

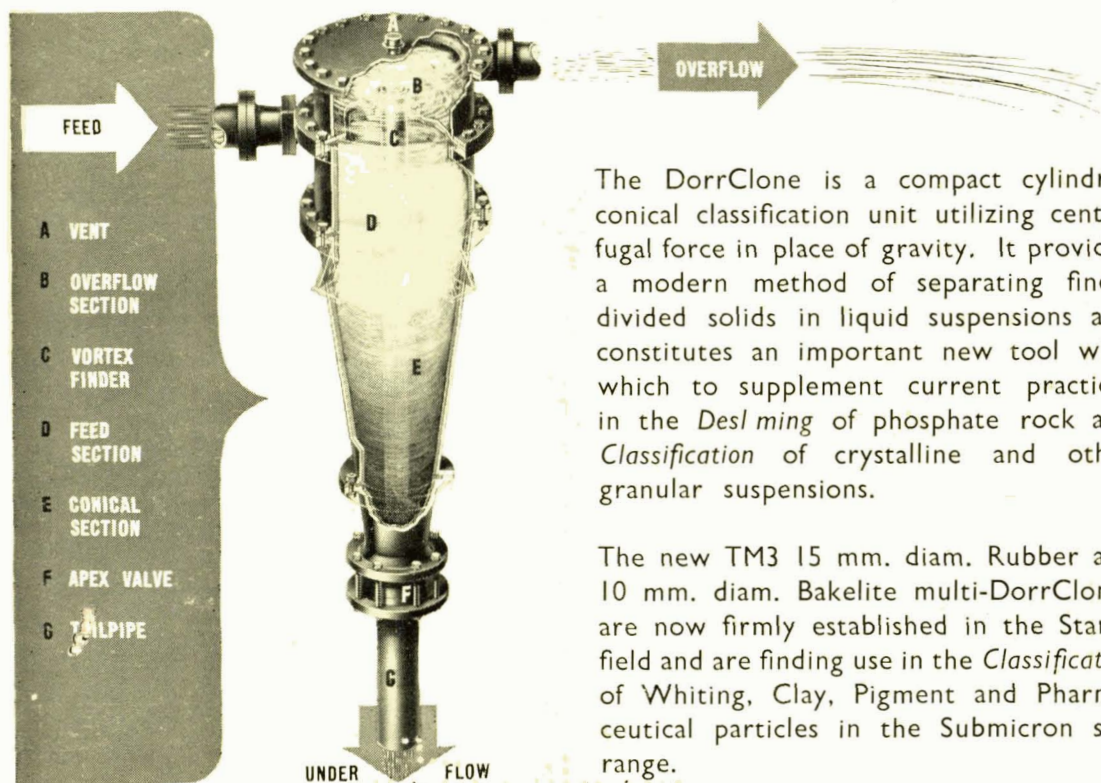
THE Chemical Age

VOL LXX

23 JANUARY 1954

No. 1802

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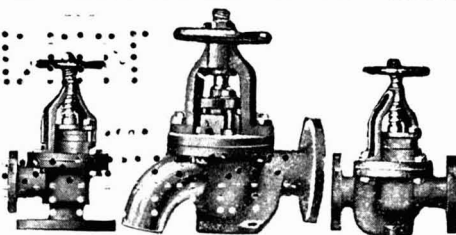
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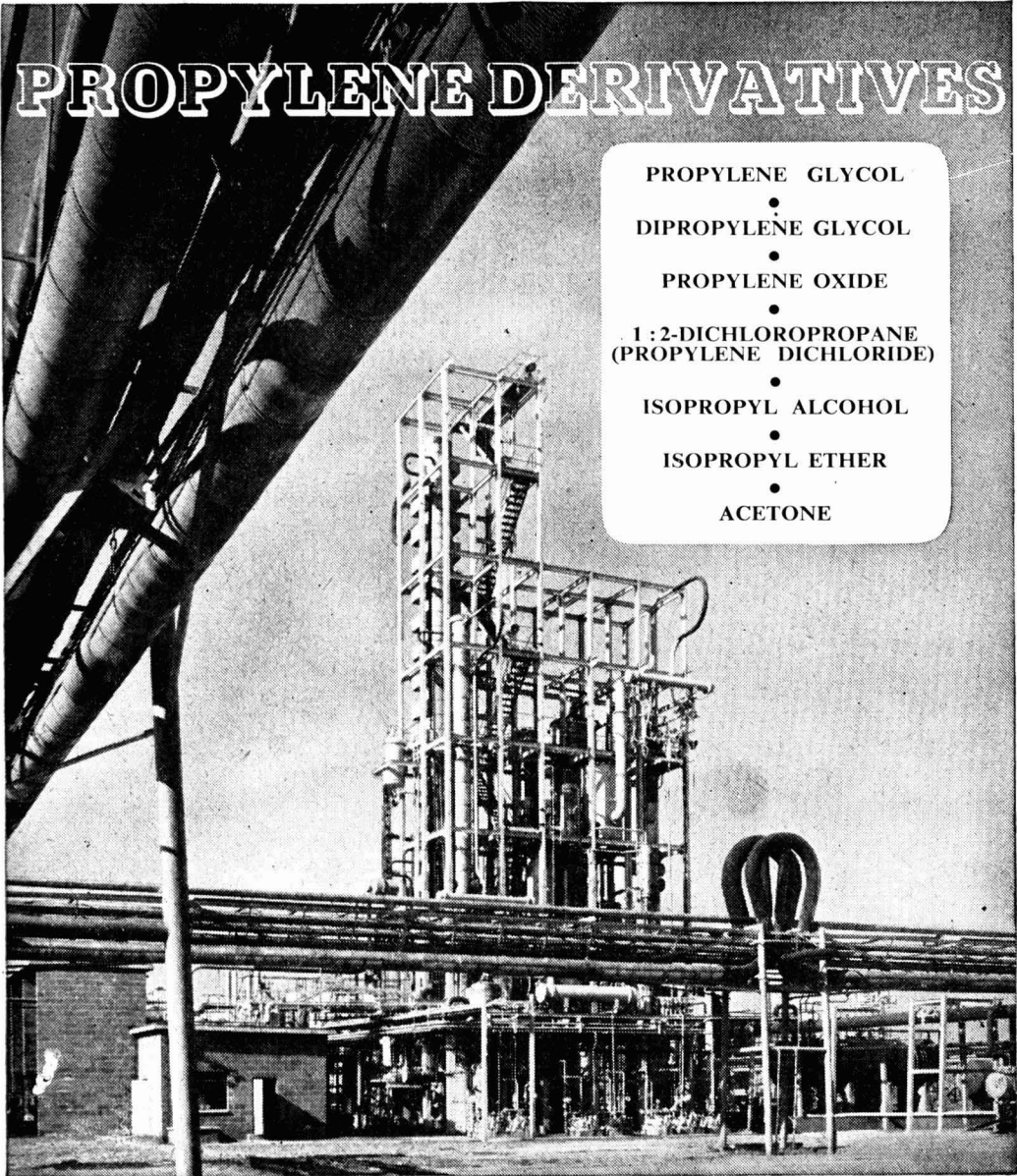
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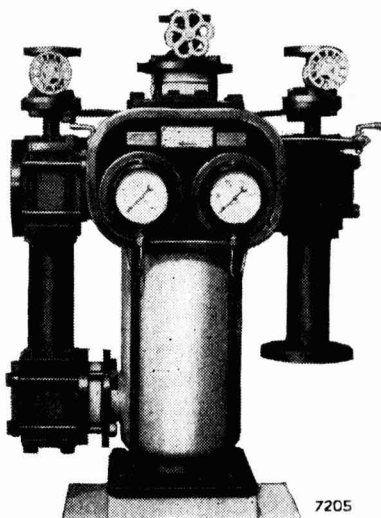
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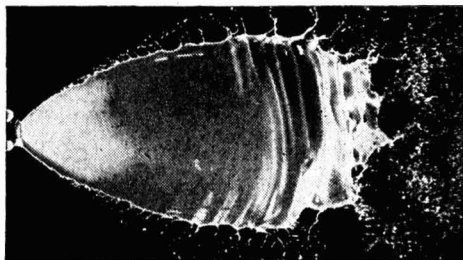
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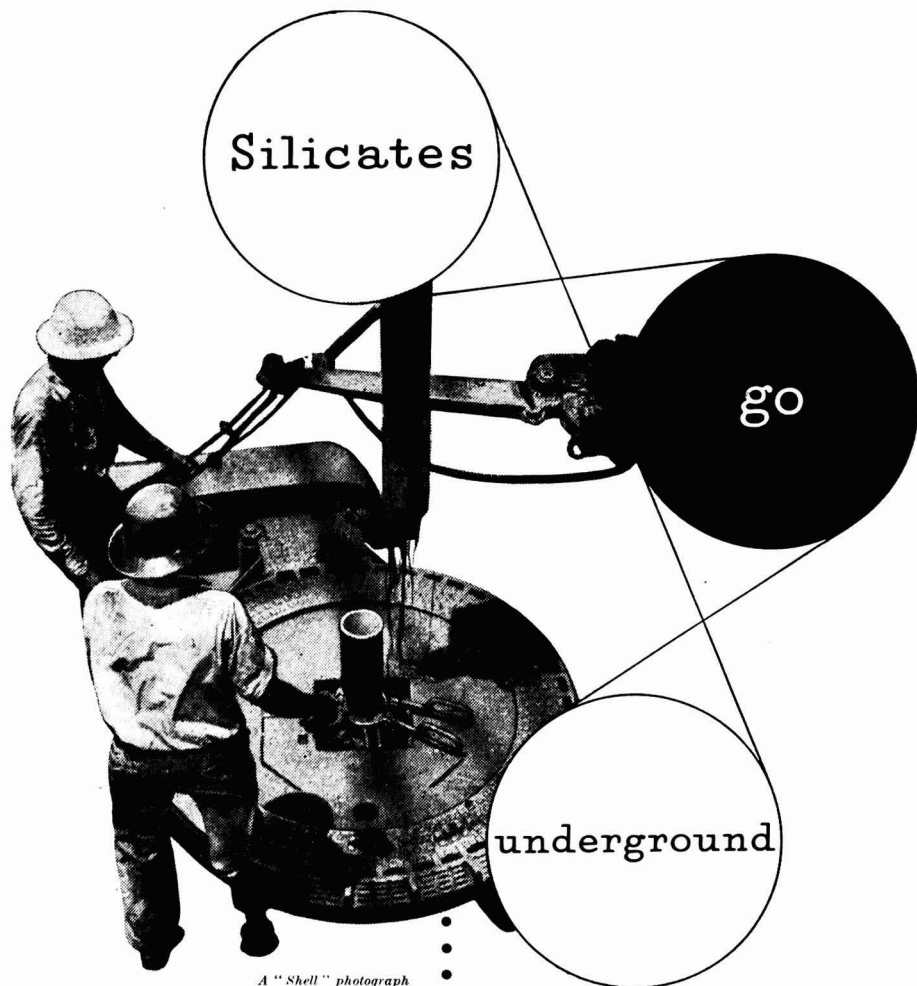
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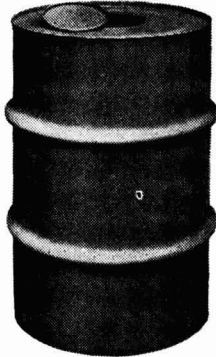
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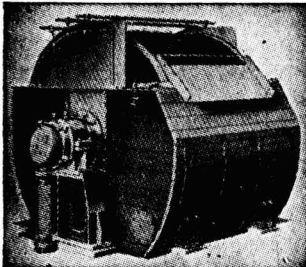


