treatment there is no effluent as such, which is a great relief to certain Rivers Boards' officials. The plant shown in Fig. 4 has been evolved with a view to yielding a relatively innocuous effluent, not exceeding 2 parts oxygen absorption per 100,000 parts, when waste pickle liquor is treated with hydrated lime or calcium hydrate residues. Great care must be taken to ensure thorough incorporation of the calcium hydrate and the waste pickle liquor in the well. An alkaline condition is necessary. Complete precipitation of the iron salts is essential, and oxidation of the ferrous iron should be sought. When the magma is pumped through a perfectly tight filter-press, the filtrate should be of good

colour, and free from suspended matter. This filtrate is collected and treated in an automatic equipment after the filter press, by which a suitable dosage of an oxidising agent and coagulant are introduced, after which there is further filtration through a sand filter, so that the supernatant effluent liquor drawn from the balance tank reaches the sewer free from suspended matter, and possesses a low oxygen absorption figure, of the order indicated.

### Research Opportunities

The author made clear last year that it was wrong to assume that opportunities for research in the sulphuric acid industry no longer existed. It will be well to give a few further examples of problems that call for solution.

Experience of the design and operation of mechanical pyrites burners suggests that there are still questions that call for solution. One does not always get a clear picture of the particle size of pyrites. Some fundamental principles can be indicated. The more uniform the particle size of pyrites, within limits, the more efficient will be the combustion and the greater will be the throughput of the mechanical burners. Pyrites can be too fine, and lead to the creation of dust, and occasion loss. For example, pyrites concentrates under contract showed the following widely varying characteristics:

		%	%
Retained on	1/4 in. ...	13.4	14.2
"	1/8 in. ...	42.5	17.6
"	1/10 in. ...	9.7	7.2
"	1/20 in. ...	11.9	11.0
"	1/30 in. ...	4.5	5.4
"	1/40 in. ...	13.9	5.7
"	1/50 in. ...	1.4	3.0
"	1/60 in. ...	1.3	3.2
"	1/70 in. ...	1.6	3.4
"	1/80 in. ...	0.2	0.5
"	1/90 in. ...	1.3	3.8
"	1/100 in. ...	0.4	1.2
Passing	1/100 in. ...	8.1	23.8

Equally, pyrites can be too large in size, and unless they decrepitate during burning the sulphur will not be satisfactorily removed by combustion. Decrecipitation, in any case, is not too desirable a property of pyrites, in that generally a large quantity of very fine material results. There is no doubt that uniformity of particle size is a desideratum, and pyrites burner capacity should be related to the size of the pyrites.

If attempts are made to overload a mechanical pyrites burner there are two possibilities: clinker is formed on the top shelves and/or the burnt pyrites are discharged from the bottom shelf, and the expungeable sulphur is not completely removed, owing to inefficient combustion. Clinker formation, as indicated in last year's

review, can be obviated by providing two cooling arms in addition to the rabbling arms in the top two or three beds of the mechanical burner. By taking this step one reduces the temperature of the pyrites on the beds below fusion point, and thus one can obviate the formation of clinker.

### Regular Pyrites Feed

Another aspect which does not always receive adequate attention is the question of the regularity of feed of pyrites to mechanical burners. Generally speaking, an improvement is possible in this connection. But such improvement needs skilled supervision. A volumetric feeding device<sup>29</sup> was evolved some time ago. Briefly, it consists of an equipment placed on the external shelf, or drying floor, of a mechanical burner. The pyrites fines are introduced to the feeder by means of rabbles in the ordinary way. The volumetric feeding device comprises a cylindrical ring fixed on six arms, or vanes, between which the cells, or sections, of the feeding device are formed. The measuring wheel has neither top nor bottom, but it is fitted in a fixed cylindrical casing, whose bottom wall has an outlet opening, suitably placed in relation to the inlet opening. The measuring wheel is fixed on a vertical rotatable shaft, carrying on its uppermost end a gear meshing with a pinion at one end of a vertical countershaft, which also carries a toothed wheel. The teeth of the latter are so shaped that they can mesh with a number of pins, removably positioned in a series of holes in two annular L-shaped rings, which are secured on the central furnace shaft. Each pin meshing with the toothed wheel causes a partial rotation of the feeding wheel, and delivers a definite volume of pyrites to the burner. The quantity fed per unit time can thus be varied by varying the number of pins in the ring which rotates with the central shaft of the mechanical burner. The adoption of this device as a measuring medium and as a check on consumption would doubtless be of considerable advantage in those cases where the pyrites are of reasonably uniform particle size, within well-defined limits. Otherwise, such a device would suffer from the irregularity in the particle size of the pyrites.

Fluctuations of the temperature of the beds from time to time generally relate to the irregularity or otherwise of the feed, and the adequacy or otherwise of the admission of air for combustion. If a uniform feed is not maintained, then there are bound to be fluctuations in the temperatures of the various beds, especially between the top and bottom shelves. Often there is a tendency for less pyrites to be burned per 24 hours than are declared.

Another aspect relating to the combustion of pyrites in mechanical furnaces is the



avoidance of dust creation. Dust arises from the fact that the pyrites undergoing combustion are dropped at the very point where the burner gases ascend. This occurs on all the beds in most types of mechanical burner. It is a wrong principle. To avoid dust, the burning pyrites should be discharged from bed to bed at a point separate from that at which the burner gases ascend.

Dust arrested in an electrostatic precipitator is not as valuable as pyrites cinders discharged from mechanical burners. Moreover, the dust passing the electrostatic filter means loss of efficiency in the manufacture of sulphuric acid, because such dust reacts with the sulphuric acid in the Glover tower and forms sulphates of the various metals, which not only means loss of sulphuric acid, but also leads to impurities in the acid. From every viewpoint, therefore, it is highly desirable to avoid the creation of additional dust. Unusually fine particles in the pyrites fines should be avoided. To determine the efficiency of dust removal at the electrostatic precipitator, the quantities removed per day should be carefully noted. But a more important test is the ash content of the Glover acid. This should be determined regularly, and representative samples of the day's make and the nature of the ash should be ascertained from time to time. Such determinations should afford valuable data regarding the efficiency of the operation of the electrostatic precipitator.

Last year reference was made to the design of Glover towers. The author has attempted<sup>21</sup> to place the design on a scientific basis, but his studies do not appear to have led to any combined endeavour to establish fundamental information in this connection. Fig. 5 has been prepared to indicate the points at which it is vitally important that the free cross-sectional area should be examined, with a view to avoiding bottlenecks—in other words, undue pressure drop. The diameter of the tower shown is 8 ft. 6 in., and it is recommended that the free cross-sectional area at the various marked points should not be less than (a) Burner pipe: 4.8 sq. ft.; (b) on line B-C: 8.6 sq. ft.; (c) on line D-E: 9.4 sq. ft.; (d) on line F-G: 9.7 sq. ft. The gas velocities at such points, with burner gases at, say, 600°C., at the burner pipe, should be approximately: (a) 9.6; (b) 5.3; (c) 4.9; (d) 4.7 lineal feet per second.

### Cement and $\text{H}_2\text{SO}_4$ from Gypsum

As considerable interest was evinced in last year's details relating to the production of sulphuric acid and cement from anhydrite, Fig. 6 has been prepared, representing a diagrammatic lay-out of the process, but with special reference to gypsum as distinct from anhydrite.

The essential steps in the manufacture of

$\text{SO}_2$  and cement from gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ), may be cited numerically.

(1) In order to reduce sensibly the temperature of decomposition of calcium sul-

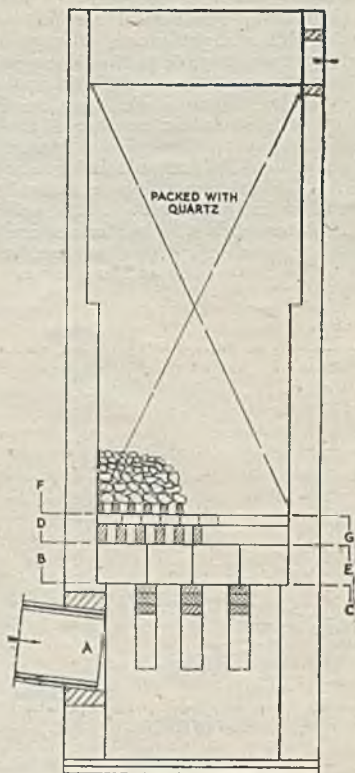


Fig. 5. Glover tower: areas of possible maximum restriction.

phate, it is necessary to add carbon (preferably finely-ground coke). The reaction which occurs is the following:

$\text{CaSO}_4 + \text{C} = \text{CaO} + \text{SO}_2 + \text{CO} - 87.36 \text{ cal.}$ , involving a temperature of decomposition of 900°C. On the other hand, if one relies on the reaction:

$\text{CaSO}_4 = \text{CaO} + \text{SO}_2 + \frac{1}{2}\text{O}_2 - 116.36 \text{ cal.}$ , a temperature of 1590°C. would be required to decompose the calcium sulphate.

(2) In order to obtain an adequately concentrated  $\text{SO}_2$  gas, (a) the mixture should be introduced dry to the rotative tube furnace, and (b) the conditions obtaining within the furnace should be feebly oxidising. If reducing conditions are allowed to obtain, it will be found that calcium oxysulphide will be a constituent of the gaseous mixture, and that calcium sulphide will appear in the clinker.

(3) The percentage of carbon indicated by the theoretical equation is not correct for

a furnace in regular operation: the reduction is too severe, and the calcium sulphide gives rise to a fused mass instead of the formation of clinker. Practical experience has shown that it is necessary to use half the theoretical quantity of carbon, and to operate with a slight excess of oxygen.

Enlarging on Fig. 6, it should be pointed out that the argillaceous shale is broken to a fine powder, fed to a silo, then dried, and afterwards is stored in another silo. The coke is broken to fine pieces, placed in a silo, then dried, afterwards being stored in a silo. The calcium sulphate is broken to a fine powder, placed in a silo and then dried. Afterwards the materials are suitably mixed in a scrupulous manner, and, to avoid dust, air separation devices are

large trunk pipes, so as to reduce entrainment of dust to a minimum, then to a dust chamber, then to a special washer, and are finally dealt with at the contact sulphuric acid plant.

(4) The important thing to ensure is that the chemical composition in the mixture of finely-ground materials is such that the correct ratio of chemical equivalents is maintained. It may be necessary to use clay or shale or marl, according to what materials are indigenous or are found within reasonable proximity to the site where the proposed plants are to be erected. It is essential to make experimental trials in the laboratory to determine what materials, and in what proportions, should be used in order to give a cement of the best quality and uni-

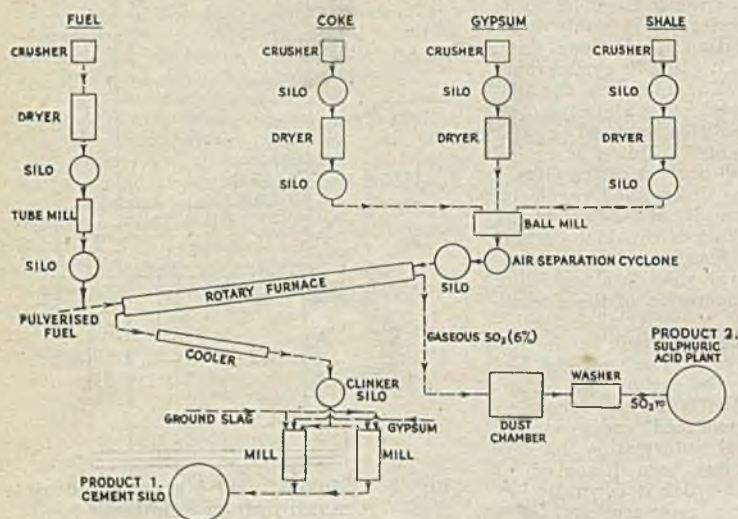


Fig. 6. Cement and sulphuric acid from gypsum—flow-sheet.

adopted. The mixed ingredients are now delivered to a large silo, which is designed with an automatic regulatable tube feed.

Meanwhile, pulverised fuel is prepared by grinding coal, drying it, placing it subsequently into a silo and then feeding it as required into a ball mill for grinding to the desired mesh: afterwards, the pulverised fuel is stored in a large silo, and subsequently feeds the burners placed at the end of the rotative tube furnace opposite to that at which the mixture, previously described, is introduced. After passage through the rotative tube furnace the clinker is discharged into a rotary dryer and subsequently passes into a clinker silo.

In the meantime, the gases evolved, containing about 6 per cent. of  $\text{SO}_2$ , are discharged from the rotative tube furnace at a point adjacent to that at which the mixture is fed. These gases are passed through

formity, at the same time affording maximum  $\text{SO}_2$  content in the gaseous mixture.

(5) The cement clinker emerging from the cooler silo may need to be fed along with ground slag and gypsum into suitable ball mills. Whether these will be required depends on the physical characteristics of the cement that is to be supplied. Gypsum is used for controlling the setting time. Actually, it slows up the setting time, and the extent to which it is used depends on the extent of deceleration required. For accelerating the setting time, calcium chloride, and proprietary products with calcium chloride as a base, are largely used: indeed, up to 4 per cent. is employed in some cases, although 2 per cent. is usually regarded as a normal quantity.

The following may be regarded as a typical analysis of cement from chalk and clay in the Medway (Kent) district:—



	Per cent.
Silica ( $\text{SiO}_2$ ) .....	22.0
Insoluble siliceous matter .....	1.0
Alumina ( $\text{Al}_2\text{O}_3$ ) .....	7.5
Ferric oxide ( $\text{Fe}_2\text{O}_3$ ) .....	3.5
Lime ( $\text{CaO}$ ) .....	62.0
Magnesia ( $\text{MgO}$ ) .....	1.0
Sulphuric anhydride ( $\text{SO}_3$ ) .....	1.5
Carbonic anhydride ( $\text{CO}_2$ ) .....	0.5
Water ( $\text{H}_2\text{O}$ ) .....	0.5
Alkalis .....	0.5
	100.0

All the constituents may vary considerably from the above proportions. The silica may range from 18 to 27 per cent.; the alumina from 5 to 10 per cent.; the ferric oxide from 0 to 7 per cent.; the lime from 58 to 67 per cent.; the magnesia up to 7 per cent.; the  $\text{SO}_3$  up to 2.75 per cent.; the alkalis up to 2 per cent.; and the water and  $\text{CO}_2$  according to the length of time the cement has been made, and the extent to which it has been exposed.

The British Standards Specification provides that "the proportion of lime to silicate and alumina shall be not more than the maximum, nor less than the minimum ratio (calculated in chemical equivalents) represented by:—



The percentage of insoluble residue shall not exceed 1.5 per cent.; the magnesia shall not exceed 3 per cent. and the total sulphur, calculated as sulphuric anhydride ( $\text{SO}_3$ ), shall not exceed 2 per cent., unless it can be shown that the cement has been ground for more than four weeks."

The ultimate composition of Portland cement is capable of being easily and accurately determined by the ordinary methods of chemical analysis: its proximate composition, that is, the nature and quantity of the chemical compounds or physical mixtures which constitute it, is not known with exactness, and cannot be determined with precision by existing methods of inquiry. It is generally held that the essential constituent

of Portland cement is tricalcium silicate,  $3\text{CaO} \cdot \text{SiO}_2$ , and that the body next in importance is a calcium aluminate, to which



Fig. 8. Parrish liquid-phase sulphuric acid towers—skeleton framework, bracing, and connections.

the formula  $2\text{CaO} \cdot \text{Al}_2\text{O}_3$ , or alternatively  $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ , has been given. The oxide of iron occurs as a calcium ferrite, the magnesia possibly as such, the sulphuric anhydride and  $\text{CO}_2$  probably as calcium sulphate and calcium carbonate, and the alkalis perhaps as double compounds with lime and silica or alumina.

