

THE Chemical Age

VOL. LXXI

24 JULY 1954

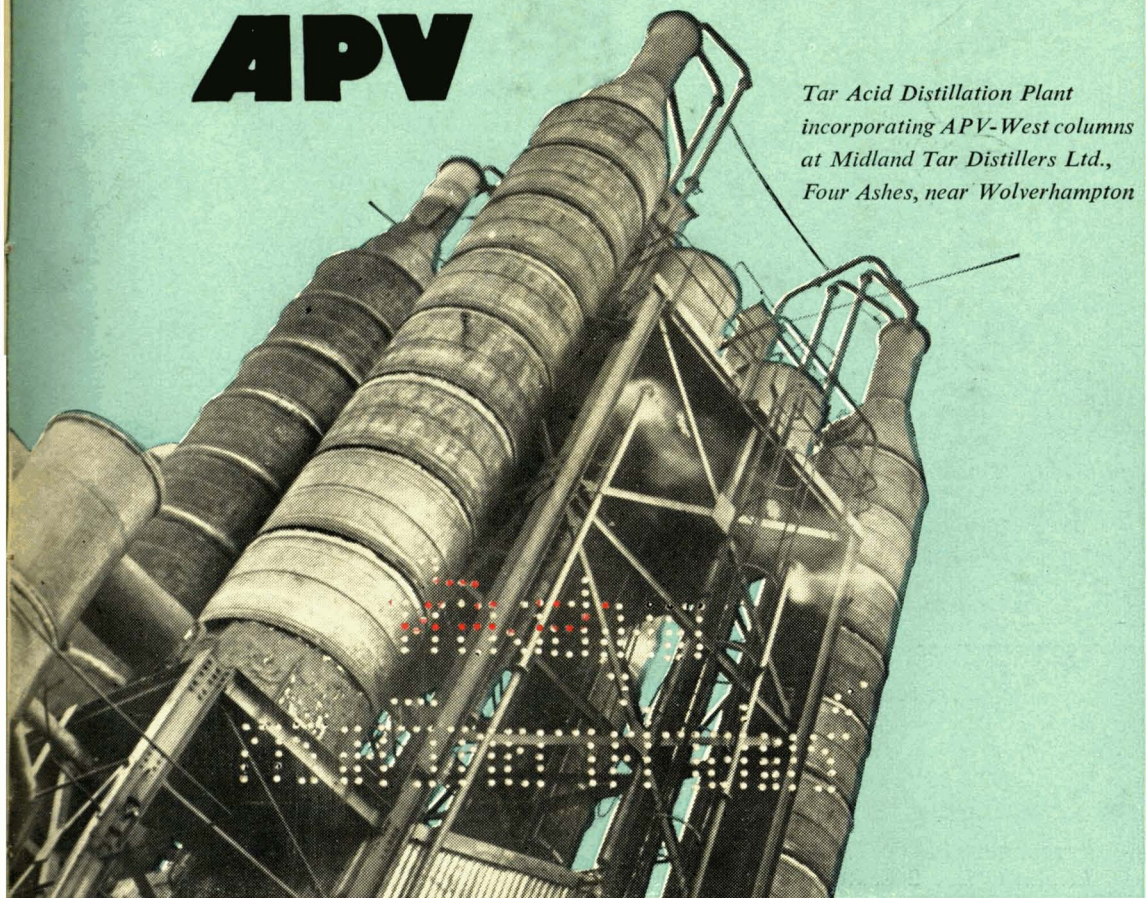
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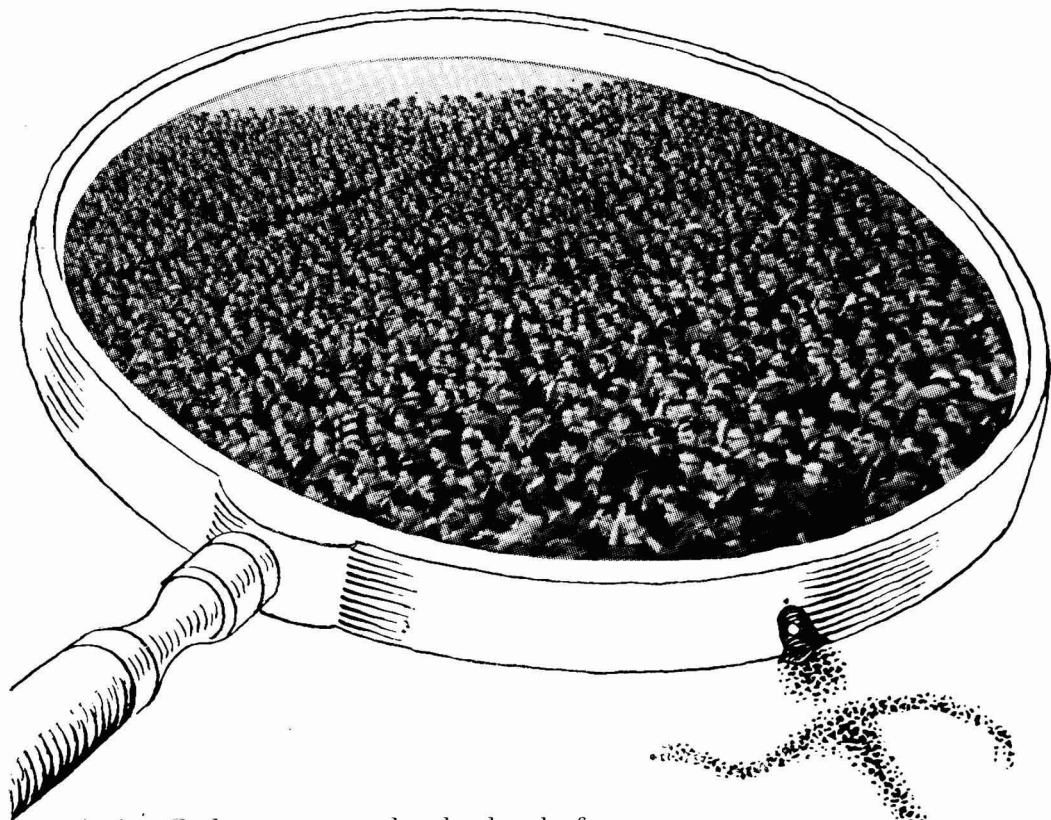
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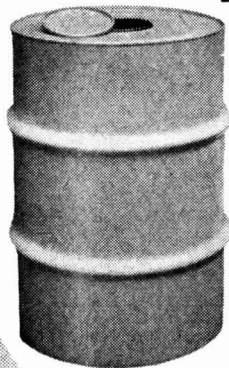
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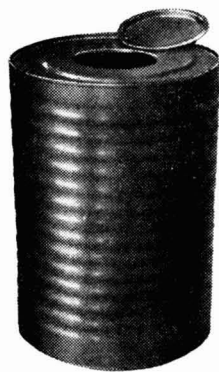
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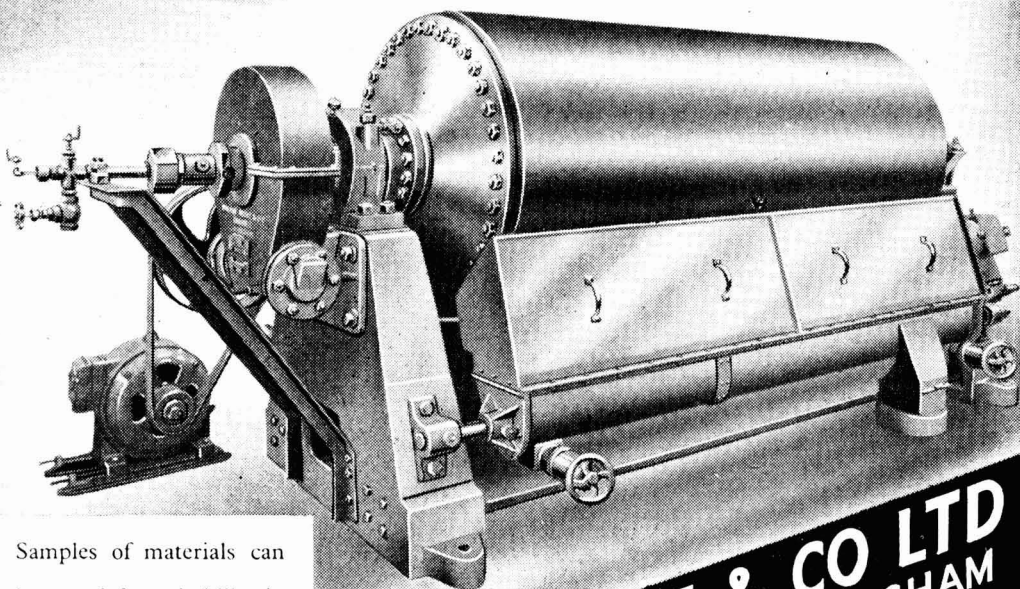
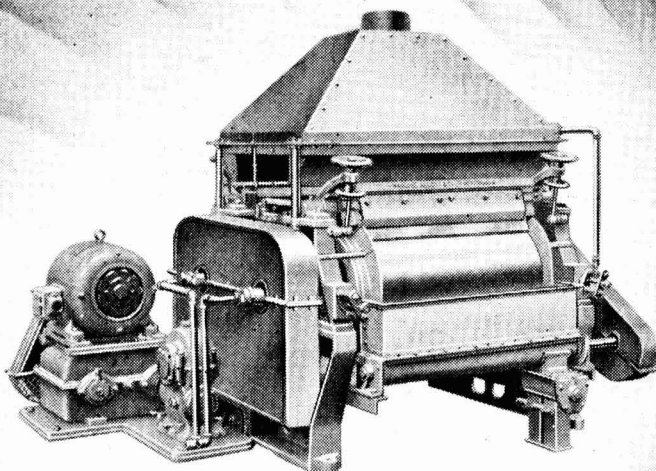
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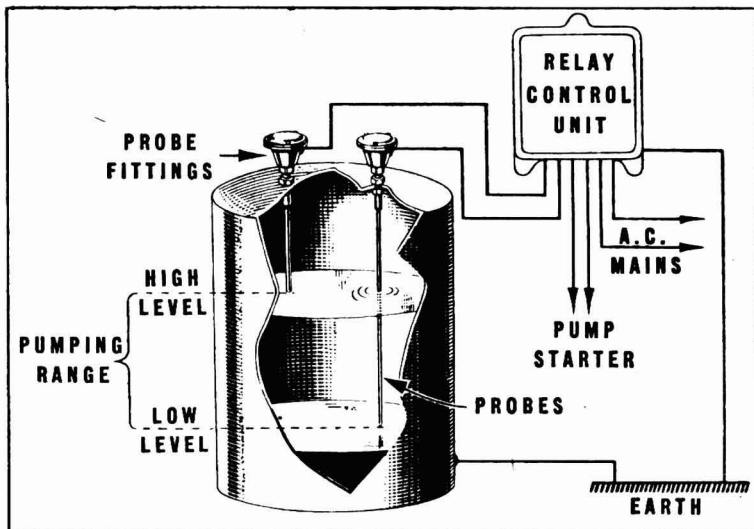
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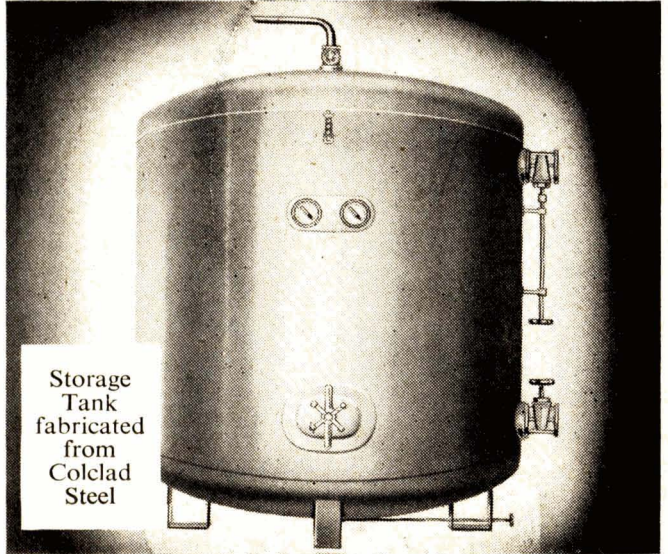
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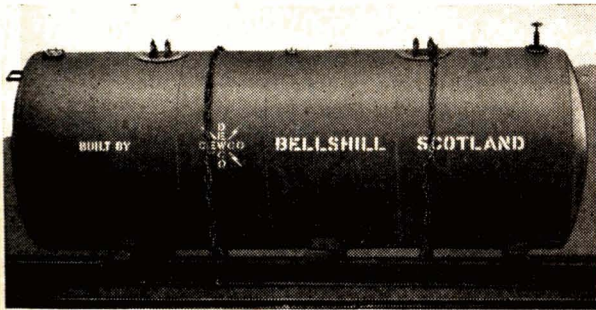
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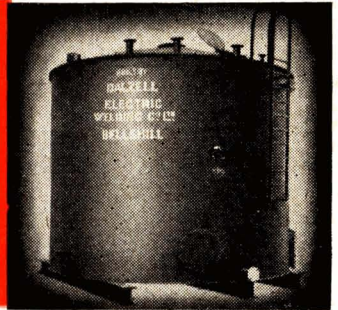
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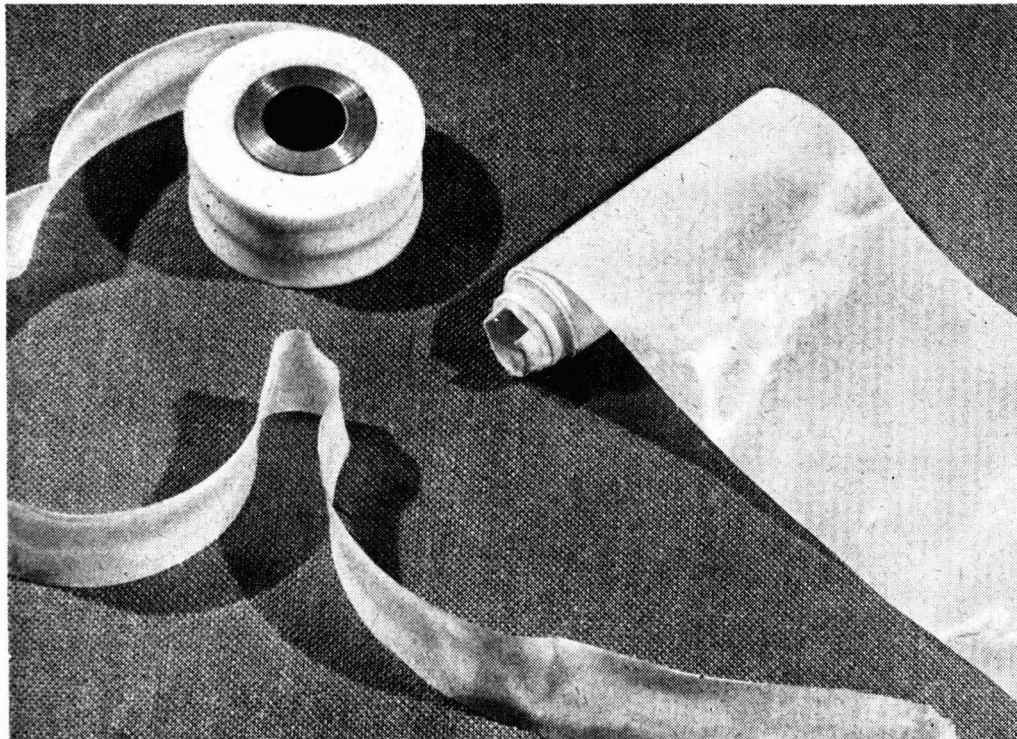
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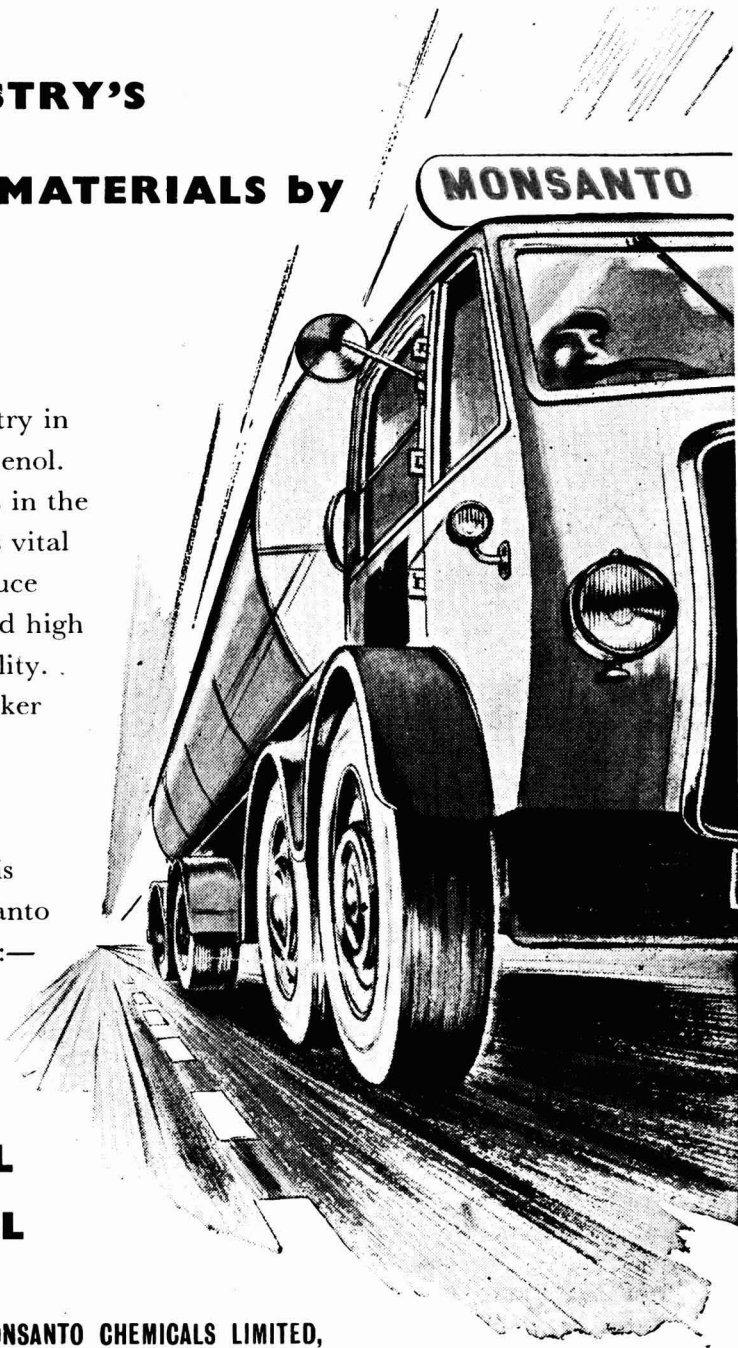
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CONTENTS · 24 JULY 1954