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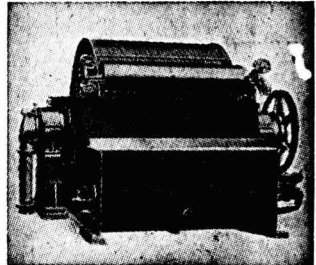
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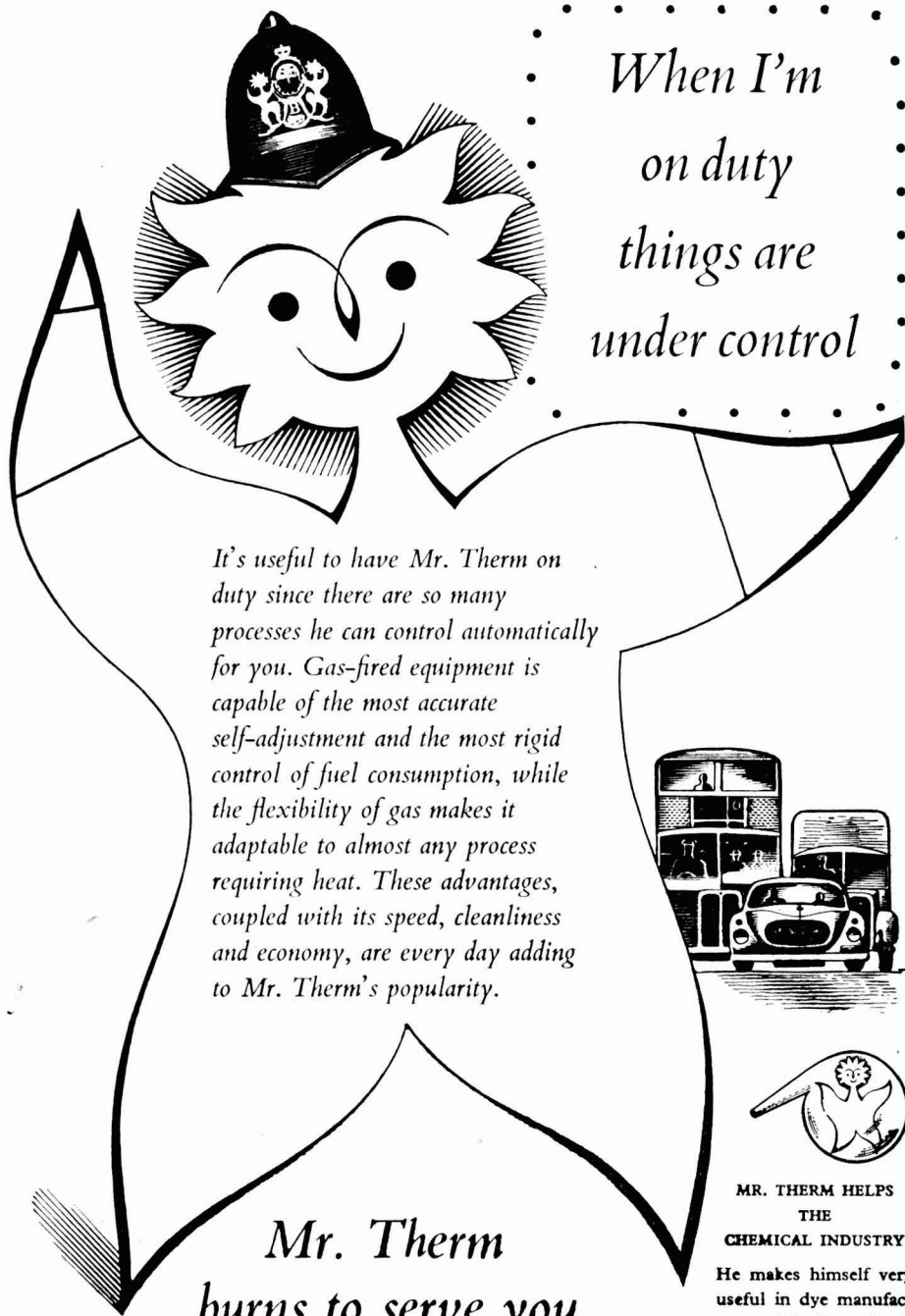
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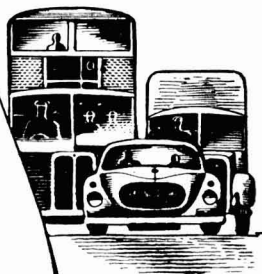
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Volume LXX
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The Chemical Age

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Management

MOST dictionaries today give a variety of definitions for the word 'manage,' and those who have been called upon to exercise the function of management in industry may derive sardonic satisfaction from the diversity of meanings their title can have. For to manage can mean to train by exercise, as a horse; to handle or wield, e.g., a tool; to control, e.g., a household; to deal tactfully with; to contrive to do something; to conduct affairs. A definition by context, given by Sir Hector Hetherington at the time the Administrative Staff College was founded (1945), is that 'the main task of management is to bring about conditions under which the work of a team can come to good effect in the achievement of some co-operative purpose.' It is a broad definition, but could any definition of 'management' not be? However, many managers may feel that it gives a somewhat over-lofty picture of their actual day-to-day work. For managers do not function in isolation. They are judged from above and from below, and many a manager can be no more than his directors allow him to be and can achieve little more than is permitted by the managed.