Generally, it is believed that the substances of primary importance are tricalcium silicate and aluminate only, the minor bodies being little more than diluents, with the exception of calcium sulphate, which has significance in that it influences the setting time of the cement-constituents proper. It would seem that the best proof that the smaller constituents referred to are not essential is revealed by the fact that Portland cement of the highest quality can be prepared containing only silica, alumina, and lime in proper proportions.

Fig. 7 shows a unit of four Parrish liquid phase tower chambers constructed of square section, 37 ft. 6 in. high by 20 ft. square, supported in a skeleton framework of B.C. pine (pitch pine not being available). The gases from the Glover tower are distributed from the main trunk by two bends near the bottom of No. 1 tower chamber, where the canopy of the ammonia oxidation unit can be seen. The oxides of nitrogen from the ammonia oxidation unit are led by an acid stoneware pipe into the chamber at an angle, and come within the flow of the  $\text{SO}_2$  containing gases. This unit, without dispersed acid, is operating uniformly and satisfactorily at less than 5 cu. ft. of chamber space per lb. of sulphur per 24 hours. With the dispersion of cooled acid, say at  $30^\circ\text{C}.$  at the rate of 400-500 gallons per hour for each tower chamber, it is anticipated that it will operate at about 3 cu. ft./lb./24 hours. At the far right-hand side will be seen a cylindrical Gaillard-Parrish tower chamber of another set, which has



Fig. 7. Parrish liquid-phase sulphuric acid plant.

been operating almost continuously for 14 years. About the leadwork of this latter set some interesting information will be afforded later. Fig. 8 gives a better view of the cross-bracing of the square form of tower chamber, and of the connecting trunks.

The advantage of tower chambers as distinct from horizontal chambers lies in the fact that the coefficients of radiation for ordinary rectangular chambers hitherto have been generally accepted as follows: 1—for the bottom; 3—for the top; and 6—for the sides and ends. Thus, to determine the quantity of heat which would be radiated from a particular chamber of ordinary construction it is necessary to use the above coefficients and to multiply by the surface area and by the difference between the average temperature at which the chamber is working, and the temperature of the ambient air which is being used for cooling. Thus, take an installation of four tower chambers, assuming the first chamber is working at 85-90°C., the second at 75-80°C., the third at 55-60°C., and the fourth at 25°C., and assuming the temperature of the ambient air, the cooling medium, is 15°C., then there is a temperature difference of, say, 70° in the first chamber, 60° in the second, 40° in the third, and 10° in the fourth, and these figures must be multiplied by the coefficients given above and by the surface area. With a horizontal chamber, while it is a fact that the storage capacity for acid is much greater, the effective radiation value is relatively low. Where water-cooling is resorted to, the water actually comes into contact with a surface of higher temperature than the water, and therefore the cooling effect is appreciably greater than can possibly arise from air-cooling; in point of fact, heat is removed (a) by conduction, and (b) by partial evaporation of the water.

The advantage of acid dispersion lies in the fact that the whole of the leadwork of the vertical walls can be irrigated with cooled acid which, it has been found in practice, is protective against the attack of the lead. Apart from the cooling due to the irrigation in question, the whole chamber is filled with a fine mist of acid vesicles, which bombard the reactants and accelerate sulphuric acid production. It is much easier to cool a stream of acid in a concentric cooler than it is to ensure cooling by water irrigation on the outside of a tower chamber.

On the subject of the protective influence of cooled acid irrigation, the following weighings of sample cuts of chemical sheet lead, taken from a set of sulphuric acid plant (Gaillard-Parrish liquid phase type) after 14 years' continuous operation, are illuminating. The chambers in question were originally built of 8 lb. per sq. ft. chemical sheet lead, containing 0.07 per

Chamber	Position	Weight per sq. ft. (taken on opposite axes)			
		lb. oz.		lb. oz.	
1	Bottom	7	8	7	12
	Centre	8	—	8	—
	Top	7	8	8	—
2	Bottom	8	—	8	—
	Centre	7	—	7	8
	Top	7	12	8	—
3	Bottom	6	12	7	—
	Centre	7	4	7	4
	Top	8	—	7	4
4	Bottom	3	4	4	—
	Centre	3	4	3	12
	Top	3	—	5	8

cent. of copper. It will be observed that the loss in weight of lead in the first two chambers is relatively small. No. 3 chamber is a partially nitrous chamber, and greater corrosive effect would naturally be anticipated. No. 4 chamber is the nitrous chamber, and one can understand the diminution of weight here.

The writer has advocated in several of his yearly reviews that there is much to recommend the construction of a chamber constituted of acid-resisting tiles, used in conjunction with acid-resisting cement, as the materials of construction for a nitrous chamber.

### The Fertiliser Industry

Concerning soil and fertilisers, *A Scientific Policy for Agriculture*<sup>22</sup> urges a fuller knowledge of British soils, remarking that unlike the U.S.A., the British soil survey is incomplete, as, indeed, is the geological survey. The completion of the work is clearly an urgent necessity, not only to the agricultural investigator, but equally for the orderly utilisation of land for industry, building and other purposes. It is emphatic in saying that "ever since the British discovery of artificial fertilisers a hundred years ago these substances have been increasingly used to supply some of the additional plant foods made necessary by the increasing withdrawals from the soil, resulting from more intense production."

It is encouraging to know, after careful study of the question, that practical farmers are right in their tenacious faith in organic manure, that is, farmyard manure, crop residues and other kinds. Science, equally, is no less insistent on their importance. Artificial fertilisers are not a substitute for, but a supplement to farmyard and other organic manure. It should be observed by those who have been misled by the Howardists and others that *the proper use of fertilisers does not poison soils: it enriches them*. Certain fertilisers, if misused, can do harm by inducing soil acidity, or forcing up a lush and soft vegetation. Crops, like animals, require a properly balanced diet, and a better under-



standing of the correct use of fertilisers is a necessity. The highly complex part played by organic matter in the soil is one of the greatest of all the ultimate problems of the use of land all over the world.

Ten million tons of phosphate rock must be produced in the year ending June 30, 1945, to meet world requirements. The goal for the following year is 12,767,000 tons. This increase arises largely owing to the need for rehabilitating Europe. Average pre-war consumption was 10,700,000 tons. North African mines will be expected to supply a substantial proportion of the raw materials to be converted into superphosphate for European agriculture. A survey of the relative values of superphosphate and basic slag has been made by M. Lerner.<sup>24</sup>

The processes of calcium superphosphate manufacture which are of significance to-day are of the continuous type, namely, the Broadfield and the Sturtevant-Moritz-Standaert. The former has been the subject of comment in earlier reviews.

The latter process comprises a den chiefly of reinforced concrete. It is a cylindrical container, which rotates slowly at a variable speed on friction rollers mounted underneath the den, and is kept in a central position by means of a circular guide path. In the centre of the container there is a rotating cylinder, projecting the full length, and supported from the stationary concrete floor above. This cylinder forms the inner wall of the den. The annular part of the container constituting the den is sealed by a stationary curtain, which projects down from the floor above, and also by a mechanical cutter, which is driven through a suit-

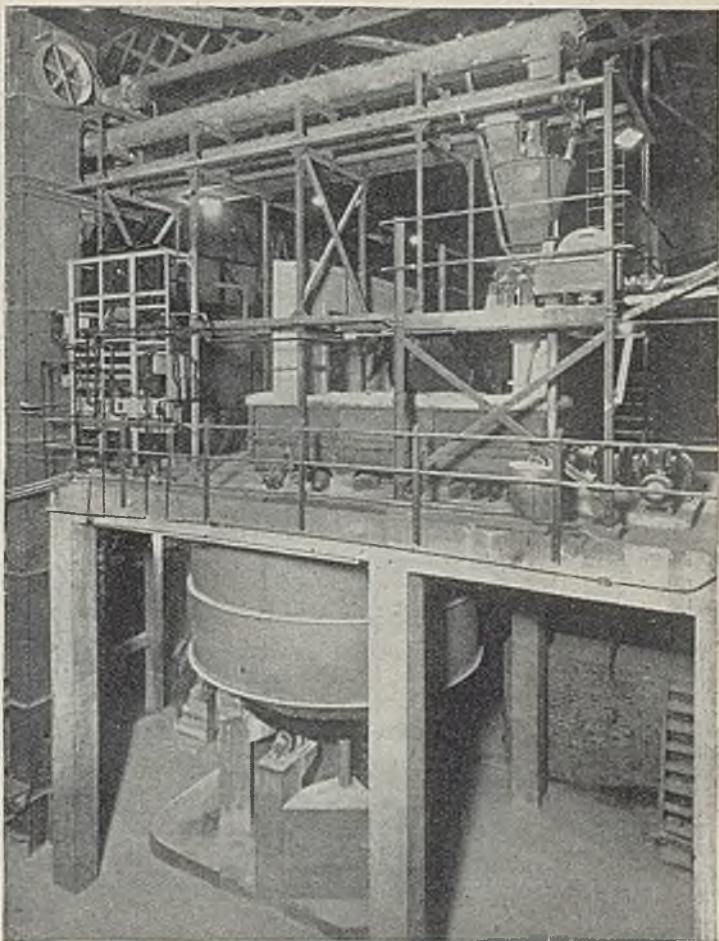


Fig. 9. Sturtevant-M.S. calcium superphosphate continuous den and equipment (10 tons per hour capacity).

able reduction gear. On the ferroconcrete floor constituting the top of the den (see Fig. 9), are mounted the superphosphate mixer and the acid and phosphate measuring devices. There is a sealing device at the bottom of the rotating container which ensures a joint between the stationary and moving parts of the den at this point, and contributes to cleanliness in operation. Inside the container there is a curved partition attached to the overhead platform which prevents the newly-mixed superphosphate from spreading backward to the cutter. It will be appreciated that the mass solidifies during the rotation of the den. The cutter consists of a mild steel circular framework, on which are mounted the cutting knives, somewhat similar to the type used in the Sturtevant batch den.

The den may rotate in two to four hours (Fig. 10 shows this mechanism very clearly in connection with a recently-erected 15-ton-per-hour den), according to the capacity and quality of the phosphate being used. About eight minutes is the time given for mixing. The superphosphate is in the den for  $1\frac{1}{2}$  to  $2\frac{1}{2}$  hours. With a 10-ton den there is a mass of about 20 tons of superphosphate. To avoid dislocation, the motor actuating the den traverse is disengaged in the event of a stoppage of the motor operating the cutter. As a guide to the consistency of the superphosphate which is being produced in the mixer, the ammeter is specially marked to indicate the resistance normally thrown by a satisfactory superphosphate. Should there be any tendency for the acid consumption to be reduced in relation

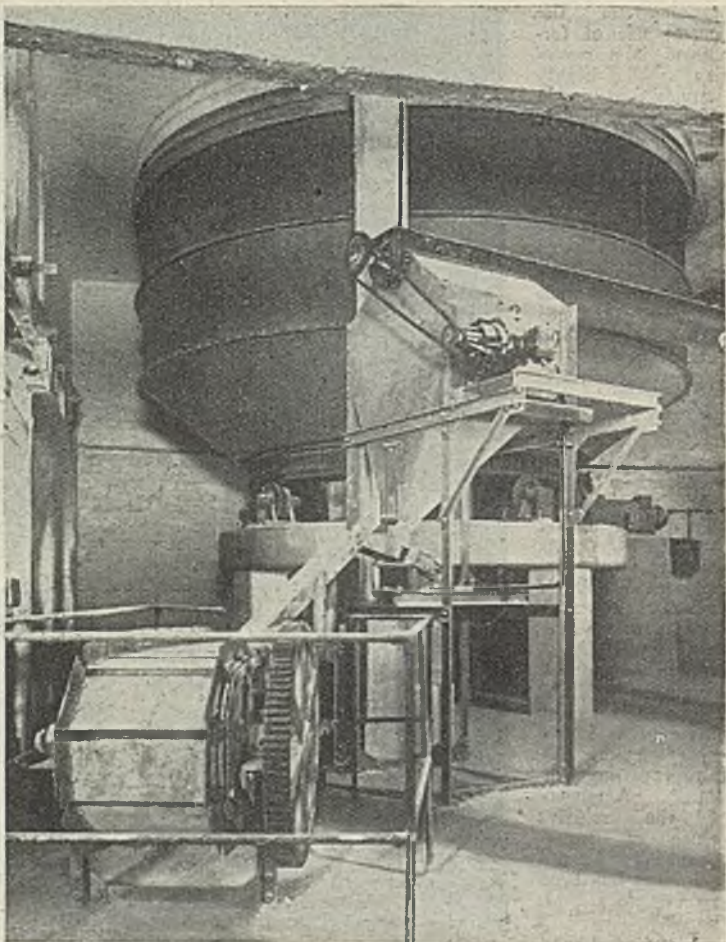


Fig. 10. Sturtevant—M.S. continuous den mechanism (15 tons per hour capacity).

to the phosphate rock fed, a greater resistance is thrown, and this is at once indicated by the ammeter.

The importance of the granulation of fertilisers has been explained by the author.<sup>25</sup> It has been suggested that the superphosphate industry must consider methods by which to reduce or otherwise avoid fixation of the water-soluble phosphoric acid in the soil. There are two methods of approaching the problem available to manufacturers. The first is to render the physical properties of the superphosphate such that fixation is reduced, or obviated. The second is to modify the chemical composition of the product. The first of these methods is already being exploited on a growing scale by granulation.

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- <sup>16</sup> *Chem. Met. Eng.*, 1944, 51, 5, 125-126.
- <sup>17</sup> *Chem. Age (Metallurg. Sect.)*, 1944, 51, 131.
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# Progress in Drugs, Fine Chemicals and Biological Products during 1944

by G. COLMAN GREEN, B.Sc., F.R.I.C., A.M.I.Chem.E.



Mr. G.  
Colman  
Green.

**D**URING 1944 bacteriostatic substances have continued to be explored and developed to the extent that they claim first consideration in this review. Among this group of substances progress in the production and chemotherapeutic applications, of penicillin, the antibiotic elaborated by the mould *Penicillium notatum*, remains of first importance. The experience in connection with its therapeutic applications which accumulates with the passage of time confirms the limits of its application without detracting in the slightest degree from its uniqueness.

So far as this country is concerned there is only a sad story to be told about production, with output inadequate for our own military needs, and no publicly known technical development of outstanding importance since Florey and his team of workers established their pilot-plant at Oxford. It is at least both satisfactory and consoling to record that the contributions of the British pioneers in this field have received official recognition in the conferring of knighthoods upon Professor Fleming and Professor Florey.