SCI 73rd Annual Meeting	167
Solvent Extraction Methods in Organic Analysis	171
Alkali, etc., Works, Chief Inspectors' Report	177
Ancient Ancestry of Griffin & George Ltd.	181
Iso-Pentane Production in UK	182
The Chemist's Bookshelf	183
Home News Items	185
Overseas News Items	186
Personal	187
Publications & Announcements	188
Law & Company News	190
Market Reports	190

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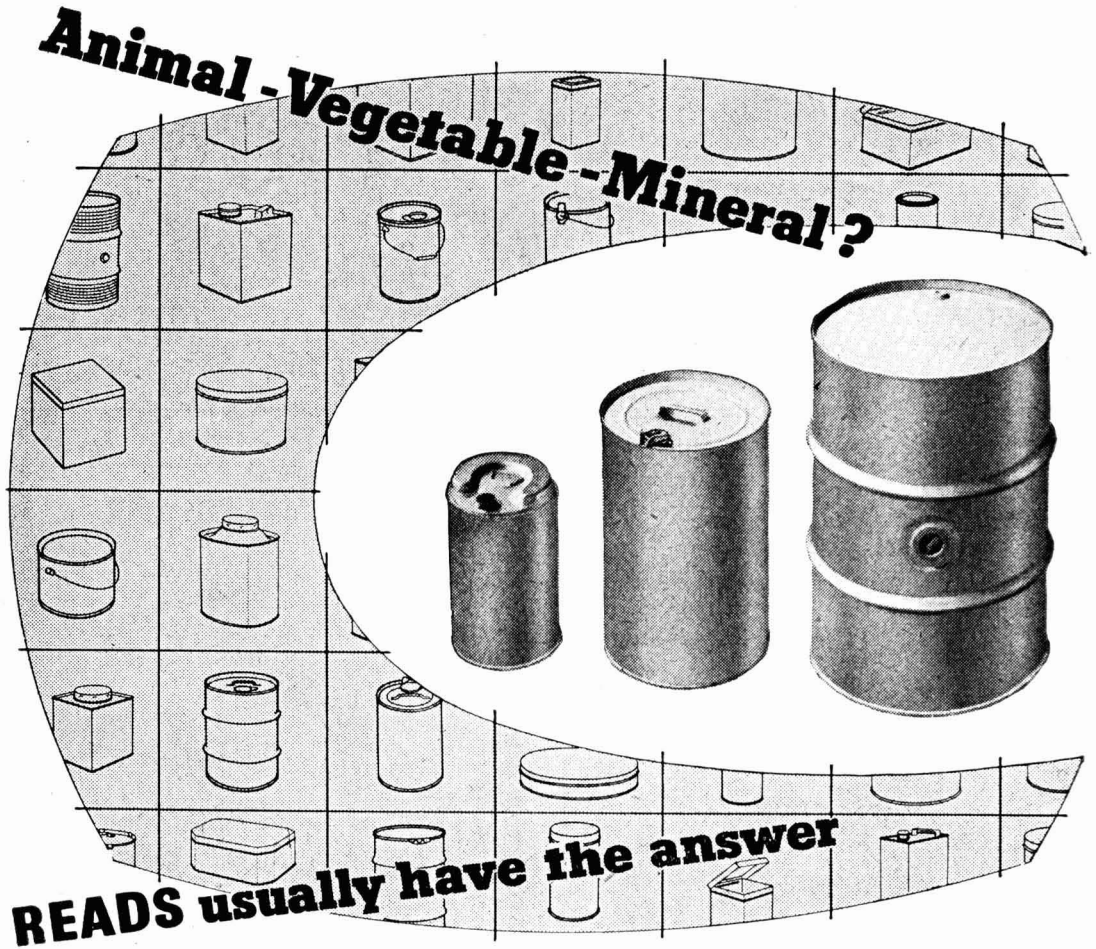
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Soil, Sewage & Town Wastes

LAST week was notable for the explosion of the persistent and popular illusion that modern civilisation is grossly wasteful in disposing of its sewage and household wastes without more effort to utilise them as materials for building soil fertility. For much of this century the steady development of urban sanitation has been accompanied by indictments of this nature; so, too, has the growth of fertiliser usage. Vehement propagandists have deplored the discard of humus and plant nutrients into our rivers and seas, and some have gone as far as describing the water-closet as man's most wasteful invention. If this wastage could be salvaged for use on the land, soil fertility would steadily rise and much of the expenditure upon fertilisers would become unnecessary — so runs the thesis. Many articles, a number of books, and innumerable letters to the Press have been devoted to it.

The unusual step has been taken of publishing a report of the Natural Resources (Technical) Committee, which was formed in 1950 by the Lord President of the Privy Council. Because the subject is so often raised, because such divergent views are held about it 'ranging from the most optimistic to the frankly sceptical,' and because it concerns all local authorities, the widest possible distribution of the Committee's report has been aimed at, although previous reports on other subjects have not been publicly issued. The Report is 'The Use of Town's Wastes in Agriculture' (1954, 25 pp., HMSO, 1s. 3d.).

It is by no means a non-chemical topic. A number of the members of the Committee are chemists. The charge that soil

fertility is declining because so much potentially useable organic matter is wasted is by implication a charge that chemical fertilisers, one of the main means by which farmers today maintain fertility and crop yields, are in fact failing in their main function. The subject has remained widely open to speculation and controversy because it has never before been examined with statistical realism, and it has been as difficult to discredit the dreams of optimists as to accept the doubts of pessimists. The facts have now been gathered together and there is no longer justification for widely ranging opinions and prejudiced argument. Comparisons with the agricultural practices of China and Japan (which have always disregarded the associated disease incidence and have never pointed out the exceptionally higher fertiliser usage of Japan) are now shown to be odious indeed.

The usefulness of sewage and town wastes has to be judged in perspective. These materials are constantly being produced and some form or another of handling and processing must be applied to them to ensure that their accumulation does not endanger public health. They undoubtedly contain important nutrients for plant growth, simple nutrients such as nitrogen and phosphates, etc., and organic matter which is likely to be converted into humus in the soil. *Qualitatively*, the case for their full utilisation as agricultural materials is an impressive one. It requires detailed study, with stress laid upon figures and costs, to show that the *quantitative* case is much weaker.

In terms of the principal plant nutrients—nitrogen, phosphates and

potash, the three nutrients with which present-day fertiliser manufacture is almost wholly concerned—the potential contribution of these town and city wastes is surprisingly poor. This is by no means the total story; their humus-making potentiality is regarded as much the more important by most of the enthusiasts. But the humus aspect can be discussed separately. The total amount of nitrogen in sewage and town wastes amounts to 102,500 tons per annum (as N); of this amount 60,000 tons is in the effluent portion at a dilution of about 40 ppm., and as such it cannot be recovered economically by present means; another 20,000 tons of nitrogen in the fine dust of household refuse is diluted with so much bulky and inert matter that its fertiliser usage would be unprofitable. Eight thousand five hundred tons of nitrogen in sewage products are already used on the land.

It follows, therefore, that the cumbersome task of fully utilising sewage and town refuse would produce only 14,000 additional tons of nitrogen. This represents no more than 1/15 of our present annual usage of nitrogen as fertiliser, of which 75 to 80 per cent is won from the air by synthetic fixation. It might also be borne in mind that for optimum productivity we should use at least twice as much nitrogen as we use at present. The contribution of all town wastes not at present utilised would therefore be only 1/30 of that ideal total. Nor do these assessments allow for the disability that in general the nitrogen of organic manures is less efficient, i.e., less fully assimilated by plants, than the nitrogen of fertilisers.

The story for phosphates and potash is no more encouraging. The phosphate (as P_2O_5) content of all sewage and town wastes amounts to 40,000 to 42,500 tons per annum, which must be compared with an annual fertiliser supply of 400,000 tons. The potash content is 25,200 tons (as K_2O), to be compared with an annual usage of 210,000 to 220,000 tons as fertiliser. And it would be over-optimistic to say that the total recovery of these nutrients in sewages and wastes could replace 10 per cent of our current fertiliser needs, for much of the phosphate and potash would have a lesser

availability than the phosphates and potash of modern fertilisers.

The organic matter contained in these wastes might be expected to provide better evidence for a full recovery programme. But the 400,000 tons of sewage sludge not already used on farms would contain only 200,000 tons of dry organic matter; and the 10,500,000 tons of refuse, which have about 13 per cent of putrescible organic matter (chiefly vegetable wastes with a high moisture content), would yield only 550,000 tons of dry organic matter. This total amount—750,000 tons—must be compared with the annual amount already added to our farm soils through the return of farmyard manure, straw, and the ploughing-in of crop residues. This total amount, again expressed as dry organic matter, is 15,700,000 tons. This is an estimated figure and it is possible that it may have been over-estimated. Yet even if we reduce the figure to 12,000,000 tons, the contribution from a full recovery programme for sewage and refuse wastes would only amount to about six per cent addition to the present annual input of organic matter. Furthermore, tests have shown that the value of organic matter in sludge and in refuse/sludge composts is inferior to that of farmyard manure's organic matter.

It is hardly surprising that the committee has concluded that the amounts of nutrients and humus-making matter that would be produced by a costly programme of full utilisation are small compared with those applied by present methods. Composting refuse and liquid sewage sludge is described as 'generally uneconomic . . . and there is no case for authorising the expenditure of public money on pilot plant experiments.' The argument that soil fertility is declining because present methods are inadequate is firmly refuted—'. . . an examination has been made of the yield per acre for various crops over the last 50 years. The figures lend no support to the view that the fertility of our land is, in fact, declining.' There can be few official reports on much discussed and controversial subjects which have led to a verdict of 'case dismissed' in such a clear-cut fashion.

Notes & Comments

Rain of Facts

WE have made several recent references to the American MCA Chemical Progress Week venture of 1954 (see *THE CHEMICAL AGE*, 1954, 70, 1186 and 1287; 71, 70), but by now it has become easier to judge its value in retrospect. A short report in *Chem. Eng.* (1954, 32, 2466) suggests that the chemical industry was like an artificial rainmaker who set out to induce a shower and got a cloudburst instead. An early and coldly statistical summary of the week's results includes these facts. Nine hundred and ninety six speeches were made to audiences totalling 155,060 people. There were over 200 TV appearances on 88 stations and nearly 500 radio programmes on 218 stations. Two hundred and thirty visits to chemical factories were made, involving a total of 34,696 people. Sixty nine special exhibits were shown. In more than 800 newspapers 1,350 'stories' about the industry appeared. Over 250,000 pieces of CPW literature and some 20,000 posters were distributed.

Drops in the Bucket

NO-ONE with the slightest experience of publicity work would expect a 100 per cent response to all these efforts. Response of any lasting value is in any case accumulative. If there was a short-term response to these public wooings, it is unlikely to have scored a higher rate than five per cent. Omitting the unknown numbers of radio and TV audiences and newspaper readers, at least 440,000 people were at the receiving end of special publicity efforts. Was the real interest of about 22,000 of them secured? To this must be added the unpredictable, but possibly more casual, effects of press, radio and TV impacts. It seems a fairly conservative estimate to suppose that in all some 30,000 people were newly converted into some degree of appreciation and understanding of the industry. This is a far from unsatisfactory start and it will expand at accelerating rate as further efforts bring both their own new effects and strengthen the

accumulative effect. Anyway, it seems agreed already that the MCA Chemical Progress Week will now be an annual event.

Oceanic Magnesium

A NEW process for extracting magnesium from sea water has been patented (USP. 2,671,714) and assigned to the Dow Chemical Co., which already has established interests in this field. The process is based upon ion exchange, a granular resin being used as the exchange agent; this is a sulphonated copolymer of styrene, ar-ethylvinylbenzene and divinylbenzene. A two-column process raises the concentration of the magnesium from its initial level of 0.0685 per cent to about 2.7 per cent, a fortyfold concentration. This has been described in *Chem. Eng.* (1954, 61 [7], 282) as one of the biggest tasks yet tackled by ion exchange methods.

Up and Down the Column

IN the first of the two exchange columns sea water enters at the bottom; in the second column a regenerant solution of over 10 per cent sodium ion concentration and 0.007 per cent magnesium concentration (SG 1.192) also enters at the bottom. The resin is continuously circulated in both columns. In the first the sea water by cation exchange is depleted of magnesium ions, and the resin from this column is picked up in a fresh water jet and sent to the top of the second column, where it falls by gravity. In this column, however, dilution of the ultimate product is controlled by spaced electrodes, a difference in electrical resistance between water and the product solution enabling the interface between the two liquid layers to be controlled. The magnesium removed from the sea water is steadily transferred to the second solution until the 2.7 per cent concentration level has been reached. It remains to be seen whether this new process will actually be utilised in the US sea-water magnesium industry, now based largely upon precipitation of magnesium by lime or calcined dolomite. Any

means other than that of evaporation to reduce the huge volumes of sea water that must be handled should appreciably improve the basic economics of these magnesium extraction processes.

Catalysis for Students

AN interesting plea for small-scale experiments to demonstrate the principles of modern industrial catalysis to students is made in *Discovery* (1954, 15, 293). 'A big gulf separates the theoretical considerations of catalysis and its practical applications. A great deal of the difficulty of bridging that gap is caused by the conditions in which most industrial catalysts work. They are not suitable for elementary laboratory demonstration . . .' Most catalysed industrial reactions today involve gaseous reactants and a solid catalyst, and high temperatures and pressures are usually applied so that the rate of collision between the molecules in the gaseous mixture is increased. The development problems of catalytic processes are mainly 'plant-structural'—designing reaction vessels which can withstand high pressures and high temperatures, or designing a plant so that necessary heat input can nevertheless

be speedily removed. On a large scale such problems differ completely from those that would arise in small-scale experiments. Nevertheless, there are some well-known industrial processes of this kind which could be used as educational examples. At temperatures and pressures well within the scope of laboratory demonstration (70° and 100 psi.) hydrogen can be added to the double bonds of fats with the assistance of an easily preparable nickel catalyst, and the course of the reaction can be easily followed by observing the fall of pressure in a hydrogen reservoir charged initially at about 200 psi. There are no doubt other industrial processes which could be similarly imitated in the laboratory, and industry would be serving its own future cause by giving some thought to this possibility. Twenty years ago the gap between academic and industrial chemistry was appallingly wide and at many teaching centres it was almost a deliberate dissociation; today the gap is just as wide but it is circumstantial rather than the product of prejudice. Any practical efforts to reduce this limitation upon chemical education will deserve universal encouragement and support.

IN THE EDITOR'S POST

Magnesium versus Petrol?