These are comments stimulated by another excellent publication from the Federation of British Industries, 'Education and Training for Management,' a report from the FBI Education Committee (1954, pp. 19, 2s.). It makes a timely contribution for, as Dr. Dunsheath points out in the foreword, training schemes for management have received a great deal of publicity in recent years and two extreme and faulty impressions have been created—the one that education and training for management is just a fashion which, like other fashions, will

quietly disappear, the other that it is the latest panacea for all industrial ills.'

Undeniably the management problem is much more keenly sensed by large organisations. The great expansion of activities that has occurred since 1939 has in itself created a vital need for more positions of managing responsibility along the chain of authority; indeed, to use as simple a word as 'chain' is misleading, for such has been the expansion in some large companies that it might be not unduly an exaggeration to talk instead of tangled skeins of authority. Disentanglement is the first task of top-level management and there is a thwarting absence of good conditions for lower-level management until this has been done. Even in small companies this problem of confused lines of responsibility can occur acutely.

The FBI booklet makes two distinctions that are closely related. Training for management and education for management are not synonymous phrases. Training concerns the techniques of management, the basic and routine operational methods; education deals with the development of outlook and personality, no less fundamental but an aspect of management that is much easier to recognise when it exists than to define in advance. The other distinction is that between the task of management and the *modus operandi* of management, and it is almost the same distinction; for however well the trained techniques are applied they cannot achieve their objective unless the proper outlook and personality is also and actively present. The best managerial skill is wasted if the manager 'cannot work with other people and bring the best out of his team' and traditional systems of educa-

tion that aim at 'leadership' are no longer adequate for 'the manager must be able to work with equals and superiors as well as subordinates.' Industry, if it is to gain from the facilities now available for management development, must first select the right human material to be developed. On this vital matter the FBI booklet is unexpectedly non-informative; indeed, it side-steps the whole issue by saying that 'it is not the purpose of this report to discuss selection methods'. The larger companies now have considerable experience, gained from mistakes as well as from successes, in selecting potential managers, but smaller firms have not; nor can they easily afford to buy experience by making mistakes. With so much emphasis laid upon 'the rightness of the man' as a prime factor, it is remarkable to find nothing said about it in human raw material.

There are many more schemes for training and education than most of us realise. There are over 100 university courses and a greater number still at the technical and commercial colleges. 'The real problem for the industrialist is the profusion of courses . . .'. Courses can be divided into three classes: (i) for the foreman group, (ii) for junior executives, and (iii) for the senior executive. Keen support and sponsorship within industry and a keen demand from workers themselves have led to the rapid expansion of foremanship training courses, especially at technical colleges through evening courses. The development of facilities for the second class appears to have been more difficult and much slower. A diploma scheme jointly drawn up by the Ministry of Education and the British Institute of Management is still too young to be appraised. Industry's reaction is far from clear. There is the danger that a young man taking one of these courses will subsequently expect a managerial appointment as his right when the real proof of the pudding is not in the diploma but in 'job performance.' It is suggested that management training will make better progress if all employers make it clear that promotions will still be made on the basis of 'job performance' and not by 'record of attendance

at courses.' This applies all the more forcibly when students take such courses on their own initiative; any other attitude with industry must play havoc with staff relationships in general and bring eventual frustration to the voluntary trainees themselves. There is some scarcity of teachers with first-rate industrial experience, and another important suggestion is that industry might help educational institutions in devising practical courses and in supplying occasional lecturers and discussion-leaders. In the third class, some of the larger companies have their own internal training schemes and there is the Administrative Staff College at Henley with its 12-week residential course for senior executives sponsored by their employers. In this class, too, at any rate theoretically, fall the university post-graduate courses; here, also, close co-operation between industry and the universities is necessary.

Despite the growth of all these facilities the FBI report states with almost damping firmness that there has been more support for them from employees than from employers. It remains a majority view among industrialists that management is best learnt 'at home'—in industry itself. Is this attitude innately correct? Or has too little attention been paid to 'educating' employers?

Where courses are open to all who choose to take them, the employer is bound to have many more reservations than where they are open only to trainees selected initially by industry. This is true for all levels of management training. The FBI Education Committee's view is that industry itself must not only co-operate with educational establishments 'but take the lead,' and that at the same time these establishments should be prepared to experiment 'to a far greater extent than at present, particularly in regard to teaching methods.' Only time can show how much managers are 'born' and how much they can be 'made,' whether managers develop only by natural evolution inside industry or whether that process can be accelerated. But the stark fact is that there is always a shortage of good managers and the tasks that face them become more complex with every year that passes.

Notes & Comments

Shocking Story

WORKING chemists have many pet rules-of-thumb which have nothing to support them but practical experience, which are, in fact, improbable at first sight, but which will inevitably survive a critical theoretical investigation. It is worth while remembering, for example, when a problem seems insoluble, that to that which hath shall be given. We recall an instance of a factory liquor which contained a small amount of organic acid impurity, and nothing would remove it until some more of the same acid had been added to the solution. Now, in a journal no less academic than *Nature* (1954, **173**, 77), we read that the addition of a little ether or pentane to liquid explosives such as nitroglycerine will render them less susceptible to initiation by mechanical shock. A letter from Mr. Elwyn Jones, a research physicist with I.C.I. Nobel Division, describes some further investigations of work carried out by a team of Cambridge scientists under Dr. F. P. Bowden (see 'Initiation and Growth of Explosion in Liquids and Solids,' C.U.P., 1952) which established that the susceptibility to shock was due to the presence of small air bubbles in the liquid. When the nitroglycerine is suddenly struck, the force is transferred to the bubbles, which suffer a nearly adiabatic compression. This raises the temperature of the vapour to something above that at which nitroglycerine dissociates, and the explosion is initiated. If, however, the vapour in the bubble has a dissociation temperature below that of the explosive, and if that dissociation is moreover endothermic, then the shock will be dissipated without danger. And that is where ether comes in—though we cannot help thinking that carbon tetrachloride, also mentioned by Mr. Jones, would be a little more acceptable in explosives factories.

There's Nothing New . . .

A FORTNIGHT ago, on 9 January, we opened our morning papers to find them taken up with half-page advertisements announcing the advent

of 'ICA,' 'NSO' and 'Volatane control.' The big three of British petrol, by what one dare only describe as a magnificent coincidence, had all developed improved motor fuels at the same time. But the improvements, although their eventual effect is the same, achieve it by different means. ICA (Ignition Control Additive), for example, which has been enjoying great popularity in America for the last six months under the title of TCP (readers of *THE CHEMICAL AGE* who consult 1951 **64**, 6; 338, will realise why it was not called TCP in this country) is tricresyl phosphate, whose function is to inhibit pre-ignition of cylinder deposits. NSO, on the other hand, 'naphthenic solvent oil,' has a solvent effect upon these deposits, while for 'Volatane control' no more is known than that it improves the octane number.