## Questions on Penicillin

In the earlier weeks of 1944 questions were asked in the Commons regarding the conditions thought to be imposed upon prospective entrants into the field of penicillin production. The form in which the questions were put reflected the profound concern of M.P.s and the knowledgeable public for the fact that, with the then impending opening of "second front" operations, penicillin production in this country was generally believed to be inadequate to meet expected military requirements, while, at the same time, it seemed to be felt that obstacles were being placed in the way of firms who believed they had suitable facilities. The replies offered by the Minister of Supply at that time did not go far in allaying public disquiet. Nevertheless, it is generally understood that, as a consequence of the pressure put upon the Minister, an independent advisory committee, under the chairmanship of Sir Henry Dale, P.R.S., was formed to assist in the rapid development of additional penicillin production. Furthermore, the Minister of Supply was able to state in October that seven plants, six of which were pilot plants, were producing in this country. Nine large-scale plants were expected to come into operation

within the next six months and two of these were about to start production. It is to be noted that no statement has been made as to the capacity of these plants, and this point will be referred to later. It is sufficient to note here that plants which the public have been led to believe were concerned with large-scale production—which no doubt they have been when compared with, for example, Florey's pilot plant—are now for the first time publicly described as "pilot plants." Whether these installations satisfy the chemical engineer's criterion of a pilot plant remains to be seen in the light of what they ultimately develop into. The fact remains that the only really large-scale plant known to be in the course of construction bears no connection, so far as the fermentation section is concerned, with the process developed in this country in the plants already established.

In addition to the firms mentioned in connection with production of penicillin last year it has since been announced that Kemball, Bishop & Co. have entered the field. This is an important addition in view of that firm's long connection with the industrial mould fermentations producing citric acid and gluconic acid. It has also been rumoured that another important firm concerned with industrial mould fermentations has lately started production.

## Types of Fermentation

The situation at the end of 1944 was that the relatively small output of this country was obtained entirely from the surface type of fermentation, mainly in glass flasks or bottles of various shapes, probably supplemented latterly by tray fermentations. The advantages and disadvantages of this method were discussed last year, and it is a direct expansion of Florey's original laboratory method. The principal advantage of the method, in theory, is that the failure of a flask merely affects that flask, and the whole batch, of which that flask is a mem-

ber, may not necessarily be affected. The labour required to handle the great number of vessels used and to fabricate replacements of these fragile vessels must be substantial. It was, however, stated in the U.S.A. in March that British production and proposed expansion was comparatively small because of lack of materials and manpower. It seems clear that, since this statement was put out, the pressure in Parliament and Press has caused plans concerning proposed expansion to be revised.

### American Penicillin

In America, by contrast, production problems have been attacked with vigour, determination and undisguised enthusiasm, and the achievements have been genuine and impressive. By mid-1944 the War Production Board was able to announce that 95 per cent. of the world's penicillin production originated in U.S.A. It is highly probable that, from the details to be considered later, this ratio has been maintained if not improved upon. Little wonder if members of the American forces regard penicillin as an all-American "invention"!

News of the development of a "deep" or "submerged mycelium" fermentation in the U.S.A. began to "leak" through to this country in March, followed by an announcement in New York that production was being carried out at one factory in 24 vessels, each with a capacity of 2500 (presumably U.S.) gall. (*The Times*, April 4). During 1941 and 1942, information was transmitted to U.S.A. by the British concerning production, and Professor Florey himself undertook a visit in this connection. The problem of production was placed in the capable and experienced hands of the fermentation experts and mycologists of the U.S. Department of Agriculture. Chemists, as well as the chemical engineers of the Massachusetts Institute of Technology, were called upon. In the meantime, private enterprises connected with the fermentation industries, and with industrial mould fermentations in particular, displayed initiative and reacted quickly to the situation. It was soon recognised that if penicillin were to become available to the forces of the United Nations in quantities which both its unique properties and the forthcoming military situation demanded, a technique different from the flask method of production would have to be devised.

In the hands of technologists with experience of industrial mould fermentations the potentialities of developing penicillin production along the lines of gluconic acid production would automatically have been explored, and this possibility appears to have occurred to the Americans at an early date. This is not to be wondered at, since the bringing of gluconic acid fermentation from a pan fermentation to a fermentation in

large enclosed rotating vessels into which large quantities of air are introduced (thus maintaining the mycelium of the organism concerned in suspension in the form of fragmented hyphae), was developed in America between the wars with commercial success. The development of the submerged mycelium fermentation for penicillin has been traced in more detail by the author elsewhere (*Discovery*, Nov., Dec., 1944; Jan., 1945).

The first outline of this development was given by Elder and Monroe (*Chem. Met. Eng.*, March, 1944, p. 103), where it is apparent from the illustrations provided that the deep-fermentation technique was being operated by Charles Pfizer & Co., who have a long-standing reputation in the conducting of industrial mould fermentations. It has been reported in a number of places that Pfizer & Co., Squibb & Co., and Commercial Solvents Corporation of America are all using the deep-fermentation method. Merck & Co. brought the only deep fermentation tank factory in Canada into production in August. Presumably the remaining 15 U.S.A. plants are using flask and/or tray methods. No detailed descriptions of the Pfizer, Squibb, or Merck plants have been made available with the exception of the photographs issued by the first-named firm.

### The Terre Haute Plant

There is, however, a most commendable description, liberally illustrated by photographs and flow-sheet, of the great commercial Solvents plant at Terre Haute (*Chem. Met. Eng.*, April, 1944). The designed capacity of the plant is 40,000 mega-units\* monthly in the form of the sodium-penicillin salt which, it has been stated elsewhere, was attained in five months from the commencement of production in January, 1944. The well-known American firm of chemical engineers, E. B. Badger & Sons, Co. were responsible for the engineering. The whole installation, which was financed by Commercial Solvents, cost \$1,750,000 (say £350,000). The principal stages in this process are: (1) submerged mycelium fermentation; (2) removal of mycelium and adsorption of penicillin on activated carbon; (3) elutriation and purification by solvent extraction leading to conversion to the sodium salt of the acid; (4) drying by high-vacuum freeze evaporation; (5) packaging, testing and storage. Thus the unit operations of adsorption, elutriation and liquid/liquid solvent extraction play an important part. It was stated in March that ten 12,000-gallon jacketed steel fermenters were included in the installation. By this process the penicillin originally contained in the 12,000-gallon charge of a single fermenter is concentrated in a final volume of 15

\* One "mega-unit" = one million Oxford units.



gallons, which yields 4.5 to 5.5 lb. dry sodium penicillin powder (1.2 per cent. moisture) containing about 20-30 per cent. pure sodium penicillin and having a titre of about 500 Oxford units per mgm.

There are 21 factories operating in the U.S. and Canada, which are reported to have a potential joint capacity of 200,000 mega-units per month. Since the Commercial Solvents Corporation has a capacity of 40,000 mega-units per month and the Pfizer plant is said to have a capacity of the same order, it is reasonably clear that the three deep-fermentation plants must account for a very substantial part of American output. This fact illustrates the limitations of the surface mycelium method with which the remaining 18 plants are concerned. These same limitations will apply to the similar types of plant which solely so far have been operated in this country. As has been mentioned, the War Production Board announced that U.S.A. were producing 95 per

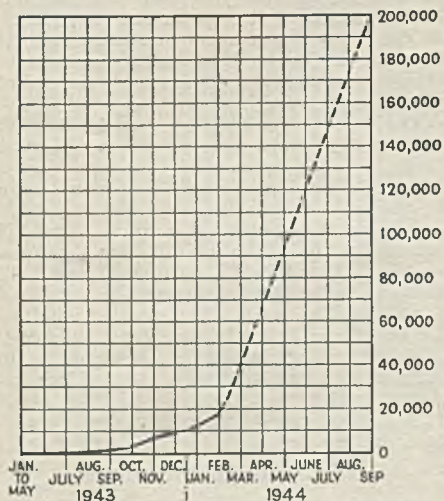


Fig. 1. American output of penicillin in mega-units per month.

cent. of the world's penicillin in mid-1944. Ignoring German production (if any, at the moment), production in the three Canadian plants and the one Australian plant, this leaves Britain with the 5 per cent. balance. Assuming that the U.S. alone, without Canada, had reached the potential capacity for both, namely 200,000 mega-units per month, by mid-1944—which is certainly not the case—then maximum British output would have been of the order of 10,000 mega-units per month. Bearing in mind the nature of the assumptions made it is apparent that the total British output cannot be anywhere near this figure if the reported statements are true.

Whatever the reasons are for allowing

this situation to develop the Government, now guided, no doubt, by the Penicillin Committee, intend to put the matter right; for it was announced in August that the world's biggest factory for producing penicillin was to be erected in N.W. England at a total cost of £1½ million. It has since been made known that the actual site is at Speke near Liverpool and that the factory is to be operated by The Distillers' Company, Ltd., as agents for the Ministry of Supply. In view of the association of this well-known company with Commercial Solvents Corporation of America, it was to be surmised that the deep fermentation system developed by the latter would be adopted. While no official announcement has been made to this effect this is now generally understood to be the case and, what is more, it is understood that most of the plant will be fabricated in the United States. No potential capacity has been mentioned for this plant any more than in the case of the "pilot-plants" and their proposed successors; but as Commercial Solvents Corporation of America invested \$1,750,000 to yield 40,000 mega-units per month, an investment of £1½ million in this country should yield an output of the order of 120,000 to 150,000 mega-units per month† assuming a direct proportionality in values.

American output has been reported from time to time and the particulars are given in Table 1 and set out diagrammatically in Fig. 1.

TABLE 1.

1943	mega-units per month.
Jan. to May	400
June	425
July	762
August	906
September	1,787
October	2,872
November	4,846
December	9,194
1944	
January	12,550
February	18,700
March (estimated)	40,000
September	(?) 200,000

The Member of Parliament for Grantham inquired of the Ministry of Supply as to the accuracy of the statement that 1,200,000 mega-units was the aggregate American production, and that 1/6th of this (200,000 mega-units) had been sent to this country under Lend-Lease. It is to be presumed that these figures were obtained from authentic sources before the question was asked; the Minister neither denied nor affirmed their accuracy.

Matching the obscurity in which plant capacities are cloaked is that in which the question of cost is surrounded in this coun-

† 1 mega-unit may be expended in a single case of severe generalised infection.

try. Again, it is known that the Ministry of Supply is the sole buyer, and no doubt the purchase has been made on the basis of processing costs in each individual plant. It would be interesting to know how these costs have compared with those made public in America where the costs are reported to have been reduced in the following manner:

Early 1943 ...	about £40	per mega-unit
January, 1944	£17	„ „ „
March, 1944	£10	„ „ „
Later, 1944	£6 10s.	„ „ „

These figures have been culled from American journals and their accuracy must be accepted with some reserve, especially as no idea is given as to the items of cost which have been admitted or excluded in their calculation. Nevertheless, they may reasonably be taken to be of something like the correct order and their trend, without doubt, reflects the effect of larger-scale working. When the three American deep-fermentation plants are in full production a further reduction may be expected.

### Higher Purity

Parallel with the increase in output and reduction in cost in the U.S.A. has come an increase in purity. Penicillin produced by the earliest work in this country had a titre varying between 50 and 100 Oxford units per mgm., being roughly 5 to 10 per cent. pure. This titre was soon increased to 100 to 150 units per mgm. No very substantial improvement has been achieved by flask fermentation procedures.

The physician may at present receive samples assaying 100 to 500 units per mgm., but the more usual range is of the order of 200-300 units or so. By contrast penicillin produced by the deep fermentation technique is notably more pure and may assay up to 1000 units per mgm. and is normally in excess of 500 units per mgm., equivalent to an approximate purity of 30 per cent. and containing 1 to 2 per cent. moisture. The balance of impurity consists of acidic substances which are generally physiologically inert, although some samples from various sources sometimes cause reactions.

Coghill (*Chem. Eng. News*, April, 1944) has briefly compared the advantages of the three principal methods of penicillin production. The flask method has, to date, proved the more certain since the risk of contamination by penicillinase-secreting organisms is reduced to a minimum. Erlenmeyer flasks give better results than milk bottles, winchesters and such-like. The pan type of fermentation (which has been widely applied in the citric acid fermentation) gives results comparable with those obtained by bottle fermentations. Surface culture on bran in pans has been found satisfactory; but, on account of the resistance of bran to heat transfer, sterilisation is as difficult as is the subsequent removal

of heat generated by the fermentation. All these methods are costly in the provision of labour and plant, the small glass vessel type of plant particularly so. The submerged mycelium type of fermentation, however, is economical in labour, space, and (in certain respects) in plant, and lends itself to indefinitely large scale production; but it suffers the demerit of liability to infection—more serious in a large bulk of medium than in a small—mainly on account of the large volumes of air which are blown through the medium and which it is always difficult to completely sterilise as anyone experienced in yeast production only too well knows.

Coghill has expressed the view that the use of corn steep-liquor in the preparation of the medium has been the greatest single factor in making possible the large scale manufacture of penicillin. The use of steep-liquor and the careful selection of the strain of *Penicillium notatum* enabled the titre of the metabolite liquor to be raised from 2 to 40 units per ml. To Moyer, microbiologist of the Fermentation Division of the U.S. Department of Agriculture, is due the credit for finding the tenfold increase in penicillin production by the use of corn steep-liquor.

The *Penicillium notatum* used for surface culture in U.S.A. was obtained by Harrop from a single spore isolation made from Fleming's original strain. The mould used in the submerged mycelium method, however, was obtained by a search among the moulds in the collection of the National Regional Research Laboratory of the U.S. Department of Agriculture and is unrelated to Fleming's strain. The results obtained by the Fleming strain in submerged mycelium culture are about half as good as in surface culture; similarly, the American deep-fermentation strain gives only about half as good results when it is used in surface culture.

### Raw-Material Difficulties

The great increase in production in U.S.A. has not been achieved without severe dislocation of raw material supplies. For example, an acute shortage of amyl acetate developed when sudden demands were made for this ester as solvent. The shortage will have been made good in view of the output of by-product amyl alcohol available from colossal U.S.A. fermentation alcohol production undertaken in connection with the synthetic-rubber programme. Lactose is also in demand as the substrate carbohydrate; 4 per cent. of lactose is added to the corn steep-liquor and it is estimated that 5 million lb. will have been required in U.S.A., in 1944, for penicillin production alone. Since a further 7 to 8 million lb. are required for all other purposes it is clear that all whey-producing sources must be tapped. In this country, too, the dairies



have been co-operating in the production of lactose. It is also estimated 3 to 4 million lb. of activated carbon will be required for penicillin alone in U.S.A. during 1945.

It appears that developments in the penicillin recovery and purification sections have been less fundamental than in the fermentation section, for some 50 per cent. of the penicillin present in the metabolite liquor is still lost in the recovery section. In this connection Berger (*Nature*, 1944, 3910) proposes a new extraction technique. Using amyl acetate or chloroform as the solvent, the extraction has hitherto been made from the aqueous phase which has been made strongly acid, a condition in which penicillin is unstable. Berger has found that if ammonium sulphate be added to the aqueous phase the whole of the penicillin will pass over into butyl alcohol, on contacting, at pH 6.4, the pH of maximum stability for penicillin. The penicillin may be brought back into aqueous solution by the addition of petroleum ether and sodium bicarbonate.

### Structure and Synthesis

Regarding the structure and synthesis of penicillin no information has been made public during the past twelve months. It is well known that the problem is being actively pursued at Oxford and in America. As to the prospects of success in synthesis one can only conclude that any hopes which may have been held of attaining that objective in the near future have receded considerably in the light of the Government's decision to invest £1½ million in the Speke deep-fermentation factory. Nevertheless, as pointed out last year, there remains the possibility that sufficient knowledge may become available concerning the structure of breakdown products, if not of penicillin itself, to enable relatively simple substances to be synthesised which may contain the chemo-therapeutically significant grouping of penicillin or which may function as chemotherapeutic analogues. Dale, however, revealed in November that several penicillins are now recognised which differ slightly from each other both in chemical tests and in that their effects on organisms are not quite identical. These different penicillins are thought to arise from some variation in metabolism, nutritive conditions, cultural conditions, or mutation within the mould itself. Three have been clearly identified and are known as 1, 2 and 3 in Britain and F, G and X in America.