SIR,—In Vol. 69 of THE CHEMICAL AGE there is on p. 1217 a report according to which 350 lb. magnesium corresponds to about 18,000 lb. aviation spirit. These figures were included in numerous technical journals accepted throughout the whole world, and also appeared in our *Chemiker-Zeitung*. However, we must now conclude from technical considerations that a fundamental error has obviously entered into these abstracted data. A comparison of the heats of combustion shows that 350 lb. magnesium is equivalent to no more than 180 lb. benzene. Moreover, we would like to call attention to the fact that the use of magnesium as a propellant would lead to the generation of enormous clouds of MgO, causing far more contamination of the atmosphere than is the case with the use of benzene.

In the hope that you can clarify this

matter, we beg you to inform us of the principles or basic calculations by which these published figures were obtained.—Yours, etc.,

MEHL.
Editor.

Chemiker-Zeitung,
Heidelberg.

(Translated from the German)

These figures, or something closely approximating to them, were given by Mr. J. H. Scharen, technical director of the Reade Manufacturing Co., to a meeting of the Magnesium Association in New York last November. Iron Age (1953, 172 [20], 123) reported that Mr. Scharen had built a prototype engine using powdered magnesium as a fuel, 1 lb. of metal being equivalent to 600 lb. gasolene. The fuel consisted of 95 per cent metal powder between 5 and 6 microns, the remainder being stabiliser. Chemical & Engineering News contained a similar report, the equivalent quantities, however, being quoted at 350 and 18,000 lb. (3,000 gal.) as in our paragraph.—Editor.

Lord Cherwell Gives Messel Lecture

Successful SCI Meeting at Liverpool

THE seventy-third annual meeting of the Society of Chemical Industry was held in Liverpool last week, under the presidency of Sir William Ogg.

The first event was the opening of the exhibition on safety in chemical laboratories, in the Students' Union at the University. A range of safety equipment used in chemical laboratories was shown, the exhibition being staged by the research department of Imperial Chemical Industries Ltd., Widnes. Much of the equipment was developed in the department, and as so much interest had been aroused during lectures in various parts of the country, it was felt that it would be very useful to have the actual articles on view.

Wizards of Wid-Nes

At the same time there were on view a series of transparencies prepared as part of the celebrations in 1950 for the centenary of the chemical industry in Widnes. These were painted by Mr. W. W. Gleave, a research chemist at I.C.I., with the assistance of two helpers in the scaling-up of the paintings. The display was entitled 'The Wizards of Wid-Nes' and described as 'A Chronicle in Colour depicting the Strange and Momentous Events of a Century which came to pass in the Land of Furnaces and Cauldrons.'

On Monday evening the members and visitors and their ladies attended a cocktail party at the Adelphi Hotel, Liverpool, by invitation of the general managers of Shell Refining and Marketing Co. Ltd. and Shell Chemicals Ltd. They were received by Mr. and Mrs. E. le Q. Herbert and Mr. and Mrs. G. H. W. Cullinan.

On Tuesday morning an official welcome was extended to all attending the conference by the Lord Mayor of Liverpool, Alderman Alexander Griffin, and by the Vice-Chancellor of Liverpool University, Sir James Mountford.

The seventy-third annual general meeting of the society was held on the same morning. A loyal message was sent to HM the Queen, and a reply was received. There were also telegrams and cables of good wishes and greetings from several past-presidents, vice-presidents, a number of mem-

bers of council and a large number of members of the society.

The Annual Report of the Council for the year 1953 was presented by Dr. E. B. Hughes (hon. secretary), and it recorded again a year of satisfactory activity and continued progress. The work of the committee on the structure of the society, under the chairmanship of Sir Eric Rideal, M.B.E., F.R.S., was completed during the year, and the thanks of the society were expressed to Sir Eric and his committee for their great services. Two honorary foreign members, Professor Raymond Delaby and Dr. Piero Giustiniani, were elected during the year.

It was stated that in 1953 the society's accounts took on a different aspect from that of the past few years, owing to the cessation of the increasingly large payments to the Bureau of Abstracts.

In proposing the adoption of the report, Dr. S. J. Kennett, vice-chairman of the Liverpool Section, said he was most grateful that the council of the society had decided to continue the publication of abstracts. And in regard to the multitude of activities recorded in the report he proposed that the meeting should record keen appreciation of the constantly loyal work of the staff.

It was announced that the following officers were appointed for the year 1954-55:—*president*, Sir William Ogg; *hon. treasurer*, Mr. Julian M. Leonard; *hon. foreign secretary*, Dr. L. H. Lampitt; *hon. secretary (home affairs)*, Dr. E. B. Hughes; *hon. publications secretary*, Mr. F. P. Dunn; *vice-presidents*, Dr. H. K. Cameron, Mr. F. A. Greene, and Mr. J. A. Oriol. *Members of Council*: Four nominations were received for the four vacancies and the following were declared elected: Dr. W. M. Ames, Dr. L. A. Jordan, Mr. P. V. Lloyd and Mr. H. V. Potter.

Presidential Address

SIR William Ogg, in his presidential address, said this was a time of change for the society—a tide in its affairs—and we must take the current when it serves or lose our ventures.'

He expressed the very sincere thanks of

the society to Dr. John Rogers (past-president), and to the members of the committee of which he was chairman—Dr. Leslie Lampitt (past-president) and Mr. W. J. Worboys—for the very great service they had rendered in acquiring the society's new headquarters at 14, 15 and 16 Belgrave Square. The buildings should be ready for occupation within a year. Mr. F. A. Greene (a vice-president) had agreed to act as honorary adviser and consultant. A house committee consisting of Dr. John Rogers, Mr. W. J. Worboys, Mr. Greene and Dr. H. K. Cameron and the honorary officers had been set up to plan the use of the accommodation.

Society Flourishing

The society was in a flourishing condition and the prospects for the future were bright; but it could not afford to be smug and self-satisfied. On behalf of the membership he thanked the honorary officers for the vast amount of time and thought they gave to the society's affairs, and also the officers of the sections and groups; and he gave a very special word of thanks to Col. Griffin and his staff for their loyal and efficient service.

It was a pleasure and a privilege to be back in the friendly and hospitable city of Liverpool, back in the region which was the cradle of heavy chemicals and where so many branches of chemical industry were so active and progressive today. In Liverpool and its neighbourhood there was one of the greatest oil refineries in the country; there were important works producing synthetic fibres, plastics and pharmaceuticals, including one of the largest penicillin units; the vast oils and fats industry; and the manufacture of soap and margarine. During the week there would be opportunities of visiting Widnes and other great chemical centres in the neighbourhood.

Finally, the president expressed great indebtedness to Dr. L. J. Burrage, the chairman of the Liverpool Section, Mr. A. G. Jones, the secretary, and all the members of the local organising committee for the admirable arrangements they had made for the annual meeting; to the authors of the papers to be presented, and to all the firms which were allowing the members and ladies to visit their works.

Following the meeting, the members and their ladies were invited to luncheon at the Adelphi Hotel, as the guests of the Liverpool section of the society.

Dr. L. J. Burrage (chairman of the section) presided, and welcomed the guests. The Liverpool Section, he said, dated back to the beginning of the society itself, its first official committee meeting being held in October, 1881. But although the section was rooted in antiquity so far as the society was concerned, it moved with the times. It had tried to adopt novel ideas for the annual meeting, and he believed it was the first section to arrange a works visit by air.

Referring to the safety exhibition, he said that in the society they were not so much concerned with the legal aspect of safety as with its moral aspect. He would like to see in the society a Safety Group which would be responsible for giving lectures on various aspects of safety to all sections and for disseminating technical information on the efficacy of various types of equipment.

The Messel Lecture

THE Messel Medal was presented by the president to the Rt. Hon. Lord Cherwell, C.H., P.C., F.R.S., at a meeting in the Arts Theatre of the University on Wednesday morning, 14 July; and Lord Cherwell delivered the Messel Lecture.

The Medal was instituted in 1921 to perpetuate the name of Rudolph Messel, president of the Society in 1911-12 and again for a short period in 1914. It is of gold, and bears on its obverse side a representation of the head of Rudolph Messel and on its reverse a symbolic female figure unrolling the scroll of fame. It is awarded every two years, and Lord Cherwell is the sixteenth distinguished recipient.

The president, in presenting the Medal, said that in inviting Lord Cherwell to accept it the society felt they were honouring themselves as well as paying tribute to his outstanding merit and his services to the country. They admired his ability as a physicist, mathematician and administrator.

Lord Cherwell, in his address, referred first to the development of chemical industry and the expansion in chemical exports. They recognised the importance of fundamental research, but, like other industries, were handicapped by shortage of technologists.

Other countries had good facilities for technical education, but the United Kingdom lacked special technological universities, and he urged that only in such organisations, where there were departments for all

branches of technology centred in one place, could proper technological training be given. One or two technological departments tacked on to a university were of no use; a complete range would swamp the existing universities (except perhaps London) and throw them out of balance. It was of no use refusing to face one of the obstacles in this country, namely, the ridiculous intellectual snobbery concerning technology. He had fought it for the last 20 years, but not with any great success.

Speaking of his own work, he said that some 35 years ago he had ventured, in connection with the theory of chemical reaction velocities, to point out that the outstanding paradox in the velocity of monomolecular reactions could be circumvented if we accepted the fundamental idea of an excited state lasting for a finite period after a molecular collision.

His view was that excited molecules were produced which remained excited for a period greater than the interval between collisions. That would explain that the reaction velocity would not depend upon the pressure until the density was so low that the interval between collisions became comparable or long compared with the duration of the excited state. Hence at very low densities a deviation from the premise that the velocity reaction was independent of pressure was to be expected. And he was glad to say that his hypothesis was confirmed and indeed carried much further by the very accurate and interesting observations of Sir Cyril Hinshelwood.

Birth Pangs of Quantum Theory

Lord Cherwell's main connection with physical chemistry, however, dated back even further to his work in Berlin with Professor Nernst more than 40 years ago. He confessed that its relationship to industry was not then in the forefront of his mind, for at that time we were experiencing the birth pangs of the quantum theory.

When Planck had put forward his ideas in his celebrated book on the theory of heat radiation, the quantum theory was believed to apply only to the interchange of energy between matter and radiation. In deriving his formula he had assumed that energy could only be transmitted in units proportional to their frequencies. That, of course, Planck could and did translate into the idea of the quantum of action—the celebrated h —but

it was difficult to see how to proceed from there. In 1905 Einstein had suggested that if the derivation of Planck's formula were true it would seem that the atomic heat of substances would fall off according to the now well-known formula.

Calibrated Heat Theorem

But nobody had taken that suggestion very seriously, for Einstein at that time was only patent examiner in Bern, without any special academic standing. When Lord Cherwell had started work in Berlin, Nernst's main concern was with his calibrated heat theorem now known as the third law of thermodynamics. That required that the sum of the molecular heats of the substances taking part in the reaction should be the same before and after the reaction at the absolute zero. To test that they made a number of observations of specific heats at low temperatures—or what were called low temperatures in those days. He had dug out Einstein's paper and had shown that his formula gave a curve not altogether inconsistent with their observations. Moreover, it was possible to show that the variable parameter required to account for the differential falling off of the specific heats as the temperature was reduced, namely, the principal frequency of the oscillating particles, could be derived by the methods of ordinary dynamics and by assuming that the melting point was the point at which the amplitudes of the oscillating atoms or molecules became so great that they collided.

Unfortunately, Einstein's formula, though it indicated the sort of curve, did not give the whole story. Nernst and himself had proposed the addition of a special subharmonic term which enabled their observations to be fitted very closely to the formula and, moreover, gave complete agreement between the frequencies required for the specific heats and the observed frequencies of the *reststrahlen* observed in substances like potassium chloride and sodium chloride. Later, Debye, making simplifying assumptions which were rather horrible from the theoretical point of view if looked at closely, had derived a rather more complicated formula which also fitted the facts, and indeed fitted them better at very low temperatures.

For the first time, Lord Cherwell said, man had it in his power to destroy all life on the planet. The question was whether he would

be able to avoid some such form of universal suicide. Lord Cherwell was sure the verdict of a true plebiscite in every country would be a vote of more than 100 to 1 against war. It was a sad reflection on our political achievement and mental processes that, despite that universal wish, man had not been able so to order his affairs to avoid war or even the threat of war. Whether *Homo sapiens* would accept the vast benefits which science offered him, or whether he would use the colossal power scientists had put at his disposal to restore the surface of this puny planet to the primeval slime from which it had emerged in the last thousand million years, the future, and perhaps the very near future, would show.

The Annual Dinner

THE annual dinner of the society was held on Wednesday evening in the Adelphi Hotel. The president presided over a company which included many distinguished guests, of whom the chief was Dr. Alexander Fleck, F.R.I.C., chairman of I.C.I., who joined the society in 1917.

Proposing the toast of the society, and making what he called a few somewhat random comments on general trends in the world in so far as they influenced chemical industry, Dr. Fleck said it was not a very peaceful or orderly world in which we lived, and yet it was one in which we must endeavour to do our ordinary business. He did not believe that we could change it overnight. Personally he did not accept the two alternatives that were sometimes posed—complete peace or total war. He expected the sort of conditions that we had experienced since 1945 to last quite a long while, probably the lifetime of most of us.

He took comfort in the memory that Europe had managed to survive and to flourish for a thousand years under the threat of invasion from the Turks. He believed we should move out of the conditions of 'cold war' only by the gradual extension of local agreement on specific issues rather than by any sudden and dramatic settlement of the majority of our problems. That meant that in the long run the peacemakers might well be the trader and the manufacturer rather than the politician.

Dr. Fleck said he could not accept the proposition that markets were to be limited in perpetuity to their present size. The aim

of all of us must be to turn potential demand into actual demand—and the potential untapped demands of the world were enormous. That was desirable not only economically, but socially. It was something which the Americans understood better than we did in Europe, and which they had succeeded in doing to a remarkable degree.

With regard to capital, as our processes appeared so often to be more complicated than their predecessors, it followed that the plants which were required to make them were themselves more complex; and since more complex things were usually more expensive, new plant and new processes cost more than old ones. The increase in instrumentation and mechanisation added further to the relative cost of new plants over old. Today it was quite common to have to spend £10,000 of capital for each person employed on a plant, whereas previously a workman could be employed for a quarter of that, or a fraction. If we were to have the capital which was needed to maintain the pace of development, we must earn a sufficiently high level of profits to be able to finance much of our new investment from our own earnings and to be able to pay sufficiently attractive dividends to draw in the extra money we needed from outside sources. He feared that the very high level of corporate taxation did not make that a very easy task.

Farmer a Big Customer

The president, in his response, said that perhaps one reason why the society had chosen an agriculturist as president was that the farmer was such a big customer of chemical industry. Where would Billingham be without the farmer? On the other hand, what would the farmer do without Billingham and all the other great chemical concerns which catered for his needs?

Apart from fertilisers and animal food-stuffs, there were weed-killers and the wide range of new materials for the control of pests. There were medicines for animals and conditioners for soils.

The members were particularly glad to have Mr. Francis J. Curtis present again on that occasion. They welcomed him as immediate past president, as a representative of the society's American section, but principally as Frank Curtis. That he had made such a long journey to be present at the meeting was still further evidence—if it were needed—of his interest in the society.

MIDLANDS SOCIETY FOR ANALYTICAL CHEMISTRY

Solvent Extraction Methods in Inorganic Analysis—Part I*

AT the final meeting for the 1953-54 session of the Midlands Society for Analytical Chemistry, the speaker was Dr. T. S. West, of the University of Birmingham. Dr. West chose as his topic for discussion 'Solvent Extraction Methods in Inorganic Analysis' and began by remarking that there were two branches of inorganic analysis in which there had been very considerable activity during the past decade, chromatography and ion-exchange.

It may be asked why these methods have received so much attention lately, and the answer surely is that they are primarily methods of separation. They are used in the first place to separate the group or ion required from the other materials with which it is associated. The analytical operation usually depends on the measurement of some chemical reactivity or physical property of the separated constituent. Alternatively these techniques may be used to remove 'foreign ions,' thus leaving the required ions behind in a relatively pure solution.

Both methods are strictly speaking of fairly recent origin, although chromatography was suggested by Tswett as early as 1906 and ion-exchange phenomena were described in early chemical experiments; both methods, particularly chromatography, can be said to involve a little art as well as science; both methods involve separation of the ion from solution, into what may be termed a solid phase, under conditions of equilibrium.

Extraction Methods Preferable

The technique of liquid-liquid extraction, in which ions are moved or transferred from one liquid phase to another, is no innovation in inorganic analytical chemistry, but it is becoming steadily more popular, and recent work has shown that in several cases it is more effective than the previous two methods. Industrially, liquid-liquid extraction procedures are used for the purification of uranium, separation of nickel and cobalt, purification of the rare-earths, etc. Indeed, as far as industrial processes are concerned solvent extraction methods are preferable to

chromatographic and ion exchange methods for they are much more readily adapted to continuous production. The stripping process is usually a very simple matter and the solvents are usually easily recovered. Toxic and fire-hazards are, of course, greater and must be set against the more favourable conditions.