. . . Under Phoebus' Car

MOST surprising feature, however, is that these additives are far from new. As long ago as the late nineteen-twenties, cresol was proposed as a motor benzole additive to prevent resinification of unsaturated components, and consequent gumming of the engine; and over 15 years ago naphthenic soaps were added to oils to prevent the formation of sludge. We acclaim the caution of the petroleum companies in subjecting their new products to exhaustive tests before marketing them, but if the improvement to be gained is all that they claim, we could have wished them to come forward a little sooner. The raging rocks and shivering shocks have shaken our car too long.

Russia's Bacterial Fertilisers

PLANT-FOODS are rarely deficient as such in soils. They are, nevertheless, needed by crops because much of the soil's natural stock is held in insoluble, non-available combinations. This broad generalisation is untrue of nitrogen, but it is valid for such nutrients as phosphorus and potassium. But steadily since 1949 there have been

Russian papers on the use of solubilising bacteria to turn non-available reserves of plant-food into active, crop-feeding supplies. In 1952 there were field trials of new 'bacterial fertilisers' on several hundred collective farms and in more than 50 agricultural research institutions. Many reports of good results have followed. It is said that at Kiev a factory producing bacterial fertilisers is working at high pressure, and the USSR Ministry of Agriculture has called for mass production output. This must be regarded as an interesting development, and none the less remarkable because it has been proceeding quietly with little attention from the Western world. In a sense it is a revival of ideas that attracted attention 40 years ago, for between 1910 and 1920 there were a number of patents issued for processes involving the use of bacterial cultures to 'activate' insoluble phosphatic and potassic materials.

Reason for Scepticism

THE orthodox view might be summed up as follows. First, it is accepted that soil bacteria make some contribution in converting locked-up nutrients into plant-assimilable forms, but that the natural rate at which these processes occur is insufficient for

economic cropping. Second, it does not seem likely that cultures of such or similar bacteria will be notably successful as soil additives, for why should we expect their population to increase rapidly if the populations of natural solubilising bacteria have for so long remained small? The same inhibiting influences must surely face the added bacteria. The Russians may have succeeded where orthodoxy has been too sceptical to encourage large-scale investigations; on the other hand, Russian agricultural science in recent years has put forward one or two revolutionary claims that have later proved to be much exaggerated. One important reservation seems already clearly established, however, and it should be stressed. The best results in tests of these new bacterial preparations have been obtained on soils rich in organic matter; and on acid soils the bacterial fertilisers have been ineffective. This is expectable, for organic matter must be the major source of food for expanding bacterial populations, and many bacteria cannot tolerate acidic environments. There is something to be said for the experimental investigation of these new Russian claims, but we wonder just how far can the results be confirmed?



Professor Sir Cyril Hinshelwood speaking at the inaugural luncheon of I.C.I. Plastics Research Laboratories (see p. 263). The heads in the foreground are those of Dr. A. Fleck and Mr. J. Swallow, and on the right is Dr. R. Holroyd

Obituary . . .

Sir Ernest Benn

WITH profound regret we announce that the death of Sir Ernest J. P. Benn, Bart., C.B.E., chief proprietor of THE CHEMICAL AGE, occurred at Oxted, Surrey, last Sunday. Sir Ernest, who was in his 79th year, had suffered indifferent health in the past year or two, but he battled against physical disability with all the sturdy resolution and indomitable courage that throughout his life were among his outstanding qualities, and right up to the time of his death he maintained his keen, alert interest in the publishing business of Benn Brothers Limited. Only five days before he died he was at his desk in Bouverie House.

Born within sound of Bow Bells, and proud to be a Cockney, Sir Ernest was the eldest son of the late Sir John Williams Benn, one-time furniture designer who launched his own trade journal, *The Cabinet Maker*, in 1880. Eleven years later Ernest Benn left the City Central Foundation School to enter the business at the bottom of the ladder as office boy, but with an eye towards eventually taking over the editorial chair of his father's journal. By and by he was sent out to gather advertisements, gaining experience which proved invaluable and for which he never ceased to be grateful. Indeed this work gave him a high regard for the calling and work of commercial travellers.

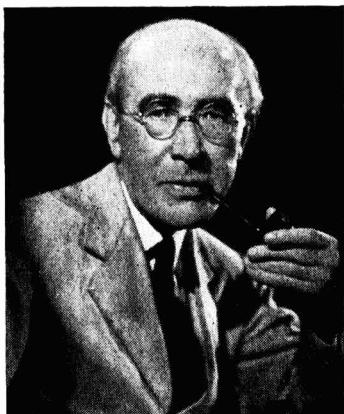
When he was in his twenties, Ernest Benn heard of the impending sale of *The Hardware Trade Journal* and carried the news eagerly to his father. The latter—content perhaps with the journal he had so successfully founded and with his thoughts turning strongly towards public service for the people of the London he loved—left the new business proposition to the judg-

ment and decision of his son. Ernest, showing early a boldness of spirit that was manifest repeatedly in later years, took the opportunity and, with boundless courage but very little cash, acquired the publication. To back up his very slender resources he infused into others something of his own enthusiasm for the project and obtained financial support from many quarters in the hardware field. Soon, however, he ran up against difficulties that would have frightened many people and did indeed alarm most of those who had ventured a modest cash investment in the journal. The young publisher himself hung on with grim

determination, and as his friends began to show uneasiness he took over without demur their holdings.

Those first years of the century, when he carried on his shoulders not only the management of *The Cabinet Maker* but the heavy task of building up his own *Hardware Trade Journal*, Sir Ernest Benn described as the hardest years of his life. From early morn to late at night he laboured, and the pains and gains of that period he graphically described in his 'Confessions of a Capitalist'—a book which ran into thirteen editions and was printed in six languages—and his more recent book, 'Happier Days.' He won through, however, and so successfully that many years later Sir John Benn declared: 'While *The Cabinet Maker* was the corner-stone, the bricks for the House that Benn built were well and truly laid by my eldest son.'

When Sir John became more deeply immersed in public life, as Member of Parliament and as Leader of the London County Council, and his second son, Wedgwood Benn (now Viscount Stansgate) followed too a natural bent for public service, the res-



possibility for maintaining and developing what was essentially a family business in the fullest sense of the term fell almost wholly upon Ernest Benn. He positively revelled in it, directing all his efforts with dynamic energy towards expanding the firm and the services of its various publications, and the business grew steadily under his guidance. There was a certain magnetic quality about the operations of the eager, progressive controller of the Benn business. As a consequence there came from time to time opportunities for further expansion, and several old-established publications were brought into the Benn group of journals and new ones started, notably THE CHEMICAL AGE.

Concentrated on Trade Press

Sir Ernest concentrated his work and energies on the trade and business Press almost without deviation. Some of the acquisitions for which he was responsible had associated with them publications of an extraneous kind; these he sheared off ruthlessly, believing that the course he had mapped out of building trade journalism to new heights of service and influence was the object he must constantly keep in view.

He did, however, widen his interests on the book publishing side. Certain technical books and standard works of reference were included with some of his journal acquisitions and he found in these the nucleus for the establishment of the book publishing company, Ernest Benn Ltd. While continuing and developing the technical side, he extended his activities as book publisher by attracting to his list distinguished writers ranging over a wide field—fiction, travel, biography and the fine arts.

Outside his own business Sir Ernest served on the Board of the United Kingdom Provident Institution, and when in 1934 he was invited to become chairman of the Institution in succession to Lord Revelstoke he relinquished his day-to-day guidance of Benn Brothers, but remained as a director. In 1949 he retired from the chairmanship of the UKPI but continued to serve on the board up to the time of his death.

As the arch apostle of individualism Sir Ernest's fight for many years for the maintenance of liberty and freedom attracted wide attention. He carried the gospel of freedom up and down the country and his writings—a score of books and a great many

articles—brought him friendships he valued highly in almost every part of the civilised world.