One of the demerits of penicillin is the ease with which it is excreted, thus rendering it difficult to maintain adequate blood levels. In the earlier days of grave scarcity it was necessary to recover, however inefficiently, the penicillin excreted in the patient's urine. Berger *et al.* (*Science*,

1944, 100, 107) have now found that, in dogs, excretion of penicillin is delayed by maintaining *p*-amino-hippuric acid in the blood at a level of 30 to 50 mgm. per 100 ml. It is suggested that this compound blocks the mechanism which is responsible for a preferential secretion of penicillin.

### The Action of Penicillin

Bigger continued his work on penicillin by demonstrating a synergic action between penicillin and sulphathiazole against *Staphylococcus aureus* in broth and in serum (*Lancet*, 1944, 6309). He has also shown that, contrary to what had formerly been stated, penicillin is inactivated in some degree in the presence of human serum and blood. The extent of inactivation is variable between different specimens of serum and is greater at body temperatures than at lower temperatures (*Lancet*, 1944, 6317). Success against *Staphylococci*, which are generally considered a penicillin-susceptible group, has not always been consistent. There have been grounds for believing resistance to be a property of certain strains. Bigger (*Lancet*, 1944, 6320) has given consideration to this point and has explored the bactericidal (in contrast with the bacteriostatic) activity of penicillin against *Staphylococcus aureus* in vitro. He finds that penicillin is lethal only towards those cells which are actively dividing. Since there are a number of cells in a population which are temporarily dormant—Bigger calls them "persisters"—these escape the action of the penicillin and are able to continue to propagate after the period of dormancy is past and when penicillin concentrations have been reduced to the level at which they cease to inhibit. The descendants of these "persisters" are shown to be penicillin-susceptible. Bigger suggests that on the occasions when penicillin has had only limited success against staphylococcal infections, "persisters" have been present in the body and have survived the administration of penicillin. He therefore suggests a technique of administration which is analogous to fractional sterilisation by tyndallisation. Penicillin is alternately administered and withheld. During the periods which penicillin is withheld the "persisters" surviving the earlier injections of penicillin would pass out of their dormancy stage and give rise to penicillin-susceptible descendants which would be inhibited by subsequent administrations of penicillin.

There still remains no chemical method of estimating penicillin and it is necessary to estimate it by assaying the bacteriostatic power of body and other fluids against a standard strain of test organism. The technique for this was developed by Fleming and he has now described recent refinements of it (*Lancet*, 1944, 6324). By means of the

micro-techniques which he has devised he has explored the blood concentration of penicillin when it is administered in varying concentrations by the available routes. By each of these routes he has indicated the frequency and amount of dosage to maintain optimum blood concentrations for necessary periods of time.

### The "Cup" Assay Method

Heatley's cup method has proved of great value in the development of penicillin production, since it gives relatively rapid results. The method consists essentially of placing an open-ended glass cylinder on agar which has been seeded by pouring on it a broth culture of the test organism *Staphylococcus aureus* (No. 6571 of Nat. Coll. of Type Cultures), draining and drying. The solutions to be assayed are placed in the cylinder and incubated. The zone of inhibition around the cylinder is measured and compared with that of a penicillin solution of known strength. The technique has been described by Heatley for the first time in detail (*Biochem. J.*, 1944), and he gives the statistics for the method.

Florey *et al.* (*Nature*, 1944, 3904) point out that a penicillin-like antibiotic is not only produced by the chrysogenum-notatum group of *Penicillia* but that it is also produced by morphologically dissimilar species.

The point has arrived at which summarisation of the properties and applications of penicillin have been desirable and this has led to the issue of a number of important publications. At the end of 1943 the National Research Council of Canada issued "Abstracts on Penicillin and other Antibiotic Substances" which was available in this country at the beginning of 1944. "The Use of Penicillin in Treating War Wounds" has been issued by the Medical Research Council (M.R.C. War Memorandum No. 12—1944), which gives an excellent and concise summary of the extent and methods of clinical application. Methods of assay are given which, as mentioned above, remain dependent upon a measurement of bacteriostatic power.

A comprehensive summary of all aspects of penicillin, excepting industrial production, is contained in *British Medical Bulletin*, 1944, 2, 1. Fleming's contribution dealing with the events leading to his discovery of penicillin and Florey's description of its first isolation in crude form are records of historical importance. There is, as usual in this publication, a series of extracts of relevant literature and an excellent list of references. Experience in the use of pharmaceutical preparations of penicillin have been summarised in a report to the Medical Research Council and War Office by Florey and Cairns (*see Pharm. J.*, January 15, 1944).

Florey, in a lecture to the Royal Society

of Arts in June, gave an up-to-date survey, illustrated by a colour film of the historic pilot plant developed by him and his team of co-workers at Oxford. A colour slide of crystals of pure sodium penicillin was also shown. Photographs of industrial plants developed from the Oxford pilot plant have been made available to the Press (*e.g.*, this *Journal*, 1944, 50, 574). Fleming made a similar survey at Edinburgh in November when he gave the first of the Lister Memorial Lectures to the Society of Chemical Industry, a series endowed by J. F. Macfarlan & Co., and T. & H. Smith & Co., who have a century-old connection with fine chemicals manufacture in Edinburgh. Fleming and Florey also opened a discussion on the clinical use of penicillin at the Royal Society of Medicine in November.

Early in the year an interesting draft monograph for penicillin was issued for criticism by the U.S. Pharmacopœia authorities. The proposal was that 60 grams of pure sodium penicillin be obtained which, if found quite stable, should become the International Standard of reference and that all penicillin titres should be expressed in terms of it. Proposals were made for characterisation, tests, and storage conditions. It must be mentioned here that pure sodium penicillin had by this time become available. It is reported that it was first obtained by means of a chromatographic method at the Squibb Institute of Medical Research. In August an important step was taken in this country by including penicillin in the Therapeutic Substances Act as a Seventh Schedule (S. R. & O. 1944, No. 922) on the grounds that its purity and potency cannot be adequately tested by chemical means. Tests for freedom from abnormal toxicity and from pyrogenic substances are defined. However, the characteristics of the standard kept at the National Institute of Medical Research, in terms of which the strength of a preparation is stated, are not referred to. The different penicillin preparations distinguished in the Schedule are: (a) Penicillin (crude filtrate) containing not less than 10 units per ml.; (b) Penicillin (dried crude filtrate) containing not less than 0.75 unit per mgm.; (c) Penicillin salt.

### A World Standard

During October a conference was organised under the auspices of the League of Nations Health Organisation and held in London. Under the chairmanship of Sir Henry Dale, P.R.S., chairman of the Ministry of Supply Penicillin Committee, representatives of Australia, Canada, France, U.S.A., and the United Kingdom, in the presence of observers of other nations, discussed the establishment of a world standard for penicillin. All the findings have not been made known at the date of this note; but



Sir Henry Dale has stated that the International Unit agreed upon was the specific penicillin activity contained in 0.6  $\mu$ gm. of the International Standard, which is a specimen of crystalline sodium salt of penicillin "2" or "G." It has been reported elsewhere that pure sodium penicillin has a titre of 1650 Oxford units per mgm. If this is also the strength of the International Standard, then 0.6  $\mu$ gm. is equivalent to 1.0 Oxford unit, nearly, and a million Oxford units, or one mega-unit, is equivalent to 0.6 gm. sodium penicillin. In other words, the proposed new International Unit is equal to the original Oxford unit, a relation which will facilitate transposition.

Among the antibiotics other than penicillin, patulin, elaborated by *Penicillium patulinum*, Bainier, and gliotoxin, elaborated by a number of moulds, have received further consideration during the past year. Vivicillin, a specific preparation from *Penicillium notatum*, too, has been developed and examined, but like patulin it has failed to justify to the full the hopes originally placed in it.

### Vivicillin

Vivicillin was made available early in 1944 and was stated to be prepared by withdrawing metabolite liquor from immediately beneath the mycelium at the time when penicillin was being most actively elaborated. The preparation was said to contain hyphae in suspension, and after removal of pyrogens the preparation was ready for injection. Clinical successes were reported from Wellhouse Hospital, Barnet, following successful animal experiments which indicated, also, the possibility of successful application in veterinary practice. The preparation was stated to be equally efficient whether injected intravenously or intramuscularly, and to be without toxic effects in man or animals (presumably over the range of therapeutic doses). One injection was said to be effective over a period of 36 to 48 hours, whereas penicillin is, of course, very rapidly excreted. Crawford *et al.* (*Lancet*, 1944, 6301) later reported results of administering vivicillin to patients in a military hospital. Not more than traces of antibacterial substances were detectable in vivicillin or in the serum of patients receiving it by intramuscular injection on testing *in vitro*.

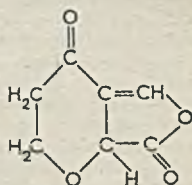
The conditions treated covered a range of infective organisms, including *Staphylococcus aureus*, hæmolytic streptococci, *Streptococcus viridans*, etc., and all infecting organisms concerned were found to be penicillin-sensitive. However, the authors were unable to show any bacteriostatic or therapeutic effect on their patients.

So far as patulin is concerned this was isolated by Raistrick and co-workers in 1943 and identified as anhydro-3-hydroxy-

methylene-tetrahydro- $\gamma$ -pyrone-2-carboxylic acid.

### Patulin

Hopkins had achieved encouraging results in a clinical trial on patients suffering from the common cold. Greenwood had analysed the data of this experiment statistically and concluded that the difference between the rates of cure in the patulin-treated and in the control group not treated with patulin was of such an order that it would occur by chance only three times in 10,000 trials; the result in favour of patulin therapy was, therefore, statistically significant. It is to be noted in the light of subsequent developments that the possibility that this result favourable to patulin treatment was due entirely to a chance occurrence is not completely ruled out but is of the order of very high improbability. At the time of publication of these results Stuart-Harris *et al.* announced that they were unable to discover any advantage in the use of patulin in modifying the course of the common cold. Their results have now been published more fully (*Lancet*, 1944) and amply support their original statement. Moreover, their work includes a chemical and chemotherapeutic examination of patulin which confirms the wide range of both gram-positive and gram-negative organisms for which patulin is actively bacteriostatic; at the same time the narrow margin between therapeutic doses and highly toxic, if not actually lethal doses, is stressed. A further most carefully planned and controlled as well as extensive clinical trial was carried out by the Patulin Clinical Trials Committee of the Medical Research Council in view of the important social implications. Tests were made on patients suffering indubitably from the common cold in widely distributed works, schools, and post-office establishments. The results were subject to statistical analysis and no evidence was found that patulin was effective in the treatment of the common cold. It is unlikely that the last has been heard of this application of patulin and the explanation of the discrepancies in the various trials may be of the highest importance in throwing light firstly on patulin chemotherapy, and secondly, on the mechanism by which therapeutic trials should be carried out and interpreted.



### Gliotoxin

Up to the present gliotoxin, a thermally stable antibacterial substance of the formula  $C_{14}H_{16}N_2S_2O_6$ , has been isolated as a metabolic product of four different organ-

isms, *Gliocadium fimbriatum*, *Aspergillus fumigatus*, and an as yet unidentified *Penicillium* and *Trichoderma* sp. Bruce *et al.* (*J. Amer. Chem. Soc.*, 1944) have obtained a neutral degradation product with a pyrazino-indole structure which may possibly be represented by the accompanying formula. Glistler and Williams (*Nature*, 1944) confirm that gliotoxin is an indole derivative and that the antibiotic called fumigacin produced by *Aspergillus fumigatus* mut. *helvola*, Yuill, is in fact a mixture of two antibiotics, gliotoxin and helvolic acid.

Similarly, clavacin, the antibiotic of *Aspergillus clavatus*, seems to be identical with the patulin from *Penicillium patulinum*, Baidier, and from *Penicillium erpansum* (Rathman *et al.*, *J. Biol. Chem.*, 1944). Florey *et al.* have shown this antibiotic to be produced by *Aspergillus giganteus*, Welmi; while Bergel *et al.* and Florey *et al.* have shown claviformin from *Penicillium claviforme* to be identical with patulin.

### Antibiotics in Plants

A search for antibiotic substances has been made among the higher plants. At Florey's suggestion Osborn examined the aqueous extracts of 2300 species for action against *Staphylococcus aureus* and *Bacillus coli*. Some correlations were found between activity of the extracts and natural classification. The *Ranunculaceae* family were outstanding in the ability of their aqueous extracts to inhibit the growth of the test organisms while in a lesser degree the *Compositae* inhibited the staphylococcus rather than *B. coli*. Wilkins and Harris have also examined the basidiomycete group of the higher fungi and in view of the difficulty of growing these organisms in plate culture have developed a special technique (*Nature*, 1944) which has demonstrated the ability of these higher fungi to produce antibacterial substances.

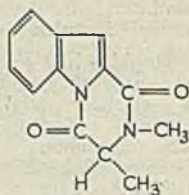
*Streptococcus cremoris* is of great industrial importance as a cheese "starter," but it often fails owing to the presence of other related streptococci which powerfully inhibit it. Oxford has isolated the antibacterial substance from two strains of the inhibiting streptococci (*Biochem. J.*, 1944). He finds it to be, like gramicidin and tyrocidin, a sulphur-free polypeptide, but possibly of greater complexity. It has, however, a lower molecular weight than a metaprotein. The method of isolation was similar to that used by other workers for the preparation of protein antigens of hæmolytic streptococci, which suggests the possibility that the antibacterial substance may be a com-

ponent of the somatic antigen of the streptococcus from which it was obtained. Oxford suggests the name "diplococcin" (from the morphological arrangement of the organism) and states that, while the substance is mainly to be obtained from the cells, the antibacterial substance of the medium—which would, of course, be the inhibitor of the cheese starter—has the same properties.

It has been seen that higher plants, fungi, bacteria and, as well, algae, have been examined for their ability to secrete, or their property of containing, antibacterial substances. One of the principal distinctions between the higher and lower plants is the possession by the former of chlorophyll, the well-characterised respiratory pigment sited in the chloroplasts which is notably closely analogous, both functionally and structurally, to the hæmoglobin of the blood of animals. It is not surprising, therefore, to find that this easily accessible chlorophyll has been explored for its anti-anæmic effects. Strong claims have been made for positive therapeutic effects in this connection. The evidence, however, is not wholly convincing and has been accepted generally with some reserve. It is noteworthy that many proprietary preparations offered to correct hæmoglobin deficiency contain iron in one or more of its forms as well as chlorophyll. Since, in certain types of anæmia, the administration of simple iron compounds in somewhat massive doses is therapeutically effective in itself, the addition of chlorophyll to these preparations could only be justified by implications of an extension of the therapeutic range or of a synergistic action.

### Chlorophyll

During the last few years, however, studies in the therapeutic applications of chlorophyll have increasingly turned to its use as an antibacterial agent. Some evidence has accumulated that it has an antibacterial effect and that, in addition, it has the power to stimulate granulating tissue and, consequently, the more rapid healing of wounds. Smith (*Amer. J. Med. Sci.*, 1944) is of the opinion that, in respect of anærobic organisms, chlorophyll is bacteriostatic in the sense that it has the capacity to interfere with oxidation-reduction mechanisms. Laboratory confirmation of the promotion of tissue healing is forthcoming from Smith and Sano (*J. Lab. and Clin. Med.*, 1944) in their observation that chlorophyll reduces almost to the point of disappearance the lag phase in the growth of fibroblasts. Smith and Livingston have studied 1372 experimentally induced wounds in animals in connection with the promotion of healing of the wounds by 17 preparations offered in the market for the purpose. Only five chlorophyll preparations showed statistically signi-





ficant effects. At the same time, wounds healed 24.9 per cent. faster when treated with chlorophyll than with the other preparations examined.