Precipitation or Extraction?

Now it may be asked, supposing two metal ions exist in solution and there are two possible methods for achieving a separation, one a precipitation method and the other a solvent extraction method, which shall be used? Naturally, no general answer can be given to such a question; each case must be treated on its own merits, but the general features of a solvent extraction may be indicated here without comparing unduly the pros and cons of solvent and precipitation separations.

The degree of separation in either case is influenced by many factors. In precipitation separations these are: solubility of the precipitate; the tendency for co-precipitation to occur; the occlusion of foreign ions in the crystals; the formation of supersaturated solutions (and hence the necessity for standing times of various durations); the degree of sub-division of the precipitate; and the influence of attendant ions (complexing action), temperature, etc.

With solvent extraction the same factors have to be considered. In place of solubility there is the distribution coefficient.

An ion may exist in several ionic species $M_1, M_2, M_3, \text{etc.}$, and these will partition between the two phases with distribution coefficients $\rho_1, \rho_2, \rho_3, \text{etc.}$ What is most important analytically is what may be termed the bulk distribution coefficient, ρ_b .

$$\rho_b = \frac{\sum C_{org}}{\sum C_{aq}}$$

However, while the solubility of a precipitate places a limit on the degree of separa-

* A paper presented in Birmingham on 14 April. Part II will be published next week.

tion which may be obtained by this method, no such limit is imposed by the distribution coefficient.

Precipitation is essentially a unit operation, but solvent extraction may be operated on a continuous basis or by repeated unit operations, so that while the operation will theoretically never be complete it is possible to obtain a very high degree of separation. Naturally, there is no risk of co-precipitation or occlusion, and this is one of the features of solvent extraction most stressed by its exponents.

However, it should be stressed that there is such a thing as co-extraction. An example of this phenomenon has been pointed out recently by P. W. West. He found that while ruthenium is not extracted by benzene containing butyric or caproic acid, it is always co-extracted when copper is present in the aqueous solution. Fortunately, co-extraction is much less frequently found than co-precipitation.

Again, there is no possibility of the formation of a supersaturated solution although the separation of a third liquid phase may be said to be comparable. This again is rather rarely found. Most extraction procedures are rapid, equilibrium being reached in a matter of seconds. Temperature and the presence of complexing ions usually exert influences similar to those found in precipitation methods.

Solubility Must be Considered

There are, of course, certain features found in solvent extraction which are absent in precipitation, e.g. the organic solvent is usually appreciably soluble in the aqueous phase, and if the latter has to be examined subsequently for other ions, the solvent may have to be removed. Then, of course, the recovery of the ion from the organic phase must be taken into consideration. Usually this is easily done—for example, ferric iron is readily removed from strong hydrochloric acid by ethers and not at all from dilute acid. To recover the iron from an ether extract one simply strips the organic solvent with acidified distilled water, whereupon the iron transfers quantitatively to the aqueous phase.

Another feature is the alteration in phase volumes brought about by the mutual solubility of the two phases. Sometimes this factor may become very pronounced. It is particularly marked, for example, in the extraction of metals from hydrobromic and

hydriodic acids with diethyl ether. Yet another feature found in inorganic solvent extraction procedures is the exothermal nature of some of the transference reactions, e.g. ferric iron from aqueous to ethereal hydrochloric acid. There are many other points which deserve attention, such as the stability of the inorganic compound in the organic phase, the difference in chemical reactivity, the limited solubility of many metal chelates in organic solvents, etc.

Apparatus for Inorganic Extraction

The type of extraction most frequently used in inorganic analysis is the single stage, or batch, extraction. Where the solvent is heavier than the aqueous layer an ordinary separating funnel may be used for repeated extractions of the aqueous phase, since the organic solvent may be added from the top of the funnel and withdrawn from the lower portion through the tap. Where the solvent is less dense than the aqueous phase, the position is less favourable and a special funnel of the type used originally by Rothe is advisable.

Continuous extractors are available for most operations. These have the advantages of being easily set up, requiring little or no attention and being very efficient. Whether the organic liquid is more dense or less dense than the aqueous solution, these devices depend on the use of a source of solvent which is continuously distilled, so that the pure organic phase passes continuously through the aqueous solution and runs back into the source vessel. In this way, the extractable solute is eventually quantitatively removed to the organic phase.

Continuous extractors are particularly effective in systems where the value of the distribution coefficient is low, or where the solubility of the inorganic compound in the organic phase is limited. They are also ideal for separations which require much manual shaking, in that they can be started and allowed to run for an indefinite length of time without any attention.

Countercurrent extraction devices have seldom been applied to inorganic procedures, but Spence and Streeton have recently described a micro-rotary extractor and have used it for the extraction of uranyl nitrate from aqueous solution. The extractor consists of a glass column with a coaxial cylinder inside. The inner cylinder rotates so that when two liquids pass through the annular space in counter current flow, vor-

tices are set up in the continuous phase and, when the rate of rotation of the inner cylinder is sufficiently great, the disperse phase is broken up into small droplets. These are carried into the vortices which then appear to form symmetrical pairs, the individual members of which rotate in opposite directions. The lighter liquid enters from the bottom of the column and collects at the top, while the heavier one enters at the top and is removed at the bottom of the extractor.

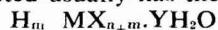
Commercial countercurrent extractors such as the *Podbielniak centrifugal apparatus* are available. This extractor works on the principle that the heavier liquid is fed in at the centre of the rotor and moves out under centrifugal force while the lighter liquid which is fed in at the perimeter is forced towards the centre. The liquids thus move in a countercurrent fashion and are intimately mixed in the contacting elements of the rotor. Quiet zones at the centre and the perimeter permit clarification of the streams leaving the rotor.

Inorganic Complexes and Organo-Metallic Salts

It is well known that hydrated inorganic ions are more soluble in water than in non-miscible organic solvents such as carbon tetrachloride or benzene, while organic compounds are more soluble in these same solvents, unless hydrophylic groups such as hydroxyl or sulphonic acid are present. Each hydrated inorganic ion may be regarded as surrounded by a shell of water molecules. The thickness and arrangement of these water molecules depends on the ion itself and on other solution factors. In the solution there are then large aggregates of water molecules gathered around the cations and anions of the salt. These aggregates disperse the attractive forces between the ions of opposite charge and discourage their association, thus favouring the solution of the salt in water. The characteristic features of solutions of inorganic salts in non-miscible organic solvents are that the molecules are generally un-ionised and that the water aggregates are cut down to a few molecules of water of hydration or are entirely absent.

The features which favour extraction of an inorganic compound into an immiscible organic solvent are therefore those which tend to break up the water aggregates and which favour association of the cations and anions. One obvious method is to combine

the cation with an organic reagent which forms chelate rings with the metal, satisfying the ionic bonding and co-ordination requirements of the ion, so that an uncharged, undissociated hydrophobic molecule is formed. This type of extraction will be discussed later (i.e. extraction of metals as their chelate compounds). The formation of associated inorganic complexes also favours extraction into organic solvents. This is particularly marked with the ether/metal halide/halogen acid system. The compound extracted usually has the composition



Applications of the Method

Extraction of Iron.—The metal halide most frequently extracted into ether is undoubtedly ferric chloride. Ferric chloride was first extracted by Rothe 1892. The extraction is fairly efficient for large amounts of ferric chloride, but the efficiency decreases with increasing dilution. Thus for 1 mg. amounts, only 80 per cent is removed in one operation. Nevertheless, it is very useful for removing large amounts of iron.

There are several disadvantages to the method: the heat of transfer is considerable and this combined with the high volatility and the inflammable nature of diethyl ether makes the operation unpleasant; the volume of the aqueous phase may increase by as much as 25 per cent owing to the solubility of the ether in the aqueous phase; chloride ion concentration is very critical and hydrochloric acid is unfortunately appreciably soluble in ether, so that the latter has to be pre-saturated with HCl gas; impurities usually present in the ether cause reduction of the ferric iron to the ferrous state, in which form it is not extracted; and the ether layer is less dense than the aqueous phase.

Consideration of these unpleasant features led Dodson, Forney and Swift to examine di-*iso*-propyl ether as an alternative solvent. It has the advantage of being less volatile and less inflammable than diethyl ether and also it is more efficient. The chloride ion concentration is less critical than for the conventional solvent, and the solvent is less miscible with the aqueous phase. Axelrod and Swift subsequently proposed $\beta\beta'$ -dichlorodiethyl ether as extracting solvent on the grounds that it was even less miscible, and was more dense than the aqueous phase. The acid concentration is not nearly so critical as with the first two solvents and the

heat effect is not so marked, but the extraction is generally thought to be less efficient and less rapid than in the previous methods.

Wells and Hunter proposed amyl acetate as a solvent for the extraction of ferric iron from concentrated hydrochloric acid solution, claiming that it is superior to the ethers. One extraction removes 99.6 per cent of the iron from the aqueous phase and addition of concentrated sulphuric or phosphoric acid further increases the percentage extracted. The heat of transference is negligible, the vapour pressure is low, and the flash point is fairly high so that even though the organic phase is less dense than the raffinate, the solvent is more efficient and more pleasant to use than diethyl ether. The extraction is very rapid.

An Advance on Ethers

This solvent is undoubtedly an advance on the ethers. Amyl acetate removes large amounts of molybdenum, tin and moderate amounts of vanadium (V). Diethyl ether extracts large amounts of Sb, As (III), Au, Mo (V), Ti (III) and Ge and moderate amounts of Sn (II) and Sn (IV).

The latest development in the extraction of iron from aqueous solution has been the work of Aven and Freiser who used tri-*n*-butyl phosphate to extract the ferric thiocyanate complex. Co, Cu, Cr and Zn are removed simultaneously, whereas the metals removed by the ether solvents and amyl acetate, i.e. Mo, Sb, U, Sn, etc., are not extracted. The optimum conditions for extraction of the iron require that the thiocyanate/iron ratio should be not less than 6, the temperature less than 25° and the pH not less than 1.

The chief advantages of the TBP method are: rapid extraction; no observable heat of transfer; no discernible change of phase volume; percentage extraction unaffected by iron concentration; and low volatility. The disadvantages are briefly: the inflammable nature of TBP; the fact that it is less dense than the aqueous phase; and the high pH requirements.

Aven and Freiser overcame the disadvantage of low density by using a 50 per cent solution of the TBP in carbon tetrachloride. This was more dense than the aqueous layer and removed 95 per cent of the iron in one operation at pH 2. The TBP alone extracted 97.4 per cent. The method was applied to the determination of aluminium in steel. TBP introduced appreciable

amounts of phosphate into the aqueous phase. Tri-*n*-butyl phosphate has been used in several solvent extraction methods in the US where it is a relatively cheap solvent.

Antimony.—Mylius and Huttner first showed that a fractional separation of tri- and pentavalent antimony could be achieved by extraction of the latter from hydrochloric acid into diethyl ether. Eighty-five per cent of the pentavalent antimony entered the organic phase accompanied by 6 per cent of the trivalent form. Edwards and Voigt used di-*iso*-propyl ether to obtain a more favourable extraction over a wider range of acid concentrations. The removal of the pentavalent form is complete in a matter of seconds, although a very small amount of it is reduced in the process and remains in the aqueous phase as the trivalent form. The small amount of trivalent antimony accompanying the pentavalent form into the organic layer may be virtually completely removed by one back extraction using more dilute hydrochloric acid without any loss of the high valency form.

Extraction with Benzene

West and Hamilton have used the solubility of antimony tri-iodide in benzene in a spot-test procedure to separate it from other metals. The extraction takes place from sulphuric acid solution. Kitahara has shown that trivalent antimony is completely extracted from 7N hydriodic acid by diethyl ether. Cadmium, mercury (II) and tin (II) are also completely extracted. Bismuth is extracted by about 34 per cent. An ether to water ratio of 4:1 is referred to, but it is not clear whether this represents one extraction, or, more probably, four extractions with an equal volume of ether. The latest development on the extraction of antimony is due to White and Rose. These authors used ethyl acetate to extract antimonic chloride from hydrochloric acid.

The procedure appears to be inferior to that of Edwards and Voigt however. Several extractions are necessary to ensure complete removal. Irving and Rossotti have recently examined the ether extraction of the group III halides and in reporting on a method for the extraction of indium from hydriodic acid solution, they comment that less than 50 per cent extraction of antimony (III) occurs under the conditions most favourable to the indium extraction. Cadmium and tin (II) are still completely removed at this acidity.

Arsenic.—No papers appear to have been published on the solvent extraction of the arsenic halides although numerous reports of arsenic extraction as an organo-metallic chelate are available. It is known, however, that in *ca.* 6*N* hydrochloric acid, diethyl ether will remove about 68 per cent of the trivalent form and 2-4 per cent of the pentavalent. This is in contrast to the behaviour of the antimony where the higher valency form is preferentially extracted. Neither Edwards and Voigt nor Dodson, Forney and Swift comment on the extraction of arsenic by di-*iso*-propyl ether. An abstract of a paper by Kitahara on the solvent extraction of fluorides reveals that from this medium diethyl ether will remove 62 per cent arsenic and only 0.4 per cent of antimony.

Chromium.—Weinhardt and Hixson have reported on the separation of chromium and vanadium salts by extraction into methyl *iso*-butyl ketone. The chromium is preferentially extracted from a mixture of sodium dichromate and sodium vanadate in hydrochloric acid medium to such an extent that a separation factor of *ca.* 4,000 may be obtained at low acid concentrations in the temperature region 0-25°. The dichromate may be stripped from the organic phase by washing the extract with three lots of distilled water. This selective extraction is taken to show that the solvent has considerable promise for industrial application, since solutions of chromium and vanadium are obtained in dealing with chromite, and chrome-bearing ores.

Removal as Perchromic Acid

Foster has shown that ethyl acetate may be used as a solvent for the extraction of chromium from vanadium products. The chromium is extracted as the blue perchromic acid which is readily formed by the action of hydrogen peroxide on chromate in solution. A single extraction at *pH* 1 removes 80 per cent of the chromium while at *pH* 2, 95 per cent is removed. At *pH* 4, on the other hand, only 30 per cent is extracted.

Brookshier and Freund established that three operations gave complete removal of chromium from aqueous solutions in the range 0.00015-0.0015 *M* and they comment that the initial chromium concentration has little effect on the per cent extraction. The stability of the perchromic acid alters mark-

edly with temperature. Below 10° it is reasonably stable and 100 per cent recovery may be obtained, but above this temperature low and erratic results occur. The acid is actually much more stable in the ester layer than in aqueous solution. Iron, mercury, vanadium, titanium, nickel and molybdenum do not interfere to any marked extent.

Considerably less information is available on the possibility of separating the two metals by solvent extracting the vanadium, but Hillebrand and Lundell point out that although only a trace of quadrivalent vanadium is extracted from hydrochloric acid by diethyl ether, a considerable amount is removed in the pentavalent form.

Optimum Conditions

Dodson, Forney and Swift reported 22 per cent extraction of the pentavalent form by di-*iso*-propyl ether under the optimum conditions for ferric chloride. Subsequently, Lingane and Meites showed that the optimum conditions were obtained in 7.5*M* acid at as low a temperature as possible. The equilibrium shifts in favour of the ether phase with increase of vanadium concentration. Vanadium may also be separated from chromium by extraction of the molybdo-vanadophosphoric acid complex with 3-methyl-1-butanol or ethyl ether, or a mixture of 1-butanol and ether or butyl acetate, butanol and ether.

Lead & Bismuth.—Mention has already been made of the extraction of indium, cadmium, tin and antimony (III) by diethyl ether from iodide solution. Two other elements which have been extracted as iodides are lead and bismuth. In this connection, West and his co-workers have used methyl *iso*-propyl ketone and methyl-*iso*-butyl ketone respectively as solvents. Metals which are at least partially extracted as iodides by the first solvent are bismuth, mercury, iron, lead, copper, palladium, cadmium, rhodium, ruthenium, and gold. A preliminary extraction of the solution containing these ions, thiocyanate, and hydrochloric acid removes most of the interferences so that only lead, cadmium and ruthenium are extracted by a second lot of solvent after addition of potassium iodide. The extraction of lead iodide is incomplete from neutral solution but is quantitative from 5 per cent *v/v* hydrochloric acid.

Bismuth can be extracted similarly by methyl *iso*-butyl ketone from solutions

containing an excess of potassium iodide. This last procedure has not been used in a quantitative procedure but only as the basis of a spot-test for bismuth.