Sir Ernest was the founder of the Society of Individualists, now the Society for Individual Freedom, and his burning zeal gathered powerful support for the cause he had so much at heart. When in 1950 he was honoured by the Society on his 75th birthday and the 25th anniversary of the organisation he was aptly described as 'this great resistance leader.'

Throughout the years of war, when personal liberties had to be temporarily sacrificed, he kept the necessity for their eventual restoration ceaselessly in the forefront of his writings—notably through his 'Murmurings of an Individualist' which were a weekly feature in *Truth* for seven years. When peace came, his keen, incisive mind fastened on and his virile pen exposed the extravagance of bureaucratic control, the wastefulness of bulk buying, the folly of the curb on free enterprise and competition.

Introduced Five-day Week

He was one of the first employers to introduce the five-day week and he introduced an early and unofficial form of PAYE. His employees, when necessary, received an advance to cover income tax demands, and repaid it by easy instalments.

Sir Ernest was a Fellow of the Institute of Journalists, a former High Sheriff of the County of London, had been president of the Boys Hostels Association, president of the Society of Individualists, president of the Advertising Association and president of the National Advertising Benevolent Association. He was president of the Institute of Export in 1933, held the Festival Appeal presidency of the Royal Commercial Travellers' Schools, and had been chairman of the Readers' Pensions Committee.

Sir Ernest and Lady Benn celebrated their golden wedding just a year ago. Lady Benn survives, and there are two sons and two daughters (one son was killed in the last war). The eldest son, John, who succeeds to the title, is chairman of the United Kingdom Provident Institution, the office formerly held for several years by his father; the second son, Glanvill, followed in his father's footsteps too, and is chairman of Benn Brothers Limited.

Research & I.C.I. Plastics Division

Speeches at the Inaugural Luncheon

AT the inaugural luncheon of the new I.C.I. (Plastics Division) research laboratories at Welwyn Garden City, on 5 January (see *THE CHEMICAL AGE*, 16 January, p. 217) the guest of honour was Professor Sir Cyril Hinshelwood. Rising to propose the toast of 'Research' with which he coupled the name of Sir Cyril, Dr. R. Holroyd, Research Director of I.C.I., said:

'For quite some time now the research workers of Plastics Division have been putting up more or less patiently with a shortage of laboratory accommodation, but they now have something of which everybody concerned can be justifiably proud. The New Year wish which I am sure we would all like to extend to the Division on this occasion is that in the not too distant future they will find themselves equally proud, if not more proud, of the research which these new facilities will enable them to carry out.

I suppose the research done in an organisation like this would be classified by most people under the heading of industrial research. Personally I never have been fond of that term, particularly when it is used in conjunction with academic research. The terms "research with industrial objectives" or "research with academic objectives" are perhaps a good deal more clumsy, but I do think that they at least convey the essential complementary character of these two types of research.

Verv Great Hopes

'We have very great hopes that the work done in this laboratory will provide a very good example of the best type of research with industrial objectives. . . . We are particularly pleased and honoured to have with us as our principal speaker this afternoon someone so renowned in the research field as Professor Cyril Hinshelwood. I am sure that he does not need any introduction from me to this particular gathering. Many of the people here were formerly his own students. . . .

'I am sure that this new laboratory could not have a more promising launching than the one which Sir Cyril Hinshelwood is going to give it this afternoon.'

Sir Cyril Hinshelwood then replied to the toast as follows:

'It has fallen to my lot on one or two previous occasions to respond to toasts on behalf of societies or individuals, but I think never before one on an abstract theme like "Research," and it seems to me almost a symbol of the festive season where I am called upon to play the part, as it were, in a masquerade of the good fairy of research. Of course, according to some people nowadays she is really a very bad fairy, but those, as we all know, are rather ignorant people. She can, of course, sometimes be rather a comic fairy, when she spells herself with a capital "R" and just gazes at herself in the mirror without paying much attention to other people.

Two Legitimate Reasons

'Well, now, what is research and what can one say about research on an occasion like this when a new laboratory is about to be or is being inaugurated? There are, I suppose, two legitimate reasons why one does research, because one wants to know something or because one wants to be able to do something, and that represents a very wide spectrum indeed. What you want to know may be the nature of the universe, what you want to do might be to get to the moon, or what you want to know and do might be just how to unblock a pipe and stop it from getting blocked up again. But I do most whole-heartedly agree with Dr. Holroyd in deploring any attempt to classify or departmentalise research. . . .

'When you are confronted with a situation like this, what is the formula for success? What are you to do about it? Well, I would not feel very confident about telling a gathering in this building what you should do about it, but I have no hesitation in making a remark which perhaps has some significance in the wider national sphere today as to what you should not do about it. What you should not do about it—and thank heavens I see no danger of it in Imperial Chemical Industries—is to collect a large number of broadly educated people who will see the large ends and will recruit a lot of hack scientists who will be on tap

—but not on top—to realise the very unimportant detail of achieving these ends. That doctrine, which I do seriously believe we are in some danger of seeing spreading in the country, that doctrine would certainly not have appealed to Dr. Ludwig Mond in his day, and I do not think it would appeal to anybody in this company now.

The Real Problem

‘Ends, of course, are very easy to conceive, means are fairly easy to provide, but what is difficult is to relate the means to the ends. It is the marriage of the two which presents the real problem always. What are you to do about that? One of the many things that you do about it, of course, is to have good relations between the industrial and the academic world. That has been one of the great contributions of Imperial Chemical Industries to national life, that they have done so much to foster those good relations.

‘So we are still left with the problem of what we need for successful research. First and foremost, I would say you need faith and a sense of adventure, but then those two, of course, can rather easily degenerate into crankiness and doctrinaire attitudes unless you are very careful. So you have to embark on the endlessly painful process of compromise. You want the resolution to go on in spite of discouragement, but you also need the strength of mind to cut your losses when you see that you are not getting anywhere. You need people who are romantic in spirit looked at in the long range, but who are realistic and hardheaded even with a touch of cynicism in the short range. You do not always get these things in the same people, but you have them within the body of people, and they react upon one another. Sometimes perhaps a little painfully, but still, on the whole, healthily. You must, of course, create your technical researches, but you do not have to be a slave to them. You see, at the present moment there is a danger in the whole country that professors will be elected not to chairs but to the howdahs of white elephants. . . .

‘When I say these things about the requirements of the researcher I am reminded that Dr. Holroyd mentioned the large number of my old pupils in this company and, in particular, in this Division. And I wonder that fate has blessed me with such

children reared in the slums of a rather decaying Midland industrial town, many of them in a building which was very inadequately converted from a nameless purpose. They have battled with life and necessity, and here they are, and I feel sure they will go on. They were loved and neglected but they managed to swim and I think they have done well, and I hope when they enter into their very splendid new surroundings here they will continue to do so.

‘Well, here we have this very splendid new laboratory which I had the great pleasure and privilege of seeing this morning, and which I very much admired and rather envied. Well, I wonder what the good fairy Research has to say about it? I think she must regard it as a new and very excellent piece of scenery for the old actors. . . . The play—you have the whole of plastics and that is undoubtedly about the most glamorous subject there is today. . . . You have actors who are probably the best in the country, equal to any, surpassed by none, and you have this beautiful new stage and now the curtain is about to go up and we cannot doubt that there will be a long and successful run and I am sure I should like to join in wishing it every success.’

The History of I.C.I. Plastics

The toast of ‘Plastics Division,’ coupled with the name of its chairman, Mr. John Swallow, was proposed by Dr. A. Fleck, chairman of I.C.I., who said:

‘The history of our plastics work in I.C.I. is of relatively recent origin, well after our Divisional system was set up, but it would not become me to decide whether the main originating root was in the Nobel Division in the work done by Dr. Crawford, or in the Dyes Division, or in the Billingham Division in what was then known as the N.R. Group—(Billingham was at that time enjoying a period of strictly logical organisation with so many sections as to exhaust simple alphabetical sequences)—but wherever the main root, the N.R. Group seems to have been more persistent along the time axis, and one readily recalls the names of Dr. Caress now chairman of the “Terylene” Council, Dr. Sisson, managing director of the Plastics Division, and Mr. Renfrew its development director. Nor should we omit to pay a tribute to Mr. Sampson for his pioneering work for the Division. . . .