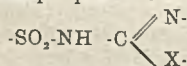
Preparations containing aqueous solutions of chlorophyll have long been available for therapeutic purposes; B.P. 564,282 now protects the use of oil-soluble fractions of chlorophyll and its derivatives. In the preparation protected by this patent, no separation of the A and B components is regarded as necessary, since each is therapeutically effective. It is suggested that chlorophyll acts in some "physio-chemical" manner by reinforcing the resistance of the cell membrane against the action of the infecting bacteria, resulting in the ultimate attenuation of the latter. Coincidentally, the granulation of the tissue cells is accelerated.

### The Sulphonamides

The sulphonamide group of chemotherapeutic agents has maintained its importance in this country although there has been a sharp drop in output in America, which is ascribed to the displacement of these drugs by the penicillin that has become increasingly available there. United States sulpha drug production aggregated 10 million lb. in 1943; but it is doubted whether the 1944 output will exceed 6.73 million lb. Large U.S. Government stocks are also believed to have contributed to this decline.

Sulphacetamide, sulphadiazine, sulphaguanidine, sulphapyridine and sulphathiazole are now to become official in the British Pharmacopoeia. The relative monographs will appear in the 7th Addendum to the 1932 B.P. to be published in February, 1945.

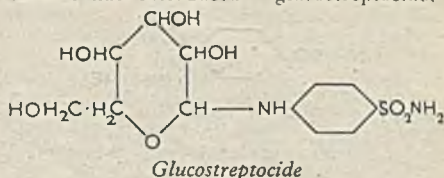
M. A. Phillips, who was associated with Twins in the introduction of 2-(p-aminobenzenesulphonamide)-pyridine (i.e., sulphapyridine, or, according to the best known of the brand names, "M. and B. 693"), has related the circumstances attending the original synthesis of this compound in 1937 (*J. and Proc. R. Inst. Chem.*, 1944, III, 99). Phillips points out that the grouping



is common to all derivatives of sulphanilamide at present in use, and that the grouping may conceivably be of chemotherapeutic significance. He briefly discusses the mode of action of these drugs, an aspect which was summarised by the writer of these notes in the corresponding annual survey of last year. This same survey made reference to the symposium on "Modes of Drug Action" organised by the Faraday Society in September, 1943. The papers contributed to this discussion have now happily been made available in booklet form (London: Gurney & Jackson), as well as in abstract in the *British Medical Bull.* (1944, 2, No. 3-4, 71). Sulphanilamide, the parent substance of

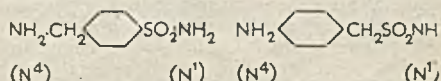
this group of bacteriostatic agents, is normally prepared by reacting aniline with acetic acid, chlorosulphonating the resulting acetanilide, and treating this with ammonia to give the acetyl derivative of sulphanilamide which is subject to appropriate hydrolysis to yield the base. In view of the shortage of acetic acid, Galat (*Ind. Eng. Chem.*, 1944) has suggested protecting the amino group by formylating or carbonylating. In addition to the saving of acetic acid, the former route economises in heat and material, while the latter route utilises the cheap and readily available urea, only one molecule of which is required per two molecules of aniline. The N:N'-diphenylurea produced is chlorosulphonated, treated with ammonia in the usual manner, producing p:p'-disulphonamido-N:N'-diphenylurea from which two molecules of sulphanilamide are split by treatment with acid.

From Moscow it has been announced that Labinin has introduced "glucostreptocide,"



which has a toxicity one-quarter that of sulphanilamide. Successful clinical applications are reported.

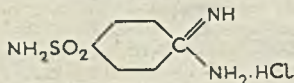
An interesting development has taken place in the homosulphanilamides. Two series of homo-derivatives are available depending upon N' or N'' becoming involved thus:—



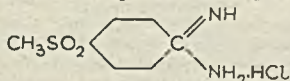
Several of the derivatives of these compounds were examined by Miller *et al.* in 1940 (*J.A.C.S.*) and found to be without significant action on their test streptococci. It was, therefore, with some surprise that there was captured from the Germans in the Western African battles a medical store described as "Marfanil Prontalbin," which was subsequently found to be composed of equal quantities of marfanil and prontalbin, the marfanil being 4-homosulphanilamide. A search of the literature revealed a paper by J. Klarer in 1944 (*Klin. Wochschr.*), the content of which had not been fully appreciated, which stated that 4-homosulphanilamide was effective in controlling experimental gas gangrene in mice. There was also a relevant U.S. patent, No. 2,288,531. It was subsequently found to be specific against the gas-gangrene organisms—usually members of the *Clostridium* group of anaerobes—in man. Fleming reported to the Medical Research Council in 1943 that he

found this compound second only to penicillin in controlling wound infection. Marfanil is not inhibited by pus or by *p*-aminobenzoic acid to any extent, and is therefore distinguished from sulphanilamide and its heterocyclic *N'* derivatives. It appears, however, that marfanil is inhibited by blood and is, therefore, not suitable for injection. Since 4-homosulphanilamide is soluble in water, its use in wound-irrigation is indicated. It is no more toxic than sulphanilamide, is non-irritating and does not interfere with the growth of epithelial tissues. Domagk has described two compound powders which he found to be effective in the local treatment of experimentally infected wounds in rabbits. The first contains equal parts of marfanil, sulphanilamide and sulphathiazole, while in the second mixture the sulphanilamide was replaced by red prontosil.

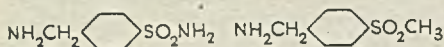
In the course of work on the chemotherapy of rickettsial infections, *p*-sulphonamidobenzamidine was found to have antibacterial



activity as well as antityphus activity by Evans *et al.* (*Lancet*, 1944, 6321). Derivatives were explored and *p*-methylsul-



phonylbenzamidine was found to have outstanding activity against gas-gangrene organisms and hemolytic streptococci, although inactive against typhus. This compound is, in effect, a sulphone, and to complete the series the sulphone corresponding with marfanil was prepared, namely, *p*-methylsulphonylbenzylamine. This latter compound has a similar high antibacterial and chemotherapeutic activity.



Marfanil = *p*-methylsulphonylbenzylamine  
4-homosulphanilamide

The two new drugs are potent in experimental gas gangrene in guinea-pigs and are not inhibited by *p*-aminobenzoic acid. They are well tolerated on parenteral injection in therapeutic doses, but are poorly absorbed when administered *per os*.

Bergeim and Braker (*J.A.C.S.*, 1944) have made a revaluation of the homosulphonamides in the light of these developments. Of the compounds tested by them, 4-homosulphanilamide and its methyl derivative, *N'*-methyl-4-homosulphanilamide, were most effective in local treatment of experimental gas gangrene in mice.

In the preparation of these 4-homo-compounds, Miller (1940) catalytically reduced

*p*-cyanobenzene-sulphonamide (diazotisation of *p*-aminobenzene-sulphonamide and treatment of product with copper cyanide); but Bergeim and Braker chlorosulphonated *N*-acetylbenzylamine to give the corresponding sulphonylchloride, which is then treated with ammonia and the acetyl group hydrolysed off with alcoholic hydrochloric acid. The usual *N'*-heterocyclic derivatives were found not to be so readily formed as in the sulphanilamide series. In the preparation of 2(4-homosulphanilamido)-4:6-dimethylpyrimidine improved yields were obtained by chlorosulphonating  $\sigma$ -phthalimidotoluene instead of  $\alpha$ -acetamidotoluene.

It is worthy of note here that penicillin has been used by the Allies in the treatment of gangrenous wounds. But since penicillin does not inhibit growth in dead tissue, toxins are still liable to be formed and absorbed and must, therefore, be neutralised by the administration of gas-gangrene antitoxin.

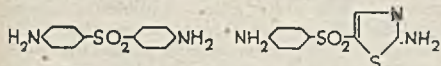
### U.S. Sulphonamide Production

No figures are available for the production of sulphonamide drugs in this country. Production in the U.S. is reported to have risen from about 2420 tons in 1942 to about 4100 tons in 1943. It has not been stated in what proportion the various members of the group contribute to the total; but it is well known that sulphapyridine, for which there was the greater demand in the early days of chemotherapy with heterocyclic derivatives of sulphanilamide, has lately become rapidly displaced by sulphathiazole, which is cheaper to prepare, less toxic, produces less intense clinical side-reactions and is equally effective. The question naturally arises regarding the reaction of the consumption of these drugs on public health, and particularly on the control of pneumonia, which still occupies a major position in returns. Anderson showed that, in Glasgow, the principal improvement had taken place during the sulphonamide era, in the treatment of patients not at the two extremes of age (*Brit. Med. J.*, 1942). Unfortunately *et al.* (*Amer. J. Pub. Health*, 1943) has drawn upon the records of a large insurance company (the individuals not being random selected from the population at large, since they comprised group-policy insured industrial workers) to show that the mortality from pneumonia fell during the sulphonamide era from 20.8 per cent. to 3.9 per cent, and, in addition, the course of the disease in non-fatal cases was shortened from 43 to 36 days.

It is to be expected that there should be widespread activity in the search for a chemotherapeutic agent which will be effective against *B. tuberculosis* without being at the same time, unduly toxic. The problem is more complicated than merely getting the appropriate drug to the site of the infection. It also involves finding a drug



to which the waxy capsule which surrounds the cell is permeable. It was noted last year that the synthetic oestrogen, stilboestrol, was effective against *B. tuberculosis* at a dilution of 1:500 *in vitro* and that *p*:*p'*-diaminodiphenylsulphone-*N*:*N'*-didextrose sulphonate ("promin") had been introduced to combat particular manifestations of the infection. This latter substance was less active *in vitro* against tubercle bacilli than the sulphone of which it is the *N*:*N'*-didextrose-sulphonate; but it had been found by Feldman *et al.* (1942) to have a marked effect in arresting progress of the disease, with, at the same time, a lessened mortality in the test animals from toxic reactions than was displayed by the parent sulphone. Feldman and his co-workers (*Proc. Mayo Clin.*, 1944, 10, 25; 33) have now introduced a new sulphone, 1:2'-diaminophenyl-5'-thiazolesulphone, with which spectacular results were achieved in experimental tuberculosis in guinea-pigs. The sulphones, in general, are regarded as more promising antibacterial agents than the sulphonamides, but, unfortunately, as a group, they are much more toxic. Roblin *et al.* were responsible for substituting the second benzene ring of the basic sulphone grouping by a pyridine ring (*J.A.C.S.*, 1941), and this latter ring has now been replaced by a thiazole ring in "promizole."



*pp'*-diamino diphenyl sulphone (= basic grouping of "promin.") "promizole"

Clinical tests of promizole are in progress, but assessment of results may not be possible for some months to come. No serious toxic symptoms have yet been observed from administration of 10 to 16 grams daily, even though this dosage was maintained in some cases for four months.

There is also news of a sulpha drug called "sulfabamide," beyond which no further description is available. It is stated to carry a lipophilic group in the shape of a fatty acid which enables it to penetrate the waxy membrane of *B. tuberculosis*. Gubner, who was reserved in his conclusions, stated that encouraging clinical results had been obtained. No toxic effects developed when the drug was administered in quantities up to one ounce in 16 hours or when administered over a period of 10 months. In preliminary clinical investigations, five cases of advanced bilateral pulmonary tuberculosis treated over 10 months gave absence of *B. tuberculosis* from sputum, and X-ray pictures showed that the lesions had gone.

Substituted naphthyl derivatives of the sulphonamides have been explored for their tuberculocidal activity. 4(2-methylamino-4-

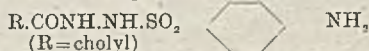
naphthylazo)-benzenesulphonamide in ethyl-one glycol solution has been found effective *in vitro* against *B. tuberculosis*; but the corresponding derivatives of sulphathiazole and sulphapyridine were found ineffective. The compound was prepared by diazotising sulphanilamide and coupling with 2-methyl-1-naphthylamine sulphate.

In the hope that increased lipid solubility attained by alkylating *N'* might lead to derivatives with tuberculostatic properties, Spring and Young (*J.C.S.*, 1944) obtained negative results *in vitro* and found that the inhibitory action of this series on haemolytic streptococci declined as the size of the alkyl group increased.

Hiebert, of the Winthrop Chemical Co., has announced that a new sulphonamide which may prove effective against *Cl. tetani* is undergoing study.

Finkelstein (*J.A.C.S.*, 1944) has tested a series of chloracetyl and aminoacetyl derivatives of the sulphonamides, and reports favourably on their effectiveness against the usual test organisms. The caproyl derivatives showed equivalent activity with the parent substances, but in no case was the activity of the latter exceeded. Chu *et al.* have coupled 2-alkyl-1-naphthols (a group related to vitamin K) with diazotised sulphonamide, but the substance was found devoid of inhibitory action towards the usual test organisms. Allen *et al.* describe the preparation of sulphonamides in the benzimidazole, benzothiazole, and benzotriazole series which have not hitherto been available. The use of thiazoles in industry and medicine has been reviewed by Hunter (*Chem. and Ind.*, 1943).

Dible and Haslewood have shown that a derivative of sulphanilamide and cholic acid



("sulphacholazine"), which is bacteriostatic towards *S. hamolyticus* and *S. pneumoniae*; but not against the coliform group, reaches high concentration in the bile of rabbits, whereas sulphapyridine and sulphanilamide achieve only low concentration in that fluid. Since rabbits' bile is highly streptocidal in any case, it was not possible to demonstrate any increase in bactericidal power due to the presence of the drug.

(To be continued)

In a review of the year's war production, Mr. C. D. Howe, Minister of Munitions and Supply, discloses that Canada, for the first time in her history, is producing synthetic rubber, mercury, magnesium, tin, tungsten, chrome, aviation gasoline, blending agents, optical glass, new types of plywood plastics, paint, lacquers and textiles. She produced approximately 1,500,000 tons of chemicals and explosives in the year.

# The Fuel and Carbonising Industries in 1944

by G. E. FOXWELL, D.Sc. F.Inst.P.

**C**OAL is the basic raw material of the carbonisation industries, and knowledgeable men in the fuel industries generally are beginning to register their anxiety that our coal reserves shall be used to the best effect, and shall be used as sparingly as possible. During the war, the industries of the country have had a foretaste of the difficulties with which they will be faced when they are not able to get the qualities of coal that they require. Coal Supplies Officers have done their best in a difficult situation, but works have been required to take types of coal different from those to which they have been accustomed, and sometimes qualities not ideally suited to the appliances installed.

If those who burn coal have met with trouble from using unaccustomed coals, those who carbonise it have found still greater difficulty. It is possible to burn almost any coal on any appliance—though the efficiency of the appliance may suffer. It is not possible successfully to carbonise any class of coal in any type of carbonising plant. The carbonising industries so far have come successfully through their coal difficulties, but the situation in which not only they, but other users of coal also, have found themselves during the past few years has underlined the lesson that after the war, and within the limits of national policy, there must be complete freedom on the part of the consumer to select whatever type of coal is required for his appliance or process. In the opinion of many users of coal, this right was not enjoyed before the war owing to the operation of the coal-selling schemes.