Tantalum & Niobium.—The separation of tantalum and niobium by chromatographic methods has recently been reported, and more recently attempts have been made to achieve the same separation by a liquid-liquid extraction method. Milner and Wood have reported the extraction of tantalum and niobium into certain polar solvents from aqueous solutions containing hydrofluoric and hydrochloric acid. More recently the problem has been taken up by Stevenson Hicks. Using di-*iso*-propyl ketone, they found tantalum to extract more readily than niobium. In addition to the HCl/HF system they studied those where HNO₃, H₂SO₄, and HClO₄ replaced HCl. The H₂SO₄/HF system offers the most nearly specific separation and purification of tantalum and niobium. When the H₂SO₄ is 5-6M, complete extraction of the tantalum is obtained, but the best separation of tantalum from niobium is achieved from HNO₃/HF. When the aqueous phase is 6M in H₂SO₄ and 9M in HF, 90 per cent of the niobium is extracted. This recovery falls to 40 per cent from 3M H₂SO₄ and 4.5M HF. Only iodine, chlorine, bromine, selenium (VI), tellurium (V), arsenic (III), antimony (V) and iron are extracted. Si (IV), Sn (IV), Ti (IV), Mn (II), Zn (IV) and Hf (IV) do not extract although these elements usually occur with niobium and tantalum.

Much Superior Method

However, what claims to be a much superior separation method is that of Leddicotte and Moore. These authors report that niobium may be virtually quantitatively removed from a strong hydrochloric acid solution by means of a solution of methyl-diocetylamine in xylene. Under the same conditions the extraction of tantalum appears to be negligible.

The niobium may be stripped from the organic phase after separation from the raffinate by re-extraction with dilute hydrochloric acid, nitric acid or sulphuric acid. From 8N hydrochloric acid 99.3 per cent of niobium is removed by the extraction with only *ca.* 1 per cent of the tantalum. An interesting feature is that niobium does not extract from nitric acid up to 10.6M or even from 12M sulphuric acid. Tantalum does

not extract from up to 10.6M, HNO₃, but is perceptibly extracted from dilute sulphuric acid. The strongest solutions extracted in Leddicotte and Moore's experiments contained 1 mg. per ml. of the metals.

Cobalt.—The solvent extraction of cobalt as its thiocyanate complex is fairly well known. The metals which extract simultaneously are iron, nickel, zinc and copper. The procedure has been used mainly for the colorimetric determination of cobalt. Bayliss and Pickering indicate that the interference due to iron may be minimised by using a mixed amyl alcohol/ether solvent since the inclusion of the ether minimises the extraction of the ferric thiocyanate. The addition of ammonium citrate completely prevents interference from ferric thiocyanate and simultaneously adjusts the pH to the most favourable value. Nickel, copper and zinc are still extracted but these metals do not interfere with the Nitroso R Salt method for cobalt. The cobalt can be stripped from the extract by 2M ammonium hydroxide. At pH 3.5, 86 per cent of the cobalt is removed by the first extraction. Three extractions give 99.7 per cent removal.

Use of Polar Solvents

A different line of attack has been used by Garwin and Hixson who made use of the solubility of cobaltous chloride in organic solvents having polar functional groups containing oxygen. The solubility of anhydrous cobalt in these solvents is thought to be due to the presence of a hydroxyl group in the alcohols or a potential hydroxyl group in ketones and esters.

It is noteworthy that ethers do not extract the Co. The solubility is higher in alcohols than in ketones. Garwin and Hixson proposed a method for the separation of cobalt from nickel on a commercial scale by extraction of the former into capryl alcohol. Separation factors of 40-90 and 10-17 were obtained in the presence of hydrochloric acid and calcium chloride respectively. The method is, however, not likely to be important analytically, since extraction does not become appreciable unless the cobalt solution is well nigh saturated. Considerable evidence is brought forward to suggest that it is the blue anhydrous cobaltous chloride which is extracted. The saturated solution would, of course, favour the breaking down of the ionic aggregates and hence favour the extraction.

Increase in Works Infractions

But Act's Penal Clauses Not Invoked Say Alkali Inspectors

ALTHOUGH the number of infractions by chemical manufacturers during the past year have been substantially greater than usual, formal notification to the owners of the works concerned has resulted in remedial steps being taken, and it has not been necessary to invoke the penal clauses of the Act, says the 90th Annual Report on Alkali, etc., Works by the Chief Inspectors (HMSO, 2s. 6d. net).

The report records that a large number of complaints relating to noxious or offensive emissions had been investigated jointly with the public health authorities. Escapes from alkali, sulphuric acid (chamber and concentration processes) and muriatic acid works were limited to maximum concentrations as specified in the Act. There had been 37 occasions when excessive concentrations had been recorded. Two infractions related to small processes which were found to be operating without registration. Fifty-seven other infractions related to scheduled works where the requirement was that the best practicable means should be provided and used efficiently so that offensive gases were either eliminated or rendered harmless and inoffensive.

No Well-defined Line

In the latter cases, there was no well-defined line between legitimate and illegitimate operation and a decision as to whether the conditions constituted an infraction rested with the district inspector and finally with the chief inspector.

A total of 141 complaints or requests for technical advice and assistance had been received. Many of these had come through the local authorities; others were received directly from aggrieved persons and some were brought to the Minister's attention by Members of Parliament. All had received or were receiving attention. Sixty-three cases had related to registered or registrable processes, 66 to non-registrable processes and 12 to spoilbanks.

Recovery from the 1952 recession, first noted towards the end of that year, had been steadily if not spectacularly maintained during 1953.

Demand for sulphuric acid, nitric acid dyestuffs, pharmaceuticals, chlorine, nylon

and other commodities, the report states, has been in excess of supply and many further expansions and developments are planned.

Superphosphates sales, however, were probably lower than in 1952. It seemed, the report points out, that farmers were now buying fertilisers only as and when they were required for immediate application rather than holding supplies in their own stores. As a result superphosphate storages were uncomfortably full at the end of the year, but the probability was that these stocks would be rapidly cleared during the next sowing season. Commissioning during the year of two major oil refineries and large extensions at others had resulted in a great increase in the output of petroleum products.

950 Works Registered

The report records that the number of works registered under the Act in 1953 was 950 involving the operation of 1,775 separate processes. Compared with 1952, there were decreases of 14 in the number of works and of 10 in the number of separate processes. Visits and inspections totalled 3,936, including 191 special visits by the chief inspector (Mr. W. A. Damon) or by his deputy (Dr. J. S. Carter). Of these visits, 376 were to or in connection with works not registered under the Alkali Act and a further 106 visits were to or in connection with spoilbanks. During the inspections, 1,950 quantitative analyses were made of gases evolved from the processes in operation, and in addition, 205 special samples were drawn and submitted for detailed examination to the Government Chemist, whose services were gratefully acknowledged.

Regret is expressed at the retirement on superannuation in November of Mr. H. G. Howson, who had carried out the duties of inspection under the Alkali Act for nearly 26 years with headquarters in Liverpool. Two new appointments had been made. These were Mr. F. E. Ireland, who had had eighteen years' experience in production, research and development of organic and inorganic chemicals, and Mr. H. Brigg, who had had five years' experience in teaching chemistry and physics and 13 years in chemical industry. With an increased establish-

ment of seven inspectors, it had been possible to adjust the boundaries to make seven instead of the former six districts. Some transfers had also been effected. Mr. L. M. Mullinger had taken charge of District II (Liverpool), and Mr. G. Tiplady had replaced Mr. Mullinger in District VI (London). Mr. F. E. Ireland had been put in charge of District III (Sheffield) in place of Mr. Tiplady, and Mr. Brigg had been given the care of the new District VII with headquarters in Manchester.

Battersea Power Station Visits

Visits in connection with processes not registrable under the Alkali Act (exclusive of those to spoilbanks) were 376, and detailed reports had been submitted to the Minister and, where a local authority had been concerned, it had also been kept informed. In this field three visits had been paid to Battersea Power Station for the purpose of assessing the extent and efficiency of gas washing as practised there for the removal of sulphur oxides from the boiler waste gases. Spot tests were made on each occasion and the laboratory records examined so as to enable assessments to be made relating to the period that had elapsed since the previous visit. The report reveals that the sulphur contained in 823,000 tons of coal was 7,660 tons. Approximately 3,120 tons of this were retained in the ash and by the washing process. The remainder, 4,540 tons, escaped to atmosphere in the form of oxides of sulphur, and for the most part in very dilute concentration.

Great activity in the building of new coke ovens and the replacement of old ones by modern batteries is also referred to in the report.

Processes for the production of selective weed killers by reaction of chlorinated phenols and cresols with chlorinated aliphatic acids had given rise to complaint in the past, but, however, there had been no complaint in 1953, a tribute to the degree of supervision given to the conduct of operations.

Much thought had been given during the second half of the year to the emission of selenium and its compounds (chiefly selenium dioxide) from certain works, on which advice had been sought by the local authority. Selenium was used in the manufacture of rectifiers by processes which are highly secret. Complaint was occasioned by damage to garden produce on neighbouring allotments. Whether this was caused in the

first place by selenium emissions or by nitric fumes evolved during the cleaning of small pieces of equipment with nitric acid it was not clear, as when advice was asked the Medical Officer had already made a survey and had established from samples taken in the area that there was significant contamination of both soil and vegetable produce with selenium up to at least 300 yards from the source of emissions. Information regarding toxicity of selenium was somewhat contradictory, but limits for selenium concentrations proposed by USA investigators were 0.5 part per million in soil and 4.0 to 5.0 parts per million in foodstuffs; the threshold of safety for daily ingestion by man was suggested to be of the order of 7.5 to 15.0 mg. and it was concluded that since respiratory absorption was usually more effective, the atmospheric concentration of selenium should be kept below 1 mg. per cu. metre. These were all very low concentrations and difficult of attainment. Meanwhile, the only safe procedure was to accept the limits set by the USA investigators. Soil and vegetable samples had been taken jointly and independently by the company and the Medical Officer and selenium contents determined separately by independent analysts. To remove doubt, the company was in process of installing a 'trace elements laboratory' remote from the works and any source of accidental contamination. By and large, it was unsafe to say more than that while the position was one to be regarded seriously, panic measures, such as stopping production at the works, were unnecessary. Inquiry by the Medical Officer from local practitioners had failed to reveal symptoms of selenium poisoning among patients treated by them.

Paintwork Discoloured

At an industrial village in the North Midlands outside paintwork had been discoloured, being worse alongside the adjacent stream and gradually decreasing in intensity to the opposite end of the village about a mile away. It had been diagnosed as due to the blackening of lead-base paints by traces of hydrogen sulphide in the air. More recent reports suggested that some iron oxide, etc., dust in the air might be settling on the paint surface and become converted to iron sulphide. As a result of low rainfall for many months practically all the water flowing in the stream had been used for industrial processes and warm effluent had

been released into an almost empty bed. Effluent from a coke oven by-product plant was put into the stream, first as raw ammoniacal liquor and later as spent liquor. An unsatisfactory discharge from a sewage farm had added to the difficulties and all circumstances had combined to produce a warm stream with conditions favourable for putrefaction and liberation of hydrogen sulphide.

Saltcake Process

The report reveals that there were 15 alkali works registered because of decomposition of common salt or, to a much less extent, of potassium chloride. A total of 57,700 tons of salt were used in the saltcake process compared with 55,600 tons in 1952, 61,000 tons in 1951, and 73,000 tons in 1950. These figures included a small amount of potassium chloride. Two works were jointly responsible for 28,000 tons of the 1953 total. In calculating the efficiency of condensation of the hydrogen chloride produced, allowance was made for the purity of the salt used and the amount of undecomposed salt remaining in the saltcake. The figure was, moreover, a weighted, not a simple arithmetical average, allowance for differing throughputs being made in the calculations. The figure, 97.9 per cent, compared with 96.8 per cent in 1952. Tests made by district inspectors throughout the year showed an average escape from the absorbers of 0.097 grain HCl per cu. ft., compared with a figure of 0.080 in 1952. Eleven infractions were recorded, eight relating to the provision of the Act that the escape shall not contain more than 0.2 grain HCl per cu. ft., and three to the 'best practicable means' sections 7 and 27 in that the final gases escaping to air were contaminated with chlorine.

Statistics supplied by the National Sulphuric Acid Association Ltd. showed that production by both the chamber and contact processes had increased by 331,000 tons over the 1952 figure, the total of 1,683,000 tons being the highest figure yet recorded. While the increase in the amount of brimstone sulphur burned was slight in comparison with 1952, that of spent oxide was substantial and that of pyrites had been almost doubled.

There had been occasions when it had been found necessary to draw attention to the need for better maintenance of plant—in one instance the matter was considered

serious enough to be regarded as an infraction—but on the whole plants had been well maintained in a good state of repair. Much overhaul and rebuilding could be recorded.

Average of all tests made by the alkali inspectors on exit gases during the year showed an acidity of 1.90 grains per cu. ft. calculated as sulphur trioxide. This was the highest figure since 1948, the increase being due almost entirely to the effect of the high tests recorded consequent on disorganisation at one works. The number of infractions, when escapes were found to be in excess of the statutory limit of 4.0 grains per cu. ft., was 15 compared with six in 1952, no less than six being debited to this same works. Last year, however, plants were for the most part working below capacity and were therefore not so liable to get out of hand.

New Units for Sulphuric Acid

Considerable increase was shown in the amount of sulphuric acid made by the contact process, most of it being due to the coming into operation of new units based on the flash roasting of pyrites. Other new units were completing and a number of units for the production of acid from anhydrite were under construction. An extremely interesting plant was under construction at one oil refinery which would derive its sulphur from a Girbotol process and from acid sludge produced in petroleum, etc., refining.

Some apprehension was felt in the industry on account of the increasing bitumen content of the sulphur available for acid making. Blockages of hot gas filters and an increase in the mistiness of the final escapes were forecast.

There had been eleven occasions when the escapes failed to satisfy the standards set, that for brimstone-burning units the escape to air shall not exceed the equivalent of 2 per cent on the sulphur burned in the case of a four-stage system, 3 per cent in the case of a three-stage system, and 5 per cent in the case of a two-stage system, or the new standard for the modern four-stage pyrites-burning units, an escape not exceeding 4 per cent on sulphur burned subject to an overriding maximum of 4 grains as sulphur trioxide per cu. ft.

At one four-stage brimstone-burning unit plant there were two infractions when the escapes were 2.3 per cent and 2.5 per cent. In the first instance, scale on the waste heat

boiler had lessened the cooling of the gases so that they entered the first stage convertor at too high a temperature. The second was due to a slip of sulphur dioxide through the absorber. At a three-stage brimstone burning unit the escape was 4.3 per cent due to temporary failure of a sulphur pump. At a four-stage brimstone burning unit deterioration of the catalyst was responsible for an escape of 2.6 per cent.

A new acid plant commissioned during the year operated satisfactorily until attempts were made to produce high strengths of oleum when dense emissions of sulphur trioxide or acid mist occurred. It had been found possible to obtain a practically invisible exit with a total acidity of about $2\frac{1}{2}$ grains (as SO_3) per cu. ft. if the gases from the absorbers were scrubbed in a tower packed with Raschig rings and irrigated with acid of about 30 per cent strength. In these circumstances there was a substantial recovery of acid. The precise implications of the technique were not fully understood and the matter would be followed up.

Superphosphate Process Infractions

The report says there were again nine infractions in superphosphate processes and the average escape to air from all plants, 0.120 grain per cu. ft. calculated as sulphur trioxide, although not excessive by comparison with other registered processes, remained almost twice what it should be. The standards set were high, but attainable. At one works the infraction related to an unduly high escape following an alteration in the rate of exhausting gas through the scrubbers. The provision of additional water sprays restored conditions to a reasonably satisfactory degree of efficiency.

A high test on another occasion was a direct result of the collapse of a waste gas flue which reduced scrubbing capacity to half the usual amount. As repair had been begun and as the escape was of but short duration no further action was taken. At another works the infraction resulted from overloading plus too infrequent cleaning of the scrubbers. Satisfactory conditions had been maintained since the scrubbers were thoroughly cleaned and slightly larger sprays provided. The problem at another works, against which three infractions had been recorded, was more fundamental. Two infractions related to a den provided with the conventional wooden scrubbers. The

first resulted from failure of a booster pump to ensure adequate pressure at the water sprays and the second was due to general deterioration of the gas scrubbing system. Conditions were now satisfactory. The fundamental problem, here, however, related to the application of an eductor absorber.

Evolution of Sulphur Dioxide

The system had much to commend it. Tests made during the year had, however, shown that acidities of the gases escaping were, as in 1952, far higher than was considered satisfactory. Despite attention no further reduction could be maintained. Determination of the constituents of the escaping gases revealed that most of the acidity was due to sulphur dioxide, the scrubbing efficiency as regarded silicon tetrafluoride, etc., being very high. The source of sulphur dioxide was at first thought to be the presence of this as an impurity in the acid used. Tests carried out both at this works and at two other works indicated that for reasons not yet clearly established, sulphur dioxide was produced when certain phosphate rocks were treated with sulphuric acid. This matter was being followed up and would receive comment in next year's report. Three further units for the production of phosphoric acid from rock phosphate came into operation during the year.