‘For the outcome of that work was a tiny

I.C.I. Division—the Plastics Division—owing practically nothing to the merging companies which formed I.C.I. The Division was formed round the nucleus of the Croydon Mouldrite, but thermosetting and thermoplastic materials had each an important place in the business of the Division. With Croydon Mouldrite and all the interest of methyl methacrylate, the Plastics Division was launched on a broad front. . . .

‘The Division was launched and set about the serious work of building up a live and well founded business in research, manufacture and sale of a wide range of plastics. That business is a modern one, although like most other modern businesses its possibility was early foreshadowed. My personal research department tells me that in 1654, Robert Hooke speculated on the possible manufacture of synthetic fibres. He wrote:—“I have often thought that probably there might be a way found out, to make an artificial glutinous composition much resembling . . . that excrement . . . out of which the silkworm wire-draws his clew. If such a composition were found, it were certainly an easy matter to find very quick ways of drawing it out into small wires for use. I need not mention the use of such an invention, nor the benefit that is likely to accrue to the finder.”

‘And yet it was not until 1855 that a crude artificial silk was made in France by treating mulberry leaves with nitric acid, and until 1883 when Sir Joseph Swan made the first practical artificial silk by squirting a solution of nitrocellulose in acetic acid into a bath of alcohol.

Many Interests in Polymers

‘In I.C.I. we have many interests in polymers and in the chemistry of adjacent fields. Practical considerations rather than technical definitions determine the detailed responsibilities of the Plastics Division. Thus while polythene was discovered and produced by our friends at Winnington in the Alkali Division, the Plastics Division have played and are playing a substantial part in its subsequent development. And here I would like to pay a tribute to Mr. John Swallow, for recognising very early the possibilities of polythene and his determination to persist with the experiments.

‘Another important aspect of business which has received valuable contribution from the Plastics Division is our ‘Terylene’

interests. It is always a matter of importance to recognise a winner when it appears and the recognition of the importance of the discovery of ‘Terylene’ by Dr. Whinfield and the Calico Printers’ Association has been an unique example of this. . . .

‘The success that this Division has already attained as a constituent part of I.C.I. and as a part of the wider plastics industry show that they are fully aware of how to meet and carry their responsibilities. Mr. Swallow gives them a leadership at once based on sound advanced science and on good business precepts. We express our appreciation of the many varied tasks so successfully accomplished in the past and our confidence that in the future the Division will make a growing contribution to the chemistry and the business of plastics.’

Mr. Swallow's Reply

Thanking Dr. Fleck, Mr. Swallow replied on behalf of the Division:—

‘First of all I would like to add to the remarks already made about our principal guest today, Sir Cyril Hinshelwood. His wisdom, his human understanding and kindness will not lightly be forgotten by the many people in this room who have been privileged to know him and by the ever increasing number of his former pupils in this Division. . . .

We have waited a very long time for this laboratory. I need not go into the reasons for the delay, but the result which we see today has come after years of thought and effort, and this building is the first instalment of a re-organisation of this site which is now to be our headquarters for research and development, while our factories will be in the north-west and north-east of England, where the raw materials necessary are available. I think that this building reflects the very greatest credit on Mr. Jefferiss Matthews and his colleagues. . . .

‘I think also that the building reflects the very greatest credit on our Engineering Director, Mr. Dibb, and Mr. Symes, and all those who have assisted him in the design of the functional aspects, and I think we may say this is one of the few laboratories, and I advisedly say few, where those who are going to work in it have had a say from the very beginning in what they wanted or what they thought they wanted. I would like to take this opportunity, if I may, of wishing our Research Director, Mr.

Edmund Williams, and his staff, every success in their endeavours in this new laboratory, where, I believe, the best traditions of British chemical research will be maintained.'

BIMCAM's Luncheon

Faith in British Industry Expressed

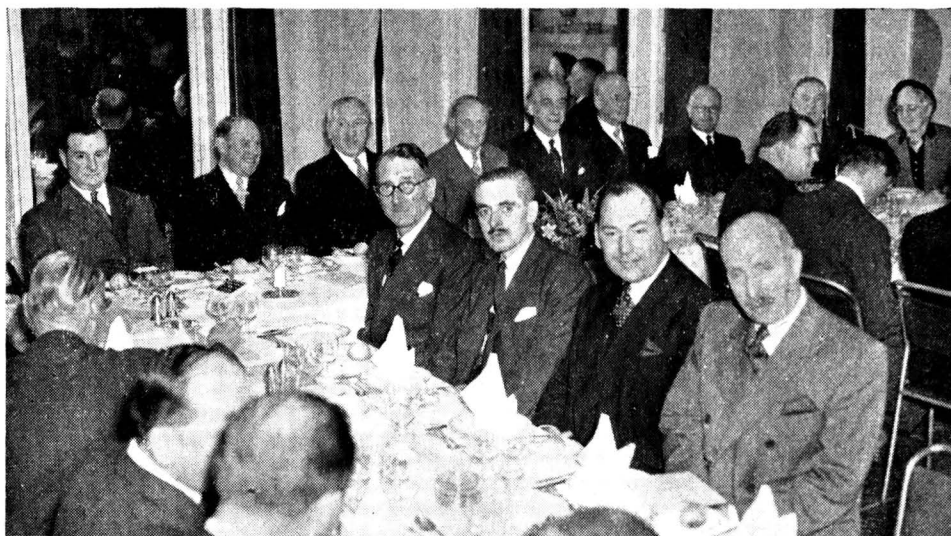
'GET off your knees to the Americans' was the advice given to British industry by Mr. Douglas Wilson, petroleum equipment expert, at the annual luncheon in London on 12 January of the British Industrial Measuring and Control Apparatus Manufacturers' Association. Over recent years, said Mr. Wilson (who is president of the European Federation of Petroleum Equipment Manufacturers) the development in industrial instruments had been very nearly miraculous. 'Instruments in oil refineries almost think aloud. Your field is absolutely illimitable. But you must become aggressive. The intuitive genius of the Englishman is equal to that of anyone in the world.' Mr. Wilson referred to the great benefits that instrumen-

tation could bring to every phase of national life and coupled with that the urgent need for the non-Communist nations of Europe to 'get together.' 'American research is plodding,' he observed. 'Use the native genius of the Englishman, who can always leap one ahead and see the answer.'

Representatives of the British industrial instrument industry and their guests at the luncheon also heard speeches from Col. Sir Harold Smith, chairman of the Gas Council, Mr. H. W. Blake, president of the Association, and Mr. W. G. Thomas, their chairman.

Sir Harold Smith, after poking playful fun at the electricity industry, expressed his admiration of the achievements of members of the association.

Mr. Thomas claimed that British equipment could compete at every point with that of the Americans and Germans, and that British equipment always lived up to the promises made about it. The exports of the instrument industry as a whole had increased by 30 per cent, and they looked to the support of the Government departments concerned with confidence.



At the 10th annual BIMCAM luncheon. At the top table, from left to right:— A. Smith, president of the Scientific Instrument Manufacturers' Association; W. G. Thomas, chairman of BIMCAM; Col. Sir Harold Smith, K.B.E., chairman of the Gas Council; H. W. Blake, president of BIMCAM; D. Wilson, chairman of the Council of British Manufacturers of Petroleum Equipment; W. G. Ardley, founder of BIMCAM; W. C. Knill, president of the Institution of Water Engineers; H. W. Arkell, deputy chairman of BIMCAM and Miss H. V. Lupton of the Ministry of Supply

MIDLANDS SOCIETY FOR ANALYTICAL CHEMISTRY**Analytical Chemistry of W & Mo****(With Particular Reference to Steel & Allied Materials)—Part I**

AT a meeting of the Midlands Society for Analytical Chemistry held recently in Birmingham, the speaker was Mr. B. Bagshawe, Chief Chemist, The Brown-Firth Research Laboratories, Sheffield. The substance of the paper has been divided into two parts: (a) Gravimetry, (b) Colorimetry; and the second of these will appear in the issue for 30 January.