## Oil from Coal in the U.S.

As an example of this need for free selection, a chemical process may be considered, namely, the hydrogenation of coal. If there were development of coal hydrogenation on a large scale it would be a condition of success that the best coals for the purpose should be used. Some idea of the differences in yields can be seen from the work of the U.S. Bureau of Mines on hydrogenation. Their Information Circular No. 7190 gives some details of the yields from American coals. Since yields of the order of 135 gallons of petrol per ton of coal can be obtained, it would clearly be absurd if a coal-selling scheme insisted that coals in the range of 60-100 gallons yield should be supplied. This is self-evident, but this is exactly the kind of treatment of which some



Dr. G. E. Foxwell.

users of coal complain. Clearly, free selection by the consumer must be an essential principle of our post-war coal policy.

During the year the post-war planning of our fuel industries has received attention. The Minister of Fuel and Power has set up several committees, the most important probably being the Fuel and Power Advisory Council. The scope and purpose of this body are not yet clear, since it appears to have been instituted only to consider such matters as the Minister may from time to time put before it. Fuel technologists hope that the Minister will put before this body the leading question as to how the fuel industries of the country should be organised in order to secure the best results from such coal reserves as we possess.

It has been pointed out by mining engineers that our methods of mining may leave in the pit from 50 to 90 per cent. of the coal initially present in any one seam, and partly on this account our reserves of certain coals are already dangerously low. One of our major problems is how we can best use our coals, having in mind the necessity for economic working of the pits. Mr. Herbert Morrison, M.P., has said that although in 1939 British coal-mining wages were only half those of the U.S.A., the cost of coal in the U.S.A. at that time was only half what it was in this country. Since then our coal prices have rocketed and, if Mr. Morrison's information is correct, our prices to industry are about three times American prices to-day. Some technologists have stated that our coal was too cheap before the war and was wasted. While waste is reprehensible, and incentives to waste should be removed, the high price of British coal is at last causing serious concern, not only to business men generally but also to the Government. A good deal of political capital has been made out of a report by U.S. mining experts on British coal-mining methods—the report was not made public. The Minister of Fuel and Power has taken



action by appointing a strong committee of mining engineers to examine British coal-mining practice.

### The Gas Industry

Another committee has been set up to inquire into the organisation of the gas industry. This body has very wide terms of reference in which the objective of cheap gas figures prominently, and it is hoped that from its deliberations there will result a scheme for the organisation of the gas industry in such a way as to remove some of the handicaps under which the industry has suffered in the past, and to fit it to cope with modern conditions. It is always difficult to decide whether an industry should be shaken up violently, or whether it should change its constitution by the slower process of organic growth. Before the war, the process of organic growth was at work in the gas industry in the absorption of smaller companies by larger ones, and in tying together numbers of small and moderate-sized companies through financial holding concerns with centralised staffs of high calibre. Both of these methods were sound, but many people think they do not go far enough. Unfortunately, the gas industry is not unanimous about future organisation, and the diverse views of private companies and municipalities have made this inquiry necessary.

A method of conserving coal, which may lead to cheaper coal, is to remove more of the coal from the pit; this method will almost inevitably result in a larger proportion of high-ash coal, for which a use must be found in industry if it should happen that it cannot be economically cleaned. Industry must be prepared to use coal of lower quality in the future.

### Water Power

Yet another committee is inquiring into the possibilities of using the Severn Barrage as a source of water power. This problem may have repercussions on the chemical industry, though it is only fair to add that very cheap water power is not to be expected, and that reasonably cheap water power can be obtained only by factories situated so close to the source of power that there are virtually no distribution charges. It may be that an efficient coal-fired power station working at a colliery on a high load factor would produce power at an equally low cost. Water power, however, would lead to coal conservation.

From all these committees of inquiry it is clear that the Minister of Fuel is obtaining the data upon which, through Parliament, he can propose measures to reorganise the fuel industries of the country. What is required is that the facts shall be ascertained without delay, that a sound policy should be based upon them, and that that policy

should be put into effect. The last of these requirements is the most important. It has too often been neglected in the past!

### Underground Gasification

The underground gasification of coal has been proposed in uninformed quarters as the panacea for the ills of the coal industry. Fortunately, this year has seen serious attempts to assess its possibilities of application to British conditions (*cf.* THRING, *Bull. B.C.U.R.*, vii, 6, p. 208; FOXWELL, *Iron and Coal Trades Rev.*, Aug. 25, 1944; WILKINS, *Fuel Economy Rev.*, 1944). It is pointed out that the conditions necessary for the production of gas of good quality do not exist in this country, that they probably exist only in steeply-sloping seams, that much coal or coke is likely to be left behind underground, and that British coals are worth more per ton as clean sized coal than when converted at low efficiency into producer gas. In Russia, underground gasification is part of a larger nexus of plant which involves the concentration of interdependent industries, including ammonia synthesis, the use of by-product oxygen for gasification, the use of the gas in the Fischer-Tropsch process for synthetic oil production, and so forth. It is true that Russian information suggests that underground gasification reduces the number of workers underground from 70 per cent. to 15 per cent., and raises the output of coal (or coal equivalent) per man from 30 tons a month to 100 tons (possibly to 500-600 tons). But even in that country, underground gasification appears to be regarded as complementary to mining, and as a means of dealing with seams of low quality, of high-ash content, or too thin for other methods to be economical. Underground gasification may have its place in the mining technique of the future, but it is likely to be limited, and, until experiments have been undertaken in this country, it would be rash to prophesy to what extent it can be used.

### Coal for Chemicals

The use of coal for the production of chemicals has been widely discussed during the year. J. G. Bennett, in the J. Arthur Reavell Lecture to the Institution of Chemical Engineers, made many suggestions for future research work which were noted in *THE CHEMICAL AGE* (June 10, p. 543). Research on some of these projects is likely to follow the formation of a company sponsored by a prominent plastics concern and a prominent colliery concern, of which Mr. Bennett has been appointed technical director. The only source of chemical raw material so far produced by the carbonising industries is coal tar, in which is included benzol. The tendency to make use of the pipe still in tar distillation has resulted in many improvements, and the continuous

fractionation marks a definite advance on the pot still. Several papers during the year have been concerned with the use of tar for roads. A lime process developed by Mr. Hodsman at Leeds University has shown very great promise, and an extension of this process made by workers at Teddington has enabled cold wet aggregate to be used for the production of road surfaces. It may well be expected that the use of tar for roads will be greatly extended after the war, since if we can avoid importing bitumen it will be all to the good.

Another chemical raw material available in this country in large quantities is ethylene. The petroleum industry has shown that ethylene can be converted into many chemical intermediates. Ethylene is now being recovered on two coke-oven plants, and if the chemical industry proves able to take the output, at a price sufficient to pay for the cost of recovery, the recovery of ethylene will no doubt become general.

Further chemical developments are to be found in the total gasification process now under investigation at Leeds University, wherein coal is converted by hydrogenation under pressure during carbonisation into methane and other gases which may well have important chemical possibilities. There is yet no sign that a Fischer-Tropsch plant will be erected in this country. It is to be expected, however, that there will have been considerable developments of this process in Germany during the war, and it is not at all unlikely that production of chemical raw materials from coal (or probably from coke) through the operation of the Fischer-Tropsch process will become standard practice all over the world after the war.

### Coke-Oven Gas

The liquefaction of coke-oven gas is also likely to be extended by the introduction of new and cheaper processes: here, again, there are important possibilities. These possibilities must be used to the full if they prove to be sound economically, because it will probably not pay to operate a liquefaction plant for the recovery of the more easily condensable gases only. The production of chemicals from coke-oven gas requires a large and expensive plant with skilled operators. If such a plant is to be economically sound, its output must be high and it must make a wide variety of products. It used to be said that everything was utilised in a pig except the squeak; a somewhat similar principle must be adopted in the utilisation of coke-oven gas for chemical purposes. It is equally important that there should be a market for the products; whether there will be or not remains to be seen. The price at which these intermediates can be produced will have a bearing on the matter.

The plastics industry, through a paper by

W. D. Scott, has asked for a great extension in the production of raw materials for plastics, and has indicated that unless this increased production can be obtained the British plastics industry will be severely handicapped in the export market. Acetylene, ethylene, propylene, and higher olefines are required as a start. The plastics industry appears to be in a position to state what it wants and how much it wants. If other branches of the chemical industry would come forward and state what they require in the way of organic chemicals and what they are able to pay for them, there might be a chance of setting up adequate factories for the production in large quantities of these chemicals from coal or from coke-oven gas. This appears to be peculiarly a matter in which the Association of British Chemical Manufacturers and the National Association of Coke Oven and By-Product Plant Owners might get together.

### Benzene and Toluene

The increasing production of benzene and toluene from petroleum should be noted. U.S. production of benzene approaches 1,000,000 tons per annum, and German production has been on a similar scale, but in this country we probably have only 250,000 tons potential production. We are, therefore, faced with the situation of being completely uncompetitive in the basic organic chemical raw material. It has therefore been suggested that steps should be taken to (a) explore every possibility of increasing benzol formation and recovery in carbonisation practice, (b) institute compulsory recovery, (c) repeal the hydrocarbon duty (this is contentious and *sub judice*), and (d) develop petroleum aromatisation. It is claimed that from 500,000 tons of benzol we could produce 200,000 tons of synthetic phenol, 100,000 tons of adipic acid for nylon, and 100,000 tons of products such as maleic anhydride, dyestuff intermediates, rubber chemicals, and pharmaceuticals. Such figures are not out of line with present U.S. production, and are adequate to permit competitive costs to be reached.

### Naphthalene

The naphthalene position also requires attention. Our total potential availability is about 70,000 tons. U.S. consumption of naphthalene for 1940 was 74,000 tons. In the past, this figure has been dependent on European availability. Half is used for phthalic anhydride in the U.S. Their production of alkyd resins is greater than that of phenolics, yet potential availability of phenol is many times greater than that of naphthalene. The development of commercial methods of producing phthalic, mellitic, and oxalic acids by direct oxidation of coal, and manufacture of maleic anhydride from benzene, will help to take the load off naph-



thalene, but it is believed that a world shortage of naphthalene is probable unless yields from coal are improved and oil aromatisation developed. Attention should also be directed to further recovery of styrene and indene, particularly at large coke oven installations, but this source remains small in relation to potential synthesis.

### The Importance of Coke

Coke has many uses, and this past year has seen activity in developing the commercial side of coke marketing. In the first place, it is clear from many indications that the Government, including the Ministry of Works and Planning, the Ministry of Health, and the Ministry of Fuel and Power, is fully alive to the importance of smoke abatement. This has been stated in official documents and in the speeches of Ministers. It is shown, also, by the fact that in all the new housing plans provision is made for open fires capable of burning coke and other smokeless fuels. It would seem probable that the way is being paved for the introduction of complete domestic smoke abolition. The importance of the carbonising industries from this aspect cannot be over-rated. Since British people like an open fire, there is every reason why coke should be produced to fulfil that need. Two or three open coke fires have been developed during the war, for example, by the Gas Light and Coke Co. and the South Metropolitan Gas Co., and have been described in the technical Press this year. These fires are a great improvement on anything that has been seen before, and when the convector principle is incorporated in them they can use coke for domestic purposes with an efficiency approaching 70 per cent. As the efficiency of a domestic hot-water boiler placed inside the house is of the order of 80 per cent., it will be recognised that all that is necessary for a really efficient use of fuel for domestic purposes is for the new houses to be adequately insulated.

On the industrial side, a report has been issued summarising the technical work that has been done over the last ten years on the use of coke. This work has been productive of results which could not possibly have been secured by commercial methods alone. The National Federation of Gas Coke Associations has published a report which indicates that the gas industry is likely to give as much attention to coke marketing as it has done to the sale of gas. The Committee of Inquiry of the Institution of Gas Engineers has also issued the second part of its report on coke quality, in which it has pointed out that coke-burning appliances should be incorporated in all new houses and in replacement of existing open coal grates; that there is need for further

improvement in the quality and preparation of coke and in the design of coke-burning appliances, and that research work should be undertaken by the Gas Research Board. A paper by G. M. Gill, before the Institution of Gas Engineers, has shown that a much improved quality of coke can be secured by blending coking with non-coking coals, a process which was killed by failure to secure the necessary qualities of non-coking coal at a reasonable price reflecting its value in a gas retort.

### Research Activities

The carbonising industries are developing their research activity on a fairly satisfactory scale. No doubt these activities will be expanded when the end of the war has released personnel and has enabled proper research laboratories to be built. The Gas Research Board is actively at work on many problems of a character highly interesting to the chemical industry. Semi-scale plants have been put into operation during the year for (a) the combined carbonisation and gasification of coal in an atmosphere of hydrogen under pressure up to 50 atmospheres, and (b) the production of methane catalytically from water-gas by the reaction  $\text{CO} + 3\text{H}_2 = \text{CH}_4 + \text{H}_2\text{O}$ . The coke-oven side of the industry has set up a Coke Research Association which has not, however, started work as yet. The Coke-Oven Managers' Association has its own research committee, which is largely concerned at this moment with by-products.

The gas industry has actively pursued new fields of gas utilisation. The new technique of drying by infra-red radiation has been developed on a works scale, and gas-fired plants for quick drying of paints, etc., are on the market. The Gas Research Board is paying attention to this problem in order to establish the fundamental principles involved, and to improve further the design of gas-heated appliances for this purpose. A new type of furnace has been described (ANDERSON, GUNN and ROBERTS, *J. Inst. Fuel*, xvii, 169), constructed of permeable refractories, in which the combustion gases are withdrawn from the furnace chamber through the furnace walls, instead of by flue ports. The resulting equalisation of temperature on either side of the chamber wall reduces loss of heat by conduction, and striking examples have been given of reduced heat consumption in day-to-day industrial practice.

The carbonising industries face 1945 with their organisation uncertain until the Government's fuel planning inquiries are completed, with many problems due to the effect of war on their plants and personnel, but with every prospect that the industries, given ample enterprise and freedom from political interference, can, and will, grasp the great opportunities now opening.

# News Events of 1944

## JANUARY

**P**ETROLEUM as a base material for the chemical industry was dealt with in a paper presented by Mr. J. C. G. Boot at a joint meeting of the Institution of Chemical Engineers, the Chemical Engineering Group, and the Institute of Petroleum.

\* \* \*

The Perkin Medal for 1944 was awarded to Mr. G. P. Dubois, head of Monsanto's research and development department, while the Medal for the Advancement of Research, awarded by the American Society of Metals, went to Mr. R. A. Hunt, President of the Aluminium Company of America.

\* \* \*

Dr. Frank Lee Pyman, director of research, Boots Pure Drug Co., died on January 1, aged 61.

\* \* \*

A unique meeting of the Royal Society—the first meeting outside Britain since the formation of the Society in 1662—was held in New Delhi, when the Indian Science Congress resolved itself into a meeting of the Royal Society. Dr. H. J. Babha and Sir Shanti S. Bhatnagar were elected Fellows. The Viceroy, Lord Wavell, spoke to the Congress.

\* \* \*

The education of the chemist was dealt with in a report prepared by the Chemistry Advisory Board, Royal Institute of Chemistry, presided over by Professor Alexander Findlay.

\* \* \*

Dr. A. C. Shearman, a brilliant young research worker, died from the premature explosion of an anti-tank grenade while on Home Guard duties.