Of seven infractions at muriatic acid works, two related to operations at fibre separation or wool carbonising works, an industry confined to the West Riding of Yorkshire.

The number of sulphate and muriate of ammonia works showed a further decrease, 92 compared with 95 last year, and 641 in the peak year, 1916.

The report revealed that a common problem in connection with carbon bisulphide manufacture related to the amount of sulphur dioxide emitted from retort mouths during charging. After a great deal of effort and experiment there were now reasonable hopes of a solution. Success depended on the development of a suitable charcoal charging valve and while a completely satisfactory type had yet to be developed, types at present being installed represented a considerable degree of progress. The bulk of the pioneer work had been done at one very large works, where many retorts were now so fitted and completion expected by mid-1954.

New Company Has Ancient Ancestry

Chairman Outlines History of Griffin & George

AT a luncheon in London on 15 July, to mark the amalgamation of Griffin & Tatlock Ltd., W. & J. George & Becker Ltd., and Standley Belcher & Mason Ltd., the chairman of the new company, Mr. R. McKinnon Wood, O.B.E., described the ancestry of Griffin & George Ltd. He said:

'We date our history back to a curious title "Griffin's Chemical Museum," which came into being in the year 1826. The firm of Richard Griffin & Co. were publishers and booksellers for the Griffin Chemical Museum and the younger son, John Joseph Griffin, wrote some very popular books on science, the most notable having the curious title "Chemical Recreations" . . .

'Many good things come from the northern part of this island, and this was no exception. This John Joseph Griffin was a man of some note in his day, to such an extent that George Smith when he was compiling the Dictionary of National Biography found that John Joseph Griffin was one of the 30,000 names to be included in that Dictionary. He was known not only in this country but on the continent, and was quite a notable figure in his time. In 1848 he left Glasgow and established himself in London, and in fact there are a number of occasions in this firm of Griffin's which show Scotsmen following the advice of that great lexicographer Johnson in marching from Scotland down to London.

'John Joseph Griffin died at the ripe age

of 76 and left the business of J. J. Griffin & Sons to his sons Charles and John, who carried it on for some time, and towards the end of the century we find it incorporated as J. J. Griffin & Sons Ltd., and as I first knew it, it was being managed by John Joseph's grandson, J. Ross Griffin, a friend of my father, married to a relation of my father, and a familiar figure of my boyhood.

'After a century precisely, we found Griffin's re-establishing their connection with Glasgow. In 1881 John Tatlock went into partnership with Hugh Baird and founded the firm of Baird & Tatlock. After some fifteen years the two partners split and Hugh Baird established himself in London as Baird & Tatlock (London) and John Tatlock remained in Glasgow as Baird & Tatlock (Glasgow), and in 1926 there was a marriage between J. J. Griffin & Sons and Baird & Tatlock (Glasgow) and the march of another Scotsman to London.

'Now, quite honestly, George & Becker cannot claim quite the ancient ancestry of Griffin & Tatlock. They do not quite go back to 1826, but back to 1872, when there was a firm of F. E. Becker & Co. trading in London, and this firm of Becker was acquired by W. & J. George Ltd., of Birmingham, and comparatively recently became known and traded as W. & J. George & Becker Ltd. They did not appear in the Dictionary of National Biography, but theirs is a very respectable ancestry. . . .



Talking together before the luncheon. left to right: Mr. R. H. Powell, Mr. H. R. Bettinson and Mr. R. McKinnon Wood

'We want to know what new things our customers want. We want to be in a position to spend money on research and development, and this is very expensive, and has to be spread over a big volume of production and trade not to be very expensive. And so I think we can say that it will be greatly to the benefit of the proprietors, the employees and the customers that we shall have this amalgamation to enable us to spread our overheads.'

The board of Griffin & George Ltd. is as follows: R. McKinnon Wood (chairman); H. R. Bettinson (vice-chairman); N. McKinnon Wood (managing director); N. H. G. Trepte (assistant managing); A. E. Lambert; R. H. Powell (technical director); F. H. Agar; H. C. Mayer (secretary); Mrs. J. D. Lacon; and P. St. V. Taberner. The registered offices are at Kemble Street, Kingsway, London, W.C.2.

First UK Iso-Pentane

To Provide Aviation Gasoline

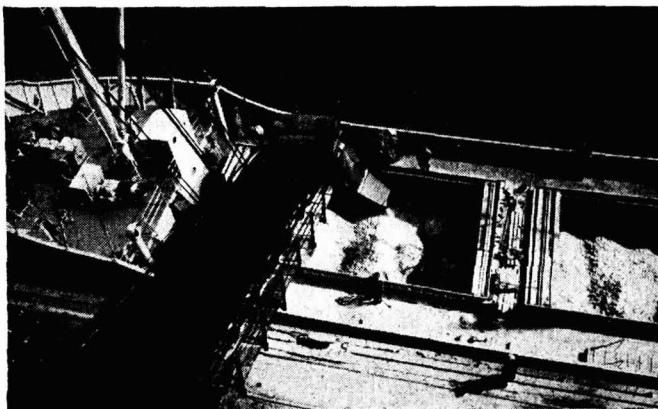
NOW under construction at Stanlow oil refinery, Cheshire, is the first plant to be built in the UK for the production of *iso*-pentane, which is an important constituent of aviation gasoline. One of the columns, believed to be the tallest of its kind in the world, will be 200 ft. high. The main contractor carrying out the work for Shell is Head Wrightson Ltd.—and the unit is scheduled for completion early in 1955.

Debutanised light platformate will be led through a steam preheater to the depen-

taniser—an 86 ft. column containing conventional bubble-cap trays—where the pentanes will be removed as a top product. The bottom stream—depentanised light platformate—will be run down to aviation component storage. The *de-iso*-pentaniser—a 200 ft. column containing 140 Turbo-grid trays—will receive two streams (the pentane fraction and debutanised straight-run gasoline), and produce *iso*-pentane as the overhead stream. The bottom product, consisting of the *de-iso*-pentanised straight-run gasoline plus the normal pentanes from the platformate, will be blended into motor spirit. A sphere is being provided for storage of *iso*-pentane.

Aviation gasoline, which must function efficiently in varying climatic conditions, is a blend of highly specialised components of different characteristics and the *iso*-pentane from the new plant will replace similar material which has hitherto had to be imported for blending up into finished aviation gasoline in the UK. In this respect the new unit is complementary to the platformer at Stanlow which came into operation last year and by means of which certain gasoline fractions are converted into other valuable aviation blending components.

Expected to cost nearly £500,000, the new plant will contribute substantially to the versatility of the refining system at Stanlow, already one of the most comprehensive refining complexes in the world. With an output of nearly 5,000,000 tons a year of various oil products Stanlow is the largest of the four Shell refineries in the UK whose combined annual capacity totals 11,000,000 tons.



On her maiden overseas voyage the Swedish MV Ingrid was specially chartered to carry 750 metric tons of sodium silicate in bulk manufactured by Joseph Crosfield & Sons Ltd. This consignment exceeded by more than 100 tons the previous largest silicate shipment from the UK



FORSCHUNGSBERICHTE DES WIRTSCHAFTS- UND VERKEHRSMINISTERIUMS NORDRHEIN WESTFALEN No. 58. HERSTELLUNG UND UNTERSUCHUNG VON STEINKOHLENSCHWELTEER. By the Gesellschaft für Kohlentechnik mbH, Dortmund. Westdeutscher Verlag, Cologne. 1953. Pp. 63. DM. 13.75.

Research into low temperature carbonisation has recently been stimulated by the fact that this process can be applied to coals which are not suitable for treatment by the usual high temperature method. However, in spite of the value of the coke produced by low temperature carbonisation as a smokeless fuel, this process has not proved economical in Germany. Research has therefore been directed towards a more profitable utilisation of the tar, and this government publication reports experiments on its detailed analysis by distillation and other methods. The book also includes descriptions of the various types of plant used for low temperature carbonisation and gives a brief history of the process.—J.C.P.S.

ORGANIC COATING TECHNOLOGY. VOL. 1. By H. F. Payne. John Wiley & Sons Inc., New York; Chapman & Hall Ltd., London. 1954. Pp. 674. 80s.

This is the second large treatise upon the subject of protective coatings to be published in the first half of this year, a certain indication of the growing importance of coating technology. A companion volume to that under review is to be published later, and together they will constitute an outline of the theory and practice of organic coatings. Although intended for the student and the fresh recruit to industry almost no historical introduction has been included and on the whole the author is to be applauded for his decision to discard all information not of immediate practical interest.

Scattered throughout the book at the beginning of each chapter, like the aphorisms printed upon commercial calendars, are

passages which the author is pleased to call 'random thoughts,' the tone of these passages being set by the extraordinary dedication on the title page. The object of these homilies, whose occurrence must be unique in a scientific textbook, is apparently to remind those struggling only with the temporal demon corrosion that there are also spiritual conflicts to be resolved. These thoughts are marked by an extravagance of language, banality of theme, contempt for the normally accepted rules of grammar and a total irrelevance to the remainder of the text.

The text itself, however, is as precise, factual and reliable as the thoughts are vague, although it bristles with such unpleasant hybrid introductions to technical jargon as 'flexibiliser' and 'brushability.' Until the second volume is published it will be impossible to discover what gaps, if any, have been left in the outline; but if we may judge from the excellent coverage of the first volume, these will be small and unimportant. Many may hope to find in a book of this type a chapter discussing the subject from the user's point of view; a review of coatings selected from the point of view of their ability to protect specific materials under certain adverse conditions. This would be in effect a summary of the collected experience of the resistance of organic coatings and could be of the greatest value. Such a chapter does not appear in the present volume, but it is to be hoped that something of this kind may be included in the second volume.

The book opens with an account of the fundamental theory of film formation, both clear and pigmented layers being dealt with. A discussion of the relationship between molecular structure, dipole moment and the properties of organic films is included. There follows in the second chapter a description of those vegetable and marine oils which may be used in the production of protective coatings. The treatment here tends to be

rather theoretical in character, the structure of the oils being discussed in some detail without more than a mention of the methods by which these structures have been established. Thus, although fractional distillation is mentioned, chromatography and infra-red analysis are ignored. There are many specimen analyses of typical oils included in the text, and the methods of obtaining these analyses are given in the chapter entitled 'Test Methods' at the end of the book.

Other chapters are devoted to the subjects of varnishes, dryers, solvents, plasticisers and synthetic resins, each class of the last named being given a separate chapter. Throughout the text there appear typical analyses, tables of properties and formulations for specific coatings, so that it is possible to carry out a comprehensive programme of practical work in following the outline.

Less familiar topics such as the technique of resinography, the microscopical examination of sections of synthetic resins, are also covered in the treatment. Although many of the formulations are based solely upon American products, nevertheless this book will be of the greatest use to all those whose work is connected with the manufacture or application of organic coatings.—J.R.M.

THE PHYSICAL CHEMISTRY OF DYEING AND TANNING. Discussions of the Faraday Society No. 16, 1954. Aberdeen University Press Ltd. Pp. 225. 35s.

The Discussions of the Faraday Society are well known as a means of assessing the present position of a particular aspect of physical chemistry and for suggestions as to further lines of research and methods of attack. The present volume, consisting of papers and discussion at a recent meeting at Leeds, is no exception to this general rule. Following a general introduction by Sir Eric Rideal, in which many of the basic problems of dyeing and tanning are outlined, the papers deal with a wide variety of physico-chemical aspects.

About two-thirds of the papers are concerned with dyeing. Two are concerned with the kinetics of absorption, one dealing with acid absorption by wool, the other on absorption of water and aqueous solutes by dry viscose. The use of techniques utilising radioactive tracers is illustrated in two papers, one of which deals with the absorption of sodium sulphate and sulphuric acid

by human hair, and the other with the diffusion of a dye into keratin. Examples of the use of new methods are also given in papers dealing with the use of the film balance in the study of dyeing processes and the use of the Hartley-Robinson models as an aid to solution of some of the stereochemical problems in dyeing. The importance of developing methods of dyeing the newer synthetic fibres is reflected in papers dealing with the absorption of non-ionic dyes by polyethylene terephthalate, the dyeing of polyacrylonitrile fibres with anionic dyes and the dyeing of synthetic polypeptides. Papers on the mechanism of dyeing include contributions on aspects of the dyeing of cellulose acetate rayon, the combination of acids with keratin, calorimetric studies of the reaction of a dye with amino acids and diffusion into and out of fibres. Other papers are concerned with the absorption of dyes on crystals, solubility and activity of a dye and the selective absorption of optical antipodes by wool.

Papers on tanning deal with diffusion processes, the tanning of monolayers, the interaction of tanning materials with collagen, the hardening of gelatin, the reaction of basic chromium salts with hide protein, and the significance of mucoïd material in hides and skins in relation to tanning processes.

Not the least interesting parts of this volume are the discussions following the papers. These include comments on the effects of interrupting certain dyeing processes, the nature of the bonds between fibre and dye, and definitions of the term 'tanning.' While of primary interest to the research worker in the fields of dyeing and tanning, the chemist engaged in these two industries will find much to interest and stimulate in this volume.—W.R.M.

In a review of 'Lehrbuch der Organischen Chemie' by P. Karrer, published on 10 April (THE CHEMICAL AGE, 1954, 70, 843) under the initials J.C.P.S., it was stated that the structure of the trimer of glyoxal had been given incorrectly. Professor Karrer has drawn our attention to this statement, and our reviewer acknowledges his error, due to his confusing the structure of this compound with that of cis-naphthodioxane. Apologies are due, both to Professor Karrer and to any of our readers who were misled by this statement.

HOME

June Steel Production

Steel production in June averaged 371,700 tons a week, which represented an annual rate of 19,328,000 tons. This is the highest figure ever achieved for the month of June, although it is slightly below the May rate as the Whitsun holidays affected production in some areas. Pig iron production reached the highest rate ever achieved of 233,200 tons a week, compared with 231,400 tons in May.

Standard Microchemical Apparatus

Part G.1 of the BS. 1,428 series ('Microchemical apparatus') specifies heating and cooling blocks of aluminium or light alloy for use with microchemical combustion boats, crucibles, filter-crucibles, beakers and centrifuge tubes. Full dimensions are given for a Type 1 block without holes and a Type 2 block consisting of a base and four interchangeable tops with holes of varying diameter and depth. Glass covers are specified for both types and an Appendix recommends a lifting tool and mountings suitable for the Type 2 block. Copies of this new part may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1, price 2s. 6d.

New Plant for Oil Additives

The Distillers Co. Ltd. and the Oronite Chemical Company of San Francisco, USA, announce the formation of Orobis Ltd., a jointly owned company, now constructing a plant for the manufacture of lubricating oil additives at Hull. A complete range of lubricating oil additives, as manufactured by Oronite in the United States, will be manufactured and marketed by the new company. Facilities will include a fully equipped engine-testing and customer service laboratory.

Natural Gas Prospecting Licences

Five prospecting licences covering an area of 942 sq. miles in north-east Lincolnshire for drilling for natural gas have been granted to the D'Arcy Exploration Co. Ltd. on behalf of the Gas Council. Mr. Geoffrey Lloyd, Minister of Fuel and Power, told the Commons recently. Applications for six more licences were under consideration, he added.

New Agency Agreement

An agency agreement has recently been signed between the Engineering and Industrial Oil Processing Research Co. Ltd. and the Hamburg firm of Hermann Bauermeister. The agreement extends to the former company the sole representation for the UK and certain Commonwealth territories for the sale of vegetable oil milling equipment manufactured by this firm. Equipment involved consists of seed cleaners, seed crushing and flaking rollers, cake breakers, hammer mills and oil seed meal grinding and sifting equipment.

Practical X-ray Crystallography Course

A course in Practical X-Ray Crystallography is to be held at Battersea Polytechnic physics department beginning on Tuesday, 28 September. It will consist of lectures, demonstrations, and practical work and will occupy about 54 hours. The course is intended for graduates and others suitably qualified who require practical experience in X-ray crystallography. Application should be made to the head of the department, and enrolment, which may be made by post, should be made as soon as possible. The fee for the course is £2 5s.

Chemical Workers' Savings

One of the best industrial savings groups in Scotland is at the Ardeer factory of Imperial Chemical Industries Ltd., where more than £638,000 has been invested in National Savings since the group was formed in 1940. In addition, more than £4,000 is deposited weekly in the Ardeer branch of the I.C.I. Savings Bank.