Tungsten and molybdenum are the most closely related of the four elements, including chromium and uranium, which together form the first sub-group of Group IV of the Periodic Table. This similarity exhibits itself throughout the analytical chemistry of the two elements. This creates difficulties for the analyst, who in determining either metal must make his choice from several reactions, which in almost every instance show some measure of interference from the other metal.

The problem for the metallurgical analyst is increased by the frequent addition of both elements to the same alloy, and even when this is not the case, residual amounts of one element are often present along with alloying amounts of the other.

Many Properties in Common

The stable form in each case is the trioxide, giving rise to tungstates and molybdates with many properties in common, including the property of complex formation; thus, both elements form a whole range of analogous heteropoly-acids of which phosphotungstic and phosphomolybdic acids are merely typical examples. Both are precipitated by salts of lead, mercury, barium, etc., from solutions of suitably regulated pH, and by α -benzoin oxime.

Both are reduced by strong reducing agents, e.g. stannous chloride and nascent hydrogen, to relatively unstable lower oxide derivatives, and both form coloured complexes with the thiocyanate ion and with toluene-3,4-dithiol. The behaviour of the two elements to acid hydrolysis does show a wider differential, but, even here the distinction is by no means as clear cut as it is often assumed to be.

These are the reactions which form in the main the basis of analytical determinations. The regulation of experimental conditions, is, therefore, of prime importance, if mutual interference is to be controlled, as the success of such methods is dependent on differences of degree rather than of principle. For example, by suitable regulation of reaction conditions it is possible to determine selectively either element with thiocyanate or with 'dithiol' without significant interference from the other. This selectivity, particularly of the colour reactions, is often used to circumvent direct chemical separations.

Avoiding Difficult Separations

In some cases it is possible to apply the colour reactions directly. In others, depending on the nature of the material being analysed, or on the amount of tungsten or molybdenum present, the reaction is applied after a preliminary separation, or used to correct for co-precipitation of molybdenum in a tungstic oxide hydrolysis residue. In either case the aim is to avoid a difficult chemical separation.

The only chemical separation which at present affords a clear-cut distinction of the two elements over a wide range of concentration and relative proportions is the somewhat objectionable precipitation of molybdenum trisulphide from acid solution in which tungsten is complexed as the non-interfering tartrate.

There are other separations less readily adapted to routine practice. Thus, molybdenum may be selectively sublimed as the compound $\text{MoO}_3 \cdot 2\text{HCl}$ by passing hydrogen chloride gas over the mixed oxides in a closed tube at 270° .

Titrimetric methods usually based on reduction in the Jones type reductor or with liquid amalgams have found little use except for specialised applications such as the determination of comparatively large amounts of molybdenum in pure compounds, in molybdenum-rich minerals and ferro-molybdenum. The process provides a convenient form of rapid assay, but it is not specific, and vanadium, chromium, tungsten, niobium, titan-

ium and several other elements interfere.

The available methods of greatest value, at least in the metallurgical field are: *For tungsten*: determination by acid hydrolysis, by α -benzoin-oxime precipitation, and by the thiocyanate or dithiol colour reaction; *For molybdenum*: determination by sulphide, α -benzoin-oxime or lead molybdate precipitation and by the thiocyanate or dithiol colour reaction.

Precipitation as Tungstic Acid

General.—In spite of all its limitations the chief method for the determination of tungsten is still that in which tungstic acid is precipitated as a product of hydrolysis from solutions of suitably controlled acid concentration.

There is considerable variation in the manner in which this hydrolysis is performed and while it is generally recognised that precipitation may be incomplete it is often assumed to be complete if cinchonine, rhodamine B¹ or one of several other reagents is used as an additional aid to precipitation. This assumption is by no means well-founded and in applying these reagents to steel solutions the recovery of tungstic oxide is invariably incomplete, varying in degree according to the tungsten concentration, conditions of hydrolysis and other factors.

It is one thing to recover, say, 50 mg. of tungsten from an otherwise pure solution, but it is quite another to recover less than 10 mg. from a steel solution. The complex-forming proclivities of tungstic acid with phosphoric acid, silicic acid and possibly other ions from the steel solutions are factors which may have some bearing on the relative difficulty of recovery.

With pure tungstate solutions, as distinct from steel solutions, cinchonine, rhodamine B, tannin-cinchonine and tannin-antipyrine all give effective precipitation at the 40 mg. tungsten level, but at 7.5 mg. the only process which gives a quantitative yield is the combined tannin-cinchonine procedure of Schoeller and Jahn² (Table I).

TABLE I
Hydrolysis Recovery; Pure Tungstate Solution

	W added (gm.)	W found (gm.)
Cinchonine	0.0074	0.0050
	0.0396	0.0386
Rhodamine B	0.0074	0.0055
	0.0396	0.0385
Tannin-Antipyrine	0.0074	0.0074
	0.0396	0.0388
Tannin-Cinchonine	0.0074	0.0075
	0.0396	0.0398

Neither tannin nor cinchonine alone is a satisfactory precipitant.

A combined tannin-rhodamine B precipitation would perhaps be equally effective. In our experience a combined precipitation of this type is the only one which will recover all the tungsten from solutions containing complex alkali salts, e.g. after treatment involving fusion with alkali carbonate or with bisulphate. The value of the process is limited, however, by the fact that it cannot often be applied without a previous separation. Direct application to steel solutions, for example, would be difficult. Precipitation with tannin is not particularly selective and the precipitate is bulky, adsorptive and difficult to wash.

Hydrolysis from Steel Solutions.—For many years routine tungsten determinations have been carried out by simple hydrolysis by digesting with hydrochloric acid and subsequently diluting without the aid of cinchonine or other organic precipitant. According to Ibbotson³ the separation of tungstic acid is quantitative from chloride solutions if the hydrochloric acid concentration does not exceed 20 per cent by volume. A long experience with Ibbotson's method has shown that his conclusions are for all practical purposes valid if the steel contains an appreciable amount of tungsten, e.g. > 2 per cent, and does not contain large alloy additions, particularly of chromium.

High Tungsten Steels

Since it is likely that most of Ibbotson's work was done on reasonably high tungsten steels and prior to the introduction of tungsten-bearing high nickel-chromium rustless and heat-resisting steels, his conclusion is probably a fair record of his experience. Thus, very satisfactory tungsten determinations can be made on high speed steel by Ibbotson's procedure and very little additional tungsten is recoverable by the use of cinchonine or other organic precipitant. For example, the following range of figures have been obtained on British Chemical Standard High Speed 'W2' (16.12 per cent tungsten):

Ibbotson's method (no cinchonine)
15.98-16.14 per cent.
Modified hydrolysis (+ cinchonine)
16.00-16.20 per cent.

The certificate of analysis with the above steel shows a range of from 15.99 to 16.24 per cent tungsten and it is interesting to observe that of nine chemists co-operating in

the official standardisation, only three report the use of cinchonine, their figures being: 16.20, 16.0 and 16.24 per cent tungsten. The remaining six used Ibbotson's method, or one very similar, without cinchonine and their reported values were 16.21, 16.0, 16.18, 16.18, 16.06 and 15.99 per cent tungsten. The above values show very little evidence for the need of cinchonine in determinations on high tungsten steel. Our experience has been similar with lower tungsten contents down to about 2 per cent, and it would appear that provided a minimum optimum concentration of tungsten is present sufficient nuclei obtain from the initial hydrolysis for post-precipitation of the remaining tungsten.