\* \* \*

Dr. Josef Blauhorn, a prominent Central European technologist and former director of the Vitkovice Ironworks, died in London, aged 61.

\* \* \*

Mr. Samuel Courtauld, speaking at Birmingham, emphasised that the worker who invests in industry all he possesses was, by plain justice, entitled to some representation on the controlling body. More public control on the higher level would be needed in future to guide and restrain powerful private business.

## FEBRUARY

Speaking to the Glasgow Chamber of Commerce, Lord McGowan reviewed I.C.I.'s war record, making reference to the building of Government factories, the loan of key men to the Government, and the development of explosives, drugs, textiles and plastics. Plans were in hand for expansion to ensure full employment after the war.

In the House of Commons, the subject of exports of strategic metals, especially wolfram, tin, chrome and iron ore, by Spain, Portugal, Turkey and Sweden to Germany was given great prominence by a number of members.

\* \* \*

A number of notable chemists and technologists died during February, including Dr. J. J. Wijs, the famous Dutchman who determined the iodine value of oils and fats—the so-called Wijs number; Dr. F. D. Chattaway, whose work covered a wide field in organic chemistry; Mr. C. Dalley, President, Institute of Petroleum; Mr. C. B. Kingston, ex-President, Institute of Mining and Metallurgy; Dr. A. Stansfield, Professor of Metallurgy at McGill University; and Mr. J. McConnell Sanders, who, in his long and varied career, spent many years in Mexico, where he organised chemical teaching and industry.



Professor P. M. S. Blackett.

Dr. Leo Hendrik Baekeland, born in Ghent in 1863, died in New York on February 28. He is best remembered for his pioneer work in plastics, a certain class of which bear his name. To his credit stand, also, developments both in the manufacture of photographic papers and of the Townsend electrolytic cell. He was a Perkin and a Messel Medallist and an honorary member of the Royal Society of Edinburgh.

\* \* \*

Dr. J. Brodbeck, President of CIBA, Basle, and of the Clayton Aniline Co., died on February 20. He took a leading part in the development of the dyestuffs industry, both in Switzerland and in this country.

\* \* \*

Professor P. M. S. Blackett succeeded Sir R. Watson-Watt as President of the Association of Scientific Workers.



De la Rue's bought a site in the Tyne-mouth area to accommodate a plastics plant, while in a Lancashire gasworks a new benzol recovery plant was inaugurated.

The United States placed an embargo on oil exports to Spain, to be lifted after a few months.

Professor Alexander Todd was elected Professor of Organic Chemistry at Cambridge.

In the House of Commons, attention was devoted at question time to penicillin, substitute fuels, underground gasification of coal, Jamaican bauxite, and the I.C.I.'s Billingham plant.

### MARCH

At a meeting of the Plastics Group of the S.C.I. and the Association of Tar Distillers, Dr. H. Levinstein introduced a discussion on "Plastics and the Coal Tar Industry," emphasising the need for a domestic oil refining industry.

A sub-committee of eight distinguished scientists was set up by the D.S.I.R. to consider the organisation of research in Great Britain.

### APRIL

The British Iron and Steel Research Association was formed.

The George Medal and the B.E.M., respectively, were awarded to a foreman and a senior overlooker for bravery in dealing with a fire in a Royal Ordnance factory.

A Committee of the Ministry of Education was set up to review the relation of universities to technical colleges.

An important debate on research and science—the first of its kind—took place in the House of Commons.

To promote the application of science in industry, a Joint Standing Council was formed by Manchester University and Manchester Chamber of Commerce.

Professor W. N. Haworth was elected President of the Chemical Society.

The use of DDT as an insecticide by the Allied armies was announced.

Mr. F. A. Greene was re-elected President of the Institution of Chemical Engineers.

### MAY

Dr. Dalton gave news of the appointment of a Committee on Patent Law Reform, with special reference to practice of Patent Office and Courts and the abuse of monopoly.

The formation of an Association of Manufacturers of Bituminous Protective Products was announced.

An Association of British Non-Ferrous Smelters was formed.



Professor W. N. Haworth.

A Treasury Committee was appointed to investigate salaries paid to scientists in Government service.

### JUNE

Within three years, membership of the Association of Scientific Workers increased from 2000 to 15,000, according to the Chairman, Professor Blackett, speaking at the 27th annual meeting.

The first J. Arthur Reavell Lecture of the Institution of Chemical Engineers was given by Mr. J. G. Bennett on the subject of "Coal and the Chemical Industry."

Sir Ardeshir Dalal, of Tata, Ltd., one of the co-authors of the 15-year "Bombay" plan for India, was appointed chief of the new Department of Planning and Development.

The Society of Instrument Technology was formed.

The Peter Le Neve Foster Lecture on penicillin was delivered by Professor Florey.

THE CHEMICAL AGE celebrated its twenty-fifth birthday on June 21.

The death took place of Sir Prafulla Chandra Ray, emeritus professor of chemistry at Calcutta University.

The Chemical Institute of Canada was formed from the Canadian Institute of Chemistry and the Canadian Chemical Association.

## JULY

The British Coke Research Association was registered.

\* \* \*

Dr. E. K. Rideal succeeded Mr. Wallace Cohoe as President of the Society of Chemical Industry.

\* \* \*

Dr. G. Egloff was re-elected President of the American Institute of Chemists for a further two years.



Dr. E. K. Rideal.

Replying to the debate on the third reading of the Finance Bill, the Chancellor of the Exchequer dealt with special tax relief for expenditure on research, as announced in his Budget speech.

\* \* \*

A debate on coal was held in the Commons, in the course of which Mr. David Grenfell, a former Minister of Mines, made a strong plea for underground gasification of coal in Britain.

\* \* \*

I.C.I. instituted 80 Fellowships in scientific research in nine British universities.

## AUGUST

A United Nations' Standards Co-ordinating Committee was established.

\* \* \*

Professors Simonsen and Robinson reached the Caribbean area on a research mission to utilise Colonial raw materials.

## SEPTEMBER

The Hydrocarbon Oil Duties' Committee was formed.

\* \* \*

The death was announced of Professor L. F. Goodwin.

\* \* \*

The Society for Visiting Scientists was established in London.

\* \* \*

A Fuel Research Institute was formed in India.

Details were revealed of war-time developments in domestic oil production in Britain.

## OCTOBER

Several leading Indian scientists arrived in Great Britain as guests of H.M. Government.

\* \* \*

At the annual meeting of the Society of Chemical Industry, Dr. W. Cullen was elected an honorary member, and Professor A. V. Hill, M.P., recipient of the Messel Medal, delivered the Messel Lecture on "Science in India."

\* \* \*

The London Section of the British Association of Chemists discussed the importance of the safeguarding of "master key" industries at an open meeting.

\* \* \*

Mr. Gordon Robbins, Chairman of Benn Brothers, Ltd., proprietors of THE CHEMICAL AGE and associated publications, died suddenly on October 10.

## NOVEMBER

The fifth Hinchley Memorial Lecture was given by Sir Alexander Gibb, before the Institution of Chemical Engineers, on the subject of hydro-electric development.

\* \* \*

Dr. T. Swinden, a leading metallurgist, died at the age of 58.

\* \* \*

An increasing number of questions on the promotion of science and its application was being asked by members of all parties in the House of Commons.

\* \* \*

Oxford University accepted an offer made by I.C.I. to endow research fellowships in chemistry and physics.



Professor A. V. Hill.

A debate on penicillin took place in the House of Commons.

\* \* \*

The Eighth Report from the Select Committee on National Expenditure, devoted to



the Chemical Controls of the Ministry of Supply, was published.

\* \* \*

Major Glanvill Benn was elected Chairman of Benn Brothers, Ltd., in succession to the late Mr. Gordon Robbins.

\* \* \*

THE CHEMICAL AGE, with a special picture supplement, *Women and Heavy Chemicals*, paid tribute to the magnificent effort made by the women of this country in industry during this war.

\* \* \*

The Lavoisier Bicentenary Lecture was delivered before the Royal Society by Sir Harold Hartley.

Sir John Jacob Fox, F.R.S., Government chemist, died in London on November 28, aged 70.

## DECEMBER

The development of a new synthetic fibre, Ardil, was announced by I.C.I.

\* \* \*

Dr. Thomas Midgley, President of the American Chemical Society, died at Worthington, Ohio.

\* \* \*

Dr. Henry Dreyfus, Chairman of British Celanese and a pioneer in cellulose chemistry, died in London.

## Royal Institute of Chemistry

### Annual Meeting Date

IT is announced that the annual meeting of the Royal Institute of Chemistry will be held on March 12 at 4 p.m. Dr. L. H. Lampitt is due to retire from the office of vice-president, and there will be another vacancy in the list of vice-presidents on account of the death of Sir John Fox.

The following will be ineligible for election as district members of Council: Messrs. J. Andrews, L. V. Cocks, G. J. Denbigh, D. A. Derrett-Smith, D. M. Freeland and H. Stevenson. The remaining district members have been nominated for re-election, except Dr. N. M. Cullinane, in whose place Mr. R. H. Jones was nominated for Wales and Monmouth, and Dr. W. S. Patterson, to replace whom Mr. H. N. Wilson was nominated for Newcastle-upon-Tyne and the North-East Coast.

Retiring general members of Council who are ineligible for re-election, are: Dr. E. F. Armstrong, Mr. A. L. Bacharach, Dr. William Cullen, Mr. Norman Evers, Dr. H. H. Hodgson, Dr. E. B. Hughes, Mr. S. J. Johnstone and Dr. F. G. Mann.

## Plant Design

### The Function of the Chemical Engineer

IN an address on "Some Principles of Chemical Plant Design" given to the North-Western branch of the Institute of Chemical Engineers in Manchester, on December 16, Mr. W. H. H. Demuth, chairman of I.C.I., Ltd., Dyestuffs Division, spoke on the function of a chemical engineer in the chemical industry. He illustrated the preparation of flow sheets and of engineering drawings by the design, together with photographs, of a plant for the preparation of penicillin. Such designs, he pointed out, should be prepared in the drawing office with full collaboration between the various specialists. He proceeded to discuss capital cost, running costs, the health of the

workers, the thoroughness of the research on the processes involved, the expectation of life of a modern plant, the merits and disadvantages of continuous and batch processes, and the instrumentation of plant. Mr. Demuth indicated that it was necessary to modernise British plants and processes and to tackle the problem of obtaining, cheaply and efficiently, the heat stored in coal; and he predicted rapid technical advances in the production of synthetic drugs and insecticides in this country.

## Petroleum Technology

### Lectures at Cass Institute

A COURSE of lectures on the General Technology of Petroleum will be given at the Sir John Cass Technical Institute, Jewry Street, Aldgate, on the ten successive Thursdays from January 11 to March 15 inclusive, commencing at 3 p.m. and lasting an hour. The fee for the course is 10s. These annual lectures were instituted as far back as 1920 and are now being revived after a break due to the war. Particulars of the new course are: January 11, Mr. C. A. P. Southwell: "Geology, Exploration and the Drilling of Wells"; January 18, Mr. J. B. Kay: "The General Management of Oilfields, including the separation of Gas and Water"; January 25, Mr. E. J. Sturgess: "The Bulk Storage of Oil and its Transport by Pipelines and Tankers"; February 1, Mr. E. Le Q. Herbert: "The Work of the Refineries"; February 8, Mr. W. A. Wilson: "Gasolines and Aviation Spirits and their Test Engines"; February 15, Mr. W. H. Thomas: "White Spirits, Solvents and Kerosene"; February 22, Dr. T. K. Hanson: "Diesel Oils and their Testing Engines"; March 1, Mr. E. A. Evans: "Lubricating Oils and their Testing"; March 8, Mr. R. G. Mitchell: "Fuel Oils and Bitumens"; March 15, Dr. A. E. Dunstan: "Chemical Products from Petroleum, their Uses and Possibilities."

## Personal Notes

MR. W. C. PECK has been appointed vice-chairman of Uniformaces, Ltd.

MR. J. L. CARLYLE has been appointed to the boards of George Scott & Son (London), Ltd., and Ernest Scott & Co., Ltd.

MR. R. LL. REES has been appointed chief chemist to the London Power Company, in succession to Mr. G. W. Hewson.

MESSRS. F. H. ROGERS and B. HEASTIE have amalgamated their consulting practices under the style of Heron Rogers and Heastie.

MR. W. COWEN has left the College of Technology, Manchester, to take up the appointment of chemical engineer with Lansil, Ltd.

DR. E. C. R. SPOONER recently resigned his position as technical superintendent to the Magnesium Metal Corporation and has been appointed chemical engineering consultant to Sutcliffe, Speakman & Co.

MR. D. W. MENZIES, B.Sc., has been appointed honorary secretary of the Aberdeen and North of Scotland section of the Royal Institute of Chemistry, in succession to Dr. F. L. Hudson.

PROFESSOR I. M. HELLBRON, D.S.O., F.R.S., has taken the place of the late Sir John Fox as representative of the Royal Institute of Chemistry on the Joint Council of Professional Scientists.

MR. J. W. HAWLEY has succeeded Professor W. M. Cumming as chairman of the Glasgow and West of Scotland section of the Royal Institute of Chemistry. Mr. A. R. JAMIESON is the new vice-chairman.

DR. J. G. A. GRIFFITHS has taken the place of Mr. E. Q. Laws as hon. secretary of the London and South-Eastern Counties section of the Royal Institute of Chemistry. DR. H. BAINES will succeed Mr. D. M. Freeland as district member of Council.

MR. H. C. MANN, M.I.Chem.E., M.Inst. Gas E., announces that he has resigned his directorship with The Chemical Engineering and Wilton's Patent Furnace Co., Ltd., Horsham, and now has no connection whatsoever with that company.

DR. DOROTHY JORDAN LLOYD replaces Professor Alexander Fudlay as representative of the Royal Institute of Chemistry on the Chemical Council on January 1; she has also been appointed in place of the late Sir John Fox as a member of the Institute's Board of Examiners.

SIR FRANK LINDLEY, C.B., lately Comptroller-General of the Patent Office, and DR. W. WARDLAW, Professor of Physical Chemistry, University of London, have been appointed scientific advisers to the Appoint-

ments Department of the Ministry of Labour and National Service, as a result of the recommendations of the Hankey Committee, the findings of which are commented upon on another page.

The Therapeutic Research Corporation of Great Britain has elected the following officers: Chairman of board of directors, LORD TRENT (Boots Pure Drug), who succeeds MR. H. JEPHCOTT (Glaxo Laboratories); deputy-chairman, DR. F. H. CARR (British Drug Houses); chairman research panel, MR. F. A. ROBINSON (Glaxo Laboratories), who succeeds DR. A. J. EWINS (May and Baker); deputy-chairman, DR. C. H. KELLAWAY (Wellcome Foundation).

MR. FRANK H. SANITER, B.Sc., has been appointed director of research to the United Steel Companies, Ltd., and will take up his duties at an early date. All the research activities of the concern, including those relating to metallurgy, applied mechanics, and manufacturing processes, will be unified under one control. Mr. Frank Saniter's father, the late Mr. E. H. Saniter, was chief metallurgist to the United Steel Companies, and was awarded the Bessemer Gold Medal in 1910.