Open Days at Teddington

An exhibition of the work in progress at the Chemical Research Laboratory, at Teddington, Middlesex, may be seen during a series of open days to be held there from 28 to 30 September. Applications from industrial firms for invitations to the following sessions, should be sent to the director not later than 31 August: Tuesday, 28 September, afternoon only, 2.30-5.30 p.m.; Wednesday, and Thursday, 29-30 September, morning, 10 a.m.-1 p.m., afternoon, 2.30-5.30 p.m. It is stated that firms already on the mailing list need not re-apply.

OVERSEAS

Explosions at US Factories

Ten persons were killed, and more than 30 injured, in a series of explosions at a fireworks and munitions plant at Chesterton, Maryland, on 16 July. On the same day, an explosion at a fireworks factory in a suburb of Chicago killed three and injured two.

Turkish Cement

Preparations are proceeding for the construction of a cement plant in Mugla province, Turkey, with a capital of £T5,000,000, of which £T1,250,000 will be subscribed by the public, and the balance by the Turkish Cement Industry Joint Stock Company. The plant will produce 250 tons a day.

Mombasa Refinery Plans

Mr. Arthur Hope-Jones, Kenya's Minister of Commerce and Industry, will be coming to Great Britain in the first week of August, and will discuss departmental matters with British firms. The most important of these is the future of the proposed refinery at Mombasa, which was projected by Royal Dutch/Shell after the Persian oil dispute, but which is at present in abeyance.

South African Phosphate

Production is expected to begin towards the end of the year at the plant of the Government-sponsored Phosphates Development Corporation (Foskor) at Phalaborwa in the Letaba district of the Transvaal.

Glass & Plastics Adhesives

Chlorosilane adhesives, which are being investigated at the US Naval Ordnance Factory at Silver Springs, Maryland, are said to act as strong bonding materials for glass and plastics. It is stated that the compounds, which are based on allyltrichlorosilane, have shown superior bonding strength to that of both epoxy, phenolic and polyester resins, under test conditions.

Zinc Production in US

Mine production of recoverable zinc from domestic mines in the United States in April decreased 5 per cent from the March output of 39,000 short tons. Total output for January-April was 157,200 tons or a monthly average of 39,300 tons, compared with 44,600-ton monthly average established in 1953.

Italian Mercury Exports

Exports of Italian mercury from January to the end of April showed a 200 per cent. increase over the same period in 1953. Supplies to the US for this period increased from 98.3 tons in 1953 to 602.5 tons this year, while British purchases went up from 99.6 tons to 240.8 tons. The expansion, which is expected to increase still further, is due to the utilisation of mercury in the production of atomic energy.

Manganese Mines Close in India

Sixty-three out of 200 manganese mines in Madhya Pradesh, India, have closed during the past five months, as a result of the appearance of Russia, Brazil and other countries in the international market.

Gypsum in Nova Scotia

The National Gypsum Co. of New York has announced that its \$6,000,000 development programme for new Nova Scotia gypsum deposits will be ready for full-scale quarrying operations next spring.

Esso Cut Refining Output

Esso Standard Oil Company, the largest refiner in the US, is planning to reduce the amount of crude oil it processes. The company is expected to cut back its refinery runs by 35,000 barrels a day.

Oil Prices Increased

Increases in crude oil purchasing prices in several of Alberta's oilfields are announced by Imperial Oil Ltd. The new prices represent an increase of one cent a barrel in the Acheson, Armisic, Golden Spike and Leduc fields, and an increase of 3½ cents in the Excelsior field.

Mining Company's 300th Birthday

Three thousand guests are to be entertained at festivities which the Norwegian mining company Lökken Verk are holding to celebrate the 300th anniversary of its creation. Lökken Verk operate Norway's biggest pyrites mines near Trondheim, where about 300,000 tons of pyrites a year are now mined. Some 300 of the 1,500 employees of the company who have completed 30 years' service are to receive jubilee medals of gold produced from the mines.

PERSONAL

PROFESSOR R. M. BARRER has resigned his post as professor of chemistry at Aberdeen University on his appointment to the chair of physical chemistry at Imperial College, London. Professor Barrer, who takes up his new appointment on 1 October, is a native of Wellington, New Zealand, and before going to Aberdeen in 1949 was reader in chemistry at London University from 1946 to 1949 and head of the chemistry department at the Technical College, Bradford, from 1939 to 1946. He has been governor of the Rowett Research Institute, Aberdeen, since 1950.

Among nine British scientists who will shortly take up research fellowships in America under the technical assistance programme sponsored by the FOA are the following: DR. F. M. DEAN, lecturer in organic chemistry at Liverpool University, to University of California; DR. R. F. EVANS, CRL, to Purdue University; DR. V. A. KNIVETT, CRL, to University of Wisconsin; DR. E. M. THAIN, an organic chemist at the Lister Institute, to University of California; and DR. J. OWEN, a micro-wave spectroscopist, of Magdalen College, Oxford, to University of California.

MR. C. E. TAPSCOTT CRIDLAND, chairman and managing director of a group of companies including Aldis Brothers Ltd., of Birmingham, has been elected president of the Scientific Instrument Manufacturers' Association for 1954-55. He has served on the Association's Council since 1949.

The trustees of the Ciba Foundation have appointed PROFESSOR F. G. YOUNG, professor of biochemistry in the University of Cambridge, and PROFESSOR A. HADDOW, director of the Chester Beatty Institute, to the executive council of the Foundation to assist in its scientific work.

Blundell, Spence & Co. Ltd. announce the appointment of MR. TERENCE B. COLLINS as the new manager, Hull sales area, to succeed MR. A. C. WALTON who has held the post since 1950. Mr. Walton is shortly to retire, having been in Blundells' service since 1906. Mr. Collins, aged 27, was born in Hull, is an M.A., with 1st-class honours in

Economics, and an associate of the Incorporated Sales Managers' Association. He was appointed northern area sales manager, in Newcastle, in July last year, and takes up his new appointment in Hull on 1 August.

To replace MR. M. LANGSTRETH, the retiring general manager of Dunlop Cotton Mills Ltd., a management board of three men with upwards of a quarter of a century's service have been appointed. They are MR. JACK DYSON, who was a first-class silver medallist in spinning and subsequent processes when he went to the spinning department at Rochdale in 1921 and has been production manager there for the last eight years; MR. ARNOLD FLETCHER, who has been with the company for 25 years, and for the last four years has divided his activities between cotton buyer at Rochdale and production manager at the Bidstone Mill; and MR. LESTER PICKUP, who was appointed technical manager eight years ago after seven years as technical superintendent.

From 26 July Press inquiries to the British Iron and Steel Research Association should be addressed to MISS I. M. SLADE, information officer. MR. MAX DAVIES, who joined the Association in 1947 and created its public relations service, leaves at the end of July to become editor of the 'Petroleum Times.'

MR. F. L. THURSTON-MOON, who has been an active member of their staff for many years, has been elected to the board of R. H. Cole & Co. Ltd.

Obituary

M. AUGUSTE DUTREUX, president of the Société Anonyme des Pneumatiques Dunlop, Paris, and a pioneer of the French motor industry, has died in his 82nd year. A native of Luxembourg, M. Dutreux has bequeathed to his adopted country the Château de la Celle-Saint-Cloud.

MR. GEORGE H. SCHULER, an authority on dyes and director of the E.I. Du Pont de Nemours & Co.'s dyes and chemical division, has died in Delaware hospital, aged 59.

Publications & Announcements

STAUFFER Chemical Company, 380 Madison Avenue, New York 17, have recently increased its production facilities to offer commercial quantities of percholoromethyl mercaptan (PMM). This reactive intermediate has a list of potential uses in such products as lubricants and fuel additives, biocides, rubber additives, dyes or dye intermediates. The primary chemical activity of PMM centres about the reactive sulphur-linked chlorine atom. As a result it will react with amides, imides, olefines, thiols, xanthates, sodium alkoxides, and all amines. Substituted guanidines are also obtainable. A technical bulletin describing the properties and reactions of this interesting sulphur-chlorine aliphatic is available.

* * *

USE of plastics in the manufacture of cables are reviewed in an interesting 16-page booklet, 'The Application of Plastics in the Cable Industry,' published by the Telegraph Construction and Maintenance Co. Ltd. The contents are restricted to the consideration of those thermoplastics which have been developed during the last 20-25 years and are of special interest to the cable maker. The comparative properties of polythene and PVC compounds, materials most extensively used in cable manufacture, are discussed, and there are separate sections describing the merits of polythene insulated power cables, PVC insulated and sheathed wiring cables, polythene insulated PVC sheathed wiring cables, and polythene insulated and sheathed cables for telecommunication.

* * *

THE part played by the well-known firm of Wm. Butler and Co. (Bristol) Ltd., of Silverthorne Lane, St. Philips, Bristol, 2, in the pioneering work and development of coal tar distillation and the production of basic raw materials for the organic chemical industry, is described in a fascinating book which has been written by Mr. T. Howard Butler to mark the company's centenary. In a brief foreword the author, who recently retired from active business, reveals that it had always been his intention that when the company reached 100 years of its existence in 1943, he would write a history of its progress over that period. When this time arrived, however, they were in the throes of

World War 2, and the task had to be postponed. No more appropriate time, he felt, than the Coronation year of Queen Elizabeth could have been chosen for the work. In the book's first three chapters Mr. Butler highlights events during what he calls the three periods of the company's progress, viz., 1843-1889, 1889-1921 and 1921-1953, which he describes as a history of the coal tar distillation over the last century. The fourth chapter is concerned with other activities such as rosin distillation, the manufacture of naval stores and wood tar and disinfectants, the importation and distribution of petroleum and the production of lubricating oil. Another chapter reviews the company's transport equipment, and personalities and research are dealt with in remaining chapters. Illustrated with nearly fifty photographs, the book is printed on art paper, and is certainly an important contribution to the literature now being produced on the history of contemporary industrial enterprises.

* * *

MANUFACTURERS of ball and pebble mills for nearly half a century, Steele and Cowlshaw Ltd., of Hanley, Stoke-on-Trent, have issued a new catalogue covering the Steel-Shaw range of products.

* * *

BOTTLES of solidified liquids or cylinders of gas can be heated either throughout their length or in sections in a new low-temperature oven designed by the General Electric Co. Ltd. It is made in two semi-cylindrical sections, one of which is hinged so that it can be opened to admit the charge. The oven, which has Inconel sheathed wire heating elements, is well lagged between the inner and outer mild steel casings. The elements are arranged in eight sections giving a total load of 10 kW. This load can be applied in $\frac{1}{4}$ stages of any desired combination. Main connections are taken to terminal boxes on the outer casing and interconnections are carried in a flexible metal tube. To limit the temperature at the surface of a charge the unit is designed to give minimum heat transfer by radiation. It operates at temperatures up to 300°. Temperature is controlled by capillary type instruments and any switching sequence can be arranged.

PRODUCTION of chemicals from petroleum continues to form an increasingly important part of the chemical industry's activities, and in their new edition of 'Shell Chemical Solvents,' Shell Chemicals Ltd. have provided much valuable information relating to these products and their uses. The book, which has been distributed to customers, selected libraries, universities and schools, is divided into three main parts. First there is a full description of each chemical solvent and a note of its chief uses; then a chapter dealing with the applications of solvents in surface coatings, and lastly numerous tables are presented giving general data on solvents. A wide variety of illustrations includes a striking two-page coloured diagram designed to show how chemical solvents are produced from crude oil. Strongly bound, the book maintains the high standard of production always associated with Shell publications.

* * *

AN informative report on the role of automatic pH control in industry—to help executives, process engineers and chemists better understand this important technique—has just been released by Beckman Instruments, Inc., South Pasadena, California. The 12-page brochure illustrates continuous pH recording and control in three major processing fields—water treatment, control of chemical reactions, and waste disposal. Simplified diagrams and sketches describe typical pH installations for a variety of processes, with emphasis on improved product quality, better processing efficiency and lower material and maintenance costs. A separate section of chemical reactions explains pH control in emulsification, electrolysis, neutralisation, hydrolysis, biochemical processing, coagulation and precipitation, and bleaching, dyeing and conditioning of fibres and fabrics. Persons writing for free copies should request Bulletin No. 340-X2.

* * *

OIL production is the theme of the June issue of the Technical Journal of the Brush Group, published last week. Drilling for oil is discussed by Mr. D. R. N. Picard, chief engineer of British Oilfield Equipment Co. Ltd., while Mr. A. P. Quarrell, director of Associated British Oil Engines Ltd. and British Oilfield Equipment Co. Ltd., writes about internal combustion engines for rotary drilling rigs. Other articles

include those dealing with power from natural gas, oil and gas pipelines, propulsion and auxiliary machinery for oil tankers, the use of heavy oils in diesel engines of marine auxiliary sizes, and oil testing with the laboratory engine.

* * *

TEXT of a speech on the subject of 'The United Africa Group' delivered in London by Sir Geoffrey Heyworth, chairman of Unilever Ltd., and in Rotterdam by Dr. Paul Rykens, chairman, Unilever NV, at the annual general meetings of those companies on 31 May last, has been reproduced in booklet form for private circulation. Sir Geoffrey Heyworth is also chairman of the United Africa Co. Ltd.

* * *

AN article by Mr. R. A. Johnson, of Aero Research Ltd., on 'Epoxy Resins,' which was published in 'Electronic Engineering' in April, has been issued in pamphlet form by the company's technical service department.

* * *

REFRACTORY bricks are dealt with in three new sales leaflets issued by the Morgan Crucible Co. Ltd., of Battersea Church Road, London, S.W.11. One is concerned with the M.R.1 firebrick which, it is stated, can be used at temperatures as high as 1,600°; the second describes the M.I.28, a hot-face low heat-storage insulating refractory which can be used at furnace (or interface) temperatures up to 1,538°; while the third refers to the M.I.23, which can be used as a direct furnace lining up to 1,260°, or where furnace temperatures are higher, as a backing insulation to a lining of denser refractory or of another hot-face refractory, such as the M.I.28.

* * *

THE Link-Belt Company, manufacturers of conveying and processing equipment, E. Rauh & Sons Fertiliser Company, Indianapolis, and Simon J. Martenet have developed the Martenet process for the manufacture of homogeneous, granular, free flowing fertiliser, which is now available to the fertiliser industry and offered exclusively by Link-Belt Company. The process permits formulation of all ratios of fertilisers using anhydrous ammonia, ammonium nitrate and other high grade materials. Particle size can be closely controlled, and a wide range of product sizes can be obtained. The product can be stored in bags or bulk for long periods of time without caking.

Law & Company News

Commercial Intelligence

Increases of Capital

The following increases in capital have been announced:—W. H. LEGAT LTD., from £16,725 to £26,725; POLYMER (UNITED KINGDOM) LTD., from £30,000 to £100,000; SIKI LTD., from £20,000 to £40,000; PARAZONE CO. LTD., from £17,500 to £70,000.

Changes of Name

The following changes of name have been announced:—DROPTIC LTD. to F. W. ROBINSON (PRODUCE) LTD., on 10 June. COUNTY PERFUMERY CO. LTD., to COUNTY LABORATORIES LTD. on 1 June.

Company News

Laporte Industries Ltd.

Approval was given at a recent meeting of Laporte Industries Ltd. to a one-for-three scrip issue.

Anglo-Greek Magnesite Co. Ltd.

The accounts of the Anglo-Greek Magnesite Co. Ltd. for the year to 31 March, 1954, show a group net profit of £13,532 (against £5,148 for the previous year) after tax. The dividend is 5 per cent (against 4 per cent).

Distillers Co. Ltd.

In a preliminary statement for the year ended 31 March, 1954, the Distillers Co. Ltd. announce group manufacturing and trading profits of £19,717,540 (compared with £13,030,747 a year ago). The net balance attributable to the group, after outside interests, is up from £4,101,072 to £7,316,549, after a substantially higher taxation charge. A final dividend of 8 $\frac{2}{5}$ ths pence per 4s. ordinary share, or 17 $\frac{1}{2}$ per cent is recommended, making 1s. or 25 per cent for the year, compared with 10 $\frac{4}{5}$ ths pence, or 22 $\frac{1}{2}$ per cent last year.

British Tar Products

The directors of British Tar Products Ltd. have recommended a final dividend of 20 per cent to make 25 per cent for the year ended 31 March, 1954. This compares with 17 $\frac{1}{2}$ per cent final to make 22 $\frac{1}{2}$ per cent for the previous twelve months.

J. C. & J. Field Ltd.

A dividend of 30 per cent for the year to 31 March, 1954, is announced by J. C.

and J. Field Ltd. The group profit, after all charges, including tax, was £62,392 (against £41,008, for the previous year), all attributable to the holding company. The directors also announce a scrip issue in ordinary and 'A' non-voting ordinary shares, which will capitalise £137,500 from reserves. These will be distributed in the proportion of one ordinary and 10 'A' ordinary shares for every nine shares now held. Both ordinaries will rank for dividends for the year to 31 March, 1955.

P. H. Galloway Ltd.

A trading profit of £11 (compared with a loss of £2,890) is shown in the accounts of P. H. Galloway Ltd. After deducting directors' emoluments and a figure for depreciation, there is a net loss of £8,851 (against £10,707).

Market Reports

LONDON.—Activity on the industrial chemical markets has been fairly well maintained during the past week although the scale of deliveries has been very much curtailed due to the proximity of the annual holiday period. Nevertheless, there has been fair interest in forward business and the flow of export inquiry continues to be satisfactory. Among the soda products hyposulphite, chlorate and dichromate have been moving well, and most of the potash chemicals are finding a ready outlet. Although the market for pitch is quiet the demand for the coal tar products, both on home and export account, has been good and prices generally are unchanged with a firm undertone.

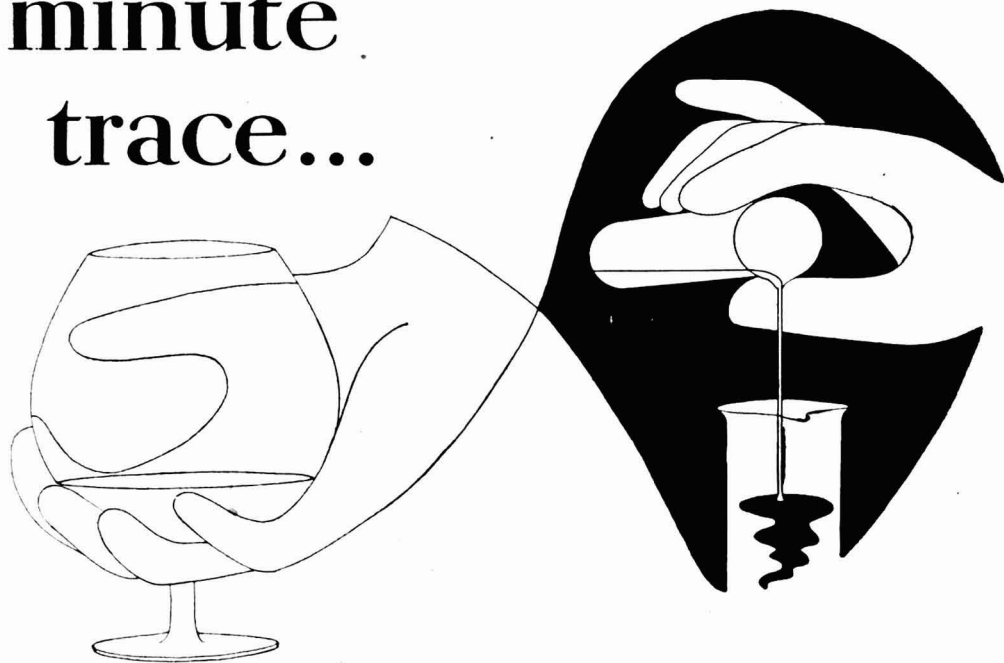
MANCHESTER.—Steady price conditions have been maintained on the Manchester market for heavy chemical products during the past week and buying interest covering a fairly wide range has been reported. Deliveries of chemicals to a number of consuming establishments in the textile and other leading industrial outlets have been affected to some extent by holiday stoppages, but in spite of this the movement of supplies has been reasonably satisfactory. No more than a moderate weight of new business has been placed in fertiliser materials, but the call for most of the light and heavy tar products has again been on steady lines.

Just a minute trace...

'Professor Leeds then showed the Society an easy method for

The Detection of Minute Traces of Water in Alcohol.

Anthraquinone is not only converted into hydroanthraquinone by zinc dust and caustic soda, but also by treatment with sodium amalgam. When the hydroanthraquinone so formed is brought into contact with water, there is formed a clear dark red solution of sodium hydroanthraquinone.'



Industrially as well as scientifically, the determination of traces of water has acquired much greater significance than it had in 1879, when this paragraph appeared in the first volume of the Journal of the American Chemical Society.

The preferred method of moisture determination to-day is that developed by Karl Fischer. B.D.H. has devised simplified methods for its application and supply prepared reagents ready for use.

A booklet on the method may be obtained on request.

LABORATORY **B·D·H** CHEMICALS

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive, or a woman aged 18-59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order, 1952.

A. BOAKE, ROBERTS & CO., LTD., LONDON, E.15, require **SENIOR CHEMISTS** for their Process Development Department. These appointments would appeal to qualified men with some years of experience of organic chemistry, seeking the opportunity to lead a team in developing new projects from laboratory to plant scale, so as to provide new or improved products. The minimum salary envisaged is £800 per annum.

The Company also requires **ASSISTANT CHEMISTS** to participate in these projects. Industrial chemical experience is desirable in these appointments. Minimum salary is £550 per annum. Applications in detail to **PERSONNEL MANAGER**.

BRITISH TITAN PRODUCTS COMPANY, LIMITED—a rapidly expanding Heavy Chemical Industry—has vacancies for the following Senior Staff positions:—

GRADUATE CHEMISTS AND CHEMICAL ENGINEERS to assist in the development and control of Chemical Plant operations at its
Grimsby (Lincs.)
and

Billingham (Co. Durham)
Factories.

Applicants should preferably be under 30 years of age, and previous experience of Chemical Plant work would be useful but not essential. Conditions of work and service are very attractive, and there are Staff Bonus and Superannuation Schemes. Commencing salary dependent on age, qualifications and experience.

Application forms may be obtained from the

PERSONNEL MANAGER,

BRITISH TITAN PRODUCTS COMPANY, LIMITED,
KRONOS HOUSE,
COPPERGATE, YORK.

CARIBBEAN—Vacancy for **CHEMICAL ENGINEER** with new Canadian alumina plant in Jamaica. Must have Degree and at least two years' operating experience and be inclined to production rather than research. Age 25-28. Excellent prospects, starting salary not less than £1,200—Write **NORTHERN ALUMINIUM, BUSH HOUSE, W.C.2.** for initial interview in London.

CHEMIST with honours degree required for research into component wear problems using radio-active methods and also other allied investigations. The position is most suitable for a young graduate without previous industrial experience, but who has a genuine interest in research of this nature. Please reply, stating age, qualifications and experience, to Personnel Manager, **JOSEPH LUCAS (ELECTRICAL) LTD., GREAT KING STREET, BIRMINGHAM,** quoting reference PM/D/17.

TRANSPARENT PAPER LIMITED requires the services of **SHIFT CHEMISTS**. Candidates should have been trained to at least National Certificate in Chemistry, and any other experience in the field of cellulose chemistry would be an advantage. The work covers a continuous process manufacturing and converting regenerated cellulose film. Salary in accordance with qualifications and ability, and there is scope for further advancement.

Apply in writing or person to the **PERSONNEL OFFICER, BRIDGE HALL MILLS, BURY, LANCs.**

SITUATIONS VACANT

CHEMIST with good knowledge of plastics technology is reqd. to take charge of small section, developing and investigating applications of cold—and thermo—setting resins to 'potted' circuit techniques. Sound basic knowledge and organising ability are the primary requirements. The post is permanent and carries good salary and prospects. Please apply in writing to the **PERSONNEL DEPT, ED/190 E.M.I. ENG. DEV. LTD. HAYES, MIDDx.**

PHYSICIST, preferably experienced in instrumentation with particular reference to inspection and testing of metallic materials. Initial salary up to £900, according to qualifications and experience.—Write **SECRETARY, THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION, 81, Euston Street, London, N.W.1.**

SITUATION WANTED

GRADUATE (1st Class Hons. M.Sc.) with long experience in colouring matters and in the asphaltic trade desires position as research chemist or administrative work. **BOX C.A. 3340, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

FOR SALE

CHARCOAL, ANIMAL AND VEGETABLE horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—**THOS. HILL-JONES, LTD., "INVICTA" WORKS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON." TELEPHONE 3285 EAST.**

'PHONE 98 STAINES

JAC. AUTOCLAVES OR VACUUM OVENS—8 ft. by 5 ft., 8 ft. by 4 ft., 7 ft. by 4 ft., and 7 ft. by 3 ft. 6 in. diam.

RUBBER LINED CYL. ENC. TANKS—850 galls. each. 1,500 gall. **ALUMINIUM CYL. ENC. TANK.**

LAB. FILTER PRESS—9 in. sq. plates and frames, with pump.

UNUSED ELEC. STIRRING ARMS, 24 in. long—400/3/50. **JACKETED 'U' TROUGH MIXER**—6 ft. 3 in. by 2 ft. 3 in. by 2 ft. 7 in. deep.

120 gall. **JAC. CYL. MIXING PAN**, 100 lb. w.p.

'**ALLEN**' **CONDENSERS**, 300 sq. ft. brass tubes; ditto by '**WEIR**,' 105 sq. ft.

100 gall. **S.S. JAC. MIXING PAN. PUMPS, BOILERS,**

HYDROS, STILLS, DRYERS, CONVEYORS, etc.

HARRY H. GARDAM & CO., LTD., STAINES

TRACTOR NEWS

THE PLATYPUS 39 H.P. DIESEL CRAWLER now ex-stock. Bare Tractor from £1,080, or complete 7 ft. Hydraulic Angledozer, £1,430.

Also Boughton Winch, Rotavators, Hydraulic Scrapers, etc.

MAIN DISTRIBUTORS AND STOCKISTS, WILLIAM R. SELWOOD, LTD., CHANDLER'S FORD, HANTS.

'Phone 2275.

FOR SALE

C. BARBER, LTD.

SEVERAL HORIZONTAL JACKETED TILTING MIXERS, 25 gallons capacity. New and unused. 500-gal. Over-driven M.S. **MIXING VESSEL**. M.S. pressure filter, 4 ft. 3 in. diam. by 5 ft. 3 in. overall height.

C.I. FILTER PRESS, 25½ in. square, by **MANLOVE ALLIOTT**, plate and frame type, 13 chambers, arranged for washing. Excellent condition.

CANNON STEAM JACKETED ENAMEL-LINED PANS 10 and 25 gallons. All new and unused.

DOULTON 25-gal. COPPERS with lids. **NEW** and unused. **WELDED VESSELS** of all types, in mild steel or stainless fabricated to customer's specifications.

C. BARBER LTD.
SILVERDALE GARDENS
HAYES MIDDLESEX

Telephone—Hayes 2735/6

ECONOMIC BOILERS, 10 ft. Danks. 12,000 lb. evap. 250 lb. pressure. Two Brand New 14 ft. by 8 ft. by 150 lb. w.p. **IMMEDIATE DELIVERY**. 400 other Boilers in stock.

STAINLESS PRESSURE TANK, 19 ft. by 5 ft. diam., 110 lb. w.p. Unused.

Whesoe Riveted Steel **MIXING TANK**, 13 ft. diam. by 15 ft. deep, 9-16 in. plate, cone base.

TWO 35 ft. long by 9 ft. diam. Lead-lined TANKS.

SIX Stainless Steel JACKETED PANS, 60 galls. **TWO Broadbent WATER-DRIVEN CENTRIFUGES**, 30 in. diam., 12 in. deep, 1,150 r.p.m.

SIX Aluminium CONDENSERS, 14 ft. long by 2 ft. 6 in. diam. 386 Tubes, ¾ in. o.d.

FORTY Riveted RECEIVERS, 8 ft. 6 in. long, 5 ft. 6 in. diam., 75 lb. w.p. Numerous other sizes.

Solid Drawn STEEL PIPES, 6 in., 8 in., 10 in., 12 in., 14 in., thousands of feet in stock, plain and flanged. **CAST-IRON PIPES**. 400 yds. 8 in. **NEW**. Also most other sizes, up to 24 in. bore.

VALVES in Stainless, Gunmetal, Enamel Lined. Free Catalogue. "Watkins Machinery Record," available.

FRED WATKINS (BOILERS), LTD.,
COLEFORD, GLOS.

MORTON, SON AND WARD, LIMITED,

o f e r
MIXERS

"**MORWARD**" "**U**" **TROUGH MIXERS**—in stainless steel or mild steel, made in sizes up to 3 tons. Scroll or paddle type agitators. Jacketed or unjacketed.

Three Tilting Trough **MIXERS**—25g., 50g., 100g., by **RICHMOND & CHANDLER**—double "Z" blades, with or without jackets. Stainless steel interior pans if required.

50g., 75g., 100g. Heavy Duty **MIXERS** by **FALLOWS & BATES**. Agitators driven through bevel gears from fast and loose pulleys.

3-cwt. Trough **MIXERS** by **CHALMERS** and **GARDNER**—stainless steel lined troughs.

JACKETED PANS

100g., 150g. and 200g. **NEW** in mild steel for 100 lb. w.p., with or without mixing gear.

200g. Stainless Steel Jacketed **PAN** and One Jacketed **AUTOClave**, with detachable cover, 150 lb. in jacket.

PUMPS

A selection of **MONO** and other **PUMPS** in stock, 2 in. to 5 in. New and second-hand.

INQUIRIES INVITED.

MORTON, SON AND WARD, LIMITED,

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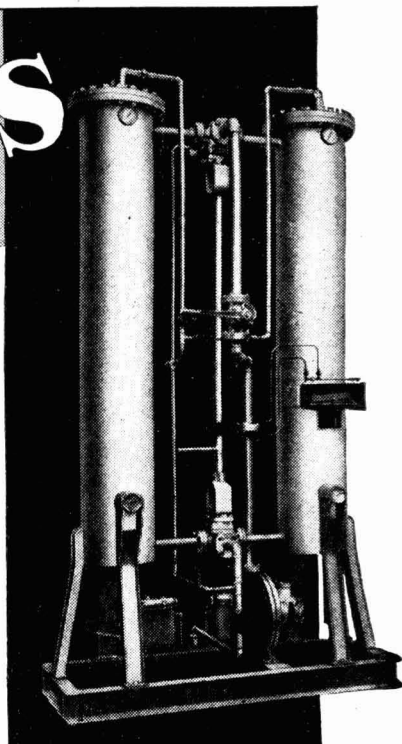
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INDEX to advertisers in this issue

	Page		Page
A.P.V. Co., Ltd. (The)	Front Cover	Kestner Evaporator & Eng. Co., Ltd.	196
Alchemy Ltd.	195	Laporte Chemicals Ltd.	154
Associated Metal Works (Glasgow) Ltd.	195	Leigh & Sons Metal Works Ltd.	196
Blundell & Crompton Ltd.	Cover iii	Leipzig Messeant, Leipzig	194
British Carbo Norit Union Ltd.	196	Manlove, Alliott & Co., Ltd.	155
British Drug Houses, Ltd.	191	Marchon Products Ltd.	153
Chemitrade Ltd.	Cover iii	Monsanto Chemicals Ltd.	160
Classified Advertisements	192, 193, 194	Penrhyn Quarries Ltd.	195
Dalzell Electric Welding Co., Ltd.	157	Pharmaceutical Laboratories Geigy Ltd. (The)	Cover iv
Elcontrol Ltd.	156	Reads, Ltd.	162
Geigy Co., Ltd. (The)	158	Richmond Welding Co.	195
Harris (Lostock Gralam) Ltd.	Cover iii	Steele & Cowlshaw Ltd.	Cover iii
Haughton's Metallic Co., Ltd.	195	Sutcliffe Speakman & Co., Ltd.	Cover ii
Holmes, W. C., & Co., Ltd.	194	Todd Bros. (St. Helens & Widnes), Ltd.	154
Imperial Chemical Industries Ltd.	159	Wood, Harold, & Sons, Ltd.	196

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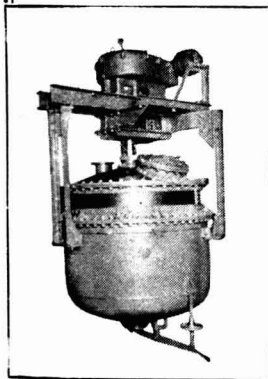
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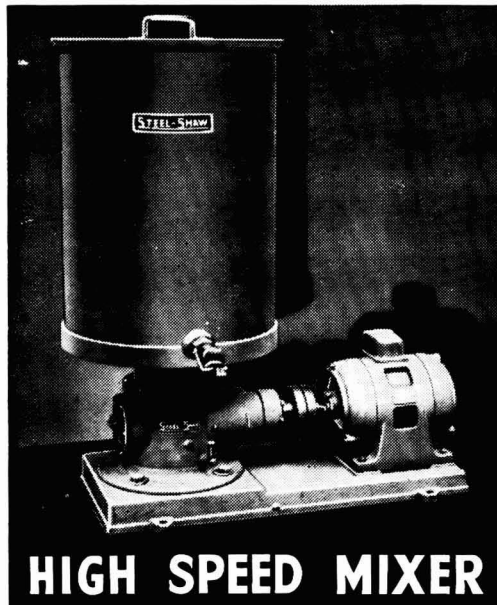
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