In addition to the awards mentioned in our last issue, the following extracts from the New Year Honours List are of interest to the chemical and allied industries. The M.B.E. is awarded to MESSRS. G. D. AYRES, chief engineer, Bryant & May, Ltd.; FRANK CLARK, superintendent, British Oxygen Co., Ltd.; D. V. HOLLINGWORTH, M.I.Chem.E., coke-oven manager, Blaenavon Colliery Co., Ltd.; R. S. WALDE, Victor Blagden & Co., Ltd.; and DR. JAMES TAYLOR, Ph.D., D.Sc., physicist and assistant manager, Research Dept., I.C.I. (Explosives), Ltd. The British Empire Medal goes to MESSRS. HARRY ASHURST, process worker, R.O.F.; GEORGE TAYLOR, process worker, I.C.I. (Explosives), Ltd.; and T. B. THOMSON, foreman fitter, I.C.I., Ltd.

PROFESSOR G. M. BENNETT, M.A., Sc.D., Ph.D., F.R.I.C., Professor of Chemistry at King's College, London, has been appointed to be Government Chemist in succession to the late Sir John Fox. His appointment will not become effective until the end of the current academic year, in July, 1945. Until then, DR. A. G. FRANCIS, O.B.E., D.Sc., F.R.I.C., Deputy Government Chemist, will continue to act as head of the department. Professor Bennett was educated at Queen Mary College, London, and St. John's College, Cambridge, at both of which he is a Fellow. After a period as a demonstrator in chemistry at Cambridge and at Guy's Hospital, he was appointed Lecturer and (in 1924) Firth Professor of Chemistry at Sheffield University. His present appointment at King's College dates from 1938.



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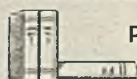
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Phthalic Anhydride  
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Diethyl Phthalate  
Dimethyl Phthalate  
Tricresyl Phosphate

### LEATHER



Phenol  
P.C.M.C.  
Paranitrophenol  
Cresylic Acid  
Salicylic Acid  
Phthalic Anhydride

### PAPER



Dibutyl Phthalate  
Tricresyl Phosphate  
P.C.M.C.  
Benzoic Acid

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Vanillin  
Methyl Salicylate  
Meta Cresol  
Diethyl Phthalate  
P.C.M.C.  
Salicylic Acid  
Benzoic Acid

### TEXTILES



P.C.M.C.  
Cresol  
Benzoic Acid

### PAINT



Phenol  
Phthalic Anhydride  
Cresol  
P.C.M.C.  
Benzoic Acid  
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## General News

A thousand pupils from Birmingham's secondary schools heard Dr. J. A. Newton Friend's lecture on "Science in Antiquity."

Permission to deal in the new issues of Palestine Potash Co., has been granted by the Stock Exchange Committee.

A new branch of the Chemical Workers' Union was opened in December at Kentig, South Wales, covering British solvents and other local plants.

The registration office of British Benzol and Coal Distillation is now at Trethomas, Bedwas, near Newport, Mon., and Mr. I. Williams has been appointed secretary.

The Control of Iron and Steel (No. 38) (Scrap) Order, (S.R. & O., 1944, No. 1423), and the Control of Iron and Steel (No. 37) Order (S.R. & O. 1944, No. 1440) have just been issued.

To commemorate the 150th anniversary of the death of Josiah Wedgwood, "the master potter," whose grave is in Stoke churchyard, a special service was held at Stoke-on-Trent Parish Church.

E. K. Cole, Limited, proposes to manufacture, fabricate and deal in all types of plastic materials, including thermo-setting and thermo-plastic and all apparatus, etc., made therefrom.

A film on the "T.V.A.," recently issued by the American Office of War Information, depicts that vast undertaking, the Tennessee Valley Authority, and is of great scientific, agricultural and scenic interest. It can be borrowed free of charge from the American and British-Commonwealth Association, 18 South Street, London, W.1.

A new type of antibacterial has been isolated from the common garlic (*Allium sativum*), by Cavallito and Bailey (*J.A.C.S.*, 1944, 66, p. 1950). The product, which has been named allicin, is a colourless oil, about 2.5 per cent. soluble in water, and relatively unstable. Its antibacterial action has been demonstrated against both gram-positive and gram-negative bacteria. It has been assigned the structure: allyl-S-S-allyl, or possibly allyl-S-O-S-allyl.

A post-graduate course in colloid science at the University of Cambridge, to be given on June 23-30, has been arranged by the Birmingham and Midlands Section of the Royal Institute of Chemistry in co-operation with the University's department of Colloid Science and Physical Chemistry. Dr. A. E. Alexander will supervise the course, the fee for which will be seven guineas. Applications should be addressed to reach the hon. secretary of the section not later than January 31.

## From Week to Week

Queen's University, Belfast, has announced its intention of appointing a professor of chemistry and a junior lecturer in chemistry as from October 1. Salaries will be £1200 and £400, rising to a maximum of £600, respectively, and selected candidates who are subject to deferment on work of approved National Service will be permitted to delay taking up duty.

Liverpool Corporation is proposing to sell two sites at Speke, on Merseyside, on 999 years' lease, for development as chemical works. One site is to go to Evans, Sons, Lescher & Webb, Ltd., adjoining their present factory; the other will be sold to the Rodmill Chemical Co., Ltd., of Liverpool. On both sites, building is to start within five years of completion of the contract.

Sir Ernest Benn, as President of the newly-amalgamated Society of Individualists and National League for Freedom, will deliver an address at a mass demonstration of the united organisation at the Central Hall, Westminster, on January 24, at 2.30 p.m. Sir Leonard Lyle, M.P., will take the chair. The address of the Society is now: The Society of Individualists and National League for Freedom, 147 Victoria Street, London, S.W.1. (Tel.: VICTORIA 7862, 7932, 7933).

## Forthcoming Events

January 15. Royal Institute of Chemistry, in the Chemistry Lecture Theatre of the University of Leeds, 6.30 p.m. R. C. Chirnside: "The Compleat Analyst."

January 16. The Institution of Chemical Engineers and The Chemical Engineering Group (S.C.I.), Rooms of the Geological Society, Burlington House, W.1, 2.30 p.m. Mr. J. Dougill: "The Cleaning of Producer Gas."

January 17. Institute of Fuel, James Watt Memorial Institute, Birmingham, 2.30 p.m. Mr. A. T. Green: "The Properties of Refractory Materials and their Significance to Fuel Economy."

January 17. Royal Institute of Chemistry (London and S.E. Counties). Lecture Theatre of the Pharmaceutical Society; 17 Bloomsbury Square, W.C.1, 6.30 p.m. Professor A. Findlay: Discussion on the Status of the Fellowship.

January 18. The Royal Institution, Albemarle Street, W.1, 5 p.m. Dr. L. A. Jordan: "Paint—The Art and the Science" (Jubilee Memorial Lecture).





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**January 18. The Chemical Society.** Burlington House, 2.30 p.m. Professor J. M. Robertson: "Diffraction Methods in Modern Structural Chemistry" (Tilden Lecture).

**January 18. Royal Institute of Chemistry.** Collinson's Café, New Street, Huddersfield, 7.30 p.m. to 11 p.m.: Dance in aid of Benevolent Fund.

**January 18. Royal Institute of Chemistry (Belfast and District).** Royal Academic Institution, 7.30 p.m. Mr. F. W. Warsap: "Cement."

**January 18. The Institution of Refrigeration.** Institution of Mechanical Engineers, Storey's Gate, S.W.1, 5.30 p.m. Mr. A. M. Clark (Research Dept. of I.C.I.): "Refrigeration in the Chemical Industry."

**January 19. Institute of Fuel (with S.C.I.).** Royal Technical College, Glasgow, 5.45 p.m. Professor D. T. A. Townend: "New Era in Combustion."

**January 19. Chemical Engineering Group, S.C.I.** Chamber of Commerce, New Street, Birmingham, 6.30 p.m. Mr. G. Lowrie-Fairs: "Calder-Fox Scrubbers and the Factors Influencing their Performance."

**January 19. Royal Institute of Chemistry and Society of Chemical Industry.** Technical College, Cardiff, 6.30 p.m. Mr. B. W. Minifie: "Cocoa, Chocolate, and Confectionery."

**January 19. Society of Leather Trades' Chemists** (London and Home Counties Group). Leathersellers' College, Tower Bridge Road, S.E.1, 2.30 p.m. Mr. J. R. Blochey and others: "What the Leather Industry Expects from the Scientist."

**January 20. Institution of Factory Managers.** Oak Room, Kingsway Hall, W.C.2, 2.30 p.m., extraordinary general meeting.

**January 20. Institution of Chemical Engineers (North-Western Branch).** Reynolds Hall, The College of Technology, Manchester, 3 p.m. Mr. J. P. Asquith: "The Unit Process of Mixing."

## Chemical and Allied Stocks and Shares

**STOCK** markets have been only moderately active, but the tone was good, with British Funds again moving higher and investment demand extending to leading industrials. Imperial Chemical strengthened to 39s. 6d., while, on further consideration of the results and annual statement, Turner & Newall moved up to 83s. 6d. Lever & Unilever were also higher at 47s. 9d., with Radiations good at 60s., and the units of the Distillers Co. prominent, rising to 113s. 6d., their highest level since 1937. Triplex Glass at 45s. were also higher on

balance, Babcock & Wilcox strengthened further to 54s. 6d., while International Combustion shares were marked up to £7. British Oxygen improved to 87s. 9d., Pressed Steel to 32s. 9d., and United Molasses to 39s.

In iron and steels, Stewarts & Lloyds improved to 56s. 9d., and Tube Investments to 112s. 6d. Guest Keen at 38s. 9d. and United Steel at 26s. 1½d. also improved. Richard Thomas at 13s., and Baldwins at 6s. 10½d., became easier following the activity in the shares prior to the approval of the merger. Dorman Long were 27s. 9d., Consort Iron 8s. 3d., Firth Brown 76s. 3d., while Birimid Industries were again higher at 89s. 3d. Allied Ironfounders strengthened to 52s. 9d. Among textiles, the general tendency was steady, with Bradford Dyers 25s., Calico Printers 19s., and Bleachers 14s. 3d. However, British Celanese fluctuated and, at 35s. 10½d., were lower on balance, the tendency being to await the annual meeting on Tuesday next, which follows the maiden dividend of 15 per cent. made possible by tax adjustments. Courtaulds were steady at 57s. 3d., and Dunlop Rubber at 48s. 6d.

Elsewhere, Sangers were prominent, rising 1s. 3d. at 31s. 6d. following the doubling of the interim dividend. Boots Drug were steady at 55s. 9d., with Timothy Whites higher at 42s. Nairn & Greenwich kept firm at 77s. 6d., following the maintenance of the dividend at 12½ per cent., while Barry & Staines improved to 51s. 9d. Wall Paper Manufacturers deferred were 44s. 3d., De La Rue were firm at 196s. 3d., but remained unaffected by the announcement of the formation of a subsidiary to deal with the big potential demand predicted for gas appliances. British Industrial Plastics eased to 6s. 10½d., awaiting the dividend announcements. Erinoid were higher at 12s. Fisons were 52s., with B. Laporte 85s. Greff-chemicals 5s. ordinary were 8s. 3d., and Monsanto Chemicals 5½ per cent. preference 23s. British Drug Houses were 29s., Burt Boulton 24s., and Cellon 5s. ordinary also 24s. W. J. Bush have been maintained at 70s., and William Blythe 3s. ordinary at 9s. 3d.

British Match kept steady at 42s. 3d., with Borax Consolidated 36s. 9d., British Aluminium 45s. 7½d., Imperial Smelting 13s. 9d., and Metal Box 91s. 3d. General Refractories remained at 17s. 4½d., and Goodlass Wall at 18s. 9d. General Electric, reflecting firmness in electric equipment shares, moved higher at 99s. 3d., with Ericsson 56s. 6d., Ever Ready 42s. 9d., and Associated Electric 57s. 6d. Elsewhere, Yorkshire Dyeing & Proofing shares changed hands up to 18s., British Tar Products 5s. shares were 9s. 7½d., and British Glues & Chemicals 4s. ordinary again 9s. Paint shares continued firm, with Pinchin Johnson 40s., aided by market hopes of the results



showing a further moderate improvement in dividend. International Paint were 116s. 3d., and Lewis Berger 106s.

Oil shares were generally well maintained. Shell, although "ex" the maintained interim of 2½ per cent. tax free, were higher at 83s. 1½d., Burmah Oil were also 83s. 1½d., and Anglo-Iranian 107s. 6d. Apex (Trinidad), however, weakened to 30s. 9d. after an earlier rally.

## British Chemical Prices

### Market Reports

**T**RADER in the London general chemicals market has now more or less reverted to normal after the recent slackening at the holiday period, although fresh inquiry has not been extensive. The price position throughout the market remains firm. In the soda products market a fair pressure is reported for supplies of soda ash, quotations for which are well held, while there is a steady demand for bicarbonate of soda, and solid and liquid caustic soda. Nitrate of soda is a good market and inquiry for hyposulphite of soda is fully maintained. Acetate of soda is steady and new buying interest in percarbonate of soda is recorded. Strong price conditions are maintained throughout the potash section, and offers of yellow prussiate of potash are finding a ready outlet. A

steady trade continues in acid phosphate of potash, and permanganate of potash is a good market. Trade in the coal-tar products market has been more active during the past week, and the home market for pitch has been steady. A steady demand is reported for crude tar and creosote oil. A fair trade is passing in the naphthas and xylois, while the demand for toluols and benzols is moderate.

**MANCHESTER.**—The Manchester chemical market during the past week has been a trifle more active both from the point of view of new inquiry and actual business, while a steady call for contract supplies in a fairly wide range continues to be reported. Caustic and most other soda products, carbonate of magnesia, pretty well all available potash chemicals, alum, and the acids are going steadily to the consuming end. Prices are on a firm basis in virtually every section of the market, with few actual changes to record. Most of the fertilisers are being sold in fair quantities, but the seasonal trade in several lines is not yet fully under way. The tar products are very strong in undertone and the majority are finding a good outlet.

**GLASGOW.**—In the Scottish heavy chemical trade, business in the home trade has resumed its moderate activities after the New Year holiday. Export inquiries are still rather limited. Prices keep very firm.

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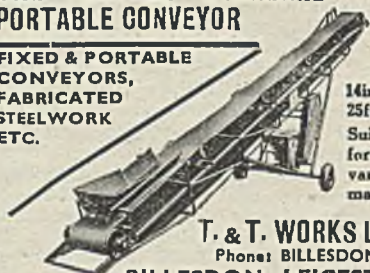
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Particulars of the proposed amendment were set forth in the Official Journal (Patents) No. 2920, dated January 10th, 1945.

Any person may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2, on or before the 10th February, 1945.

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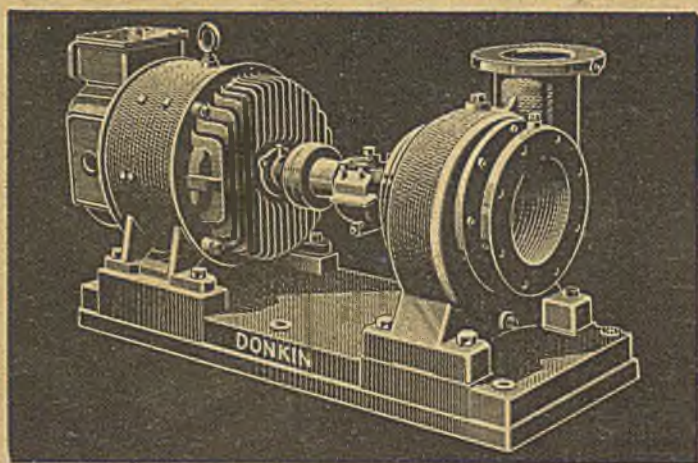


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