Effect of Standing Prior to Filtration.—

That post-precipitation does in fact occur after the initial hydrolysis induced by boiling the dilute acid solution is amply demonstrated by comparing the results of tests in which filtration was done immediately with those from tests which were allowed to stand for various intervals before filtration. (Table II.) These tests were made by ordinary hydrolysis without cinchonine or other organic precipitant. In high tungsten steel, precipitation is almost complete within 15 minutes, and standing for one hour gives a result which is sufficiently accurate for most practical purposes. Ibbotson recommends in his method that the test should be 'set aside for at least 15 minutes' before filtration.

TABLE II
Effect of Time on Completion of Hydrolysis
Standing Interval

	None	15 mins.	1 hr.	3 hrs.	Over-night
BCS High Speed Steel No. W ₂ 16.12% W ..	15.80	15.95	16.05	—	16.10
18/8 Cr-Ni Low Tungsten ..	0.46	—	—	0.63	0.64

Gregory and Stevenson suggest that a standing interval is not necessary for tungsten-rich steels, but recommend standing overnight in their cinchonine method⁴ for steels containing less than 1 per cent tungsten. Pigott⁵, who gives the same method, also recommends overnight standing, but suggests one hour for steels containing more than 1 per cent tungsten. American workers⁶ recommend various standing intervals, (i) until the WO₃ has settled if more than 2 per cent is present, (ii) 18 to 24 hours

for small amounts until the precipitate separates (1 to 3 hours) and (iii) digest for 30 minutes or longer at 90° to 95°.

We have often observed that the time required for complete or almost complete precipitation is largely a question of the tungsten content. High tungsten concentrations precipitate rapidly and precipitation is soon complete. Low tungsten contents require progressively longer standing intervals and precipitation may not be complete even on prolonged standing. This effect is illustrated by the figures on the 18/8 Cr-Ni steel (Table II). This steel contains 0.78 tungsten, and 0.14 per cent remained unrecovered on overnight standing.

TABLE III
Efficiency of Cinchonine
18/8 Cr-Ni Steel (0.78%W)
(5 gm.)
% W found

Without Cinchonine	With Cinchonine
0.64	0.72
0.65	0.71
0.61	0.63
0.67	0.71
0.72	0.61
0.61	0.69
0.67	0.67

While the need for some standing interval is fairly well recognised, many tungsten determinations are still made with little attention being paid to this point, and the common practice of offsetting this by not correcting the weight of the residue for impurities other than silica is to be deprecated.

Tungsten Contents < 2 per cent—Use of Cinchonine.—Quantitative precipitation by hydrolysis alone from dilute hydrochloric acid solution by the Ibbotson or other similar procedures is very uncertain for these smaller amounts; with very small amounts of tungsten the recovery is often negligible and as much as 0.25 per cent may escape unnoticed.

Some improvement can be made by modifying the conditions of the hydrolysis, and for many years we determined tungsten in 18/8 Cr-Ni steels (0.5 per cent W) by the following procedure: Dissolve a 5 gm. sample in 60 ml. of hydrochloric acid (SG 1.16), oxidise with nitric acid (SG 1.42) and evaporate to dryness. Bake lightly for ten minutes, extract the baked residue with 35 ml. of hydrochloric acid (SG 1.16) and evaporate to a syrup of about 15 ml. Dilute with 200 ml. of 10 per cent hydrochloric

acid (v/v) and allow it stand overnight.

This method of carrying out the hydrolysis is superior to the Ibbotson method for all amounts below 2 per cent tungsten, but for 18/8 Cr-Ni steels usually with < 1 per cent tungsten the recovery is erratic and usually low. It has become almost standard practice to rely on cinchonine to precipitate small amounts of dissolved tungsten and thereby compensate for irregularities. That this reliance cannot be confirmed is illustrated by a series of results on an 18/8 Cr-Ni steel containing 0.78 per cent tungsten. (Table III.)

These results are typical of the inconsistencies that have often been noted during the analysis of large numbers of 18/8 Cr-Ni + W steels over an extended period. While the average recovery is better with cinchonine than without, i.e., 0.69 per cent against 0.65 per cent, the values are still erratic and in every case the recovery is low. It has also been noted that treating a filtrate with cinchonine from a test not previously treated with this reagent sometimes recovers an additional small amount of tungsten, but if a filtrate from a cinchonine-treated test which has given a low recovery is further treated with the reagent no additional precipitation occurs.

Tungsten Contents < 0.5 per cent.—

Recovery becomes progressively worse with still smaller amounts of tungsten either with or without cinchonine, although it is usually better with the reagent than without it. The results given in Table IV were obtained by taking varying weighed amounts of the 18/8 Cr-Ni-W steel to give a decreasing range of tungsten contents down to 0.07 per cent tungsten. In all cases the weighed amounts were made up to 5.0 gm. with a pure 18/8 Cr-Ni steel (spectroscopically-free from tungsten).

TABLE IV

18/8 Cr-Ni (0.78% W)		Efficiency of Cinchonine		% W found	
g.	(W nil.)	% W Present	Without cinchonine	With cinchonine	
5.0	—	0.78	0.67	0.70	
2.5	2.5	0.39	0.32	0.34	
2.0	3.0	0.31	0.18	0.23	
1.0	4.0	0.16	0.04	0.08	
0.5	4.5	0.08	nil	0.02	
—	5.0	nil	nil	nil	

Hydrolysis with a Sulphurous Acid.—It has been claimed that a more complete recovery of tungsten is obtained from a reduced iron (ferrous) solution by hydrolysis

with sulphurous acid, and this procedure forms the basis of the British Standard Method for steel⁷. It is applied by evaporating the initial acid solution to a volume of 15-20 ml. and then boiling with 100 ml. of saturated aqueous sulphur dioxide solution. The precipitation is completed by adding rhodamine B.

Hydrolysis with sulphurous acid alone is almost as good as normal hydrolysis with cinchonine or rhodamine B. A combination of the hydrolysis with rhodamine B, as in the BS method, gives the nearest approach to a quantitative yield (Table V). Dithiol determination of unrecovered tungsten in the filtrates provides direct and decisive proof of the comparative inefficiency of the separation by hydrolysis, with or without additional organic precipitating reagents.

TABLE V
Separation of Tungstic Acid from Steel Solutions.
Comparison of Hydrolysis Conditions

	% W	% W	% W in Filtrate (Dithiol)
A Normal Hydrolysis from 15% HCl	0.78	0.72	0.07
B As A + Cinchonine	0.21	0.12	0.105
	0.78	0.70	0.07
	0.21	0.11	0.115
C As A + Rhodamine B	0.78	0.66	0.12
	0.21	0.13	0.09
D Reduced Fe Sol. H ₂ SO ₄ Hydrolysis	0.78	0.67	0.12
	0.21	0.09	0.15
E H ₂ SO ₄ Hydrolysis + Rhodamine B	0.78	0.74	0.04
	0.21	0.20	0.05

It is possible that incomplete recovery may be associated with a somewhat fortuitous fixation of tungsten as phosphotungstic acid or other polyacid complex, or metatungstate with metal ions present in the steel solution. Cinchonine is reputed to be a precipitant for phosphotungstic acid, and, in fact, if larger amounts of tungsten are being precipitated, i.e. 40 mg. or more, the percentage yield improves and the precipitate is known to contain phosphorus. It may be that a substantial hydrolysis precipitate induces co-precipitation of the phosphotungstate.

Other aids to precipitation.—In addition to cinchonine and rhodamine B, other organic precipitants which have found some use include Yoe's⁸ reagent *anti*-1,5-di-(*p*-methoxyphenyl)-1-hydroxylamino-3-oximino-4-pentene, antipyrine (phenazone), and ben-zidine.

Yoe's reagent is at least equal to cinchonine as a precipitant but it gives substantial co-precipitation of molybdenum. For

example, 2 mg. and 3 mg. of MoO_3 were found, respectively, in duplicate tests on the tungstic oxide residues from a steel containing only 0.26 per cent molybdenum. British Chemical Standard Steel No. 220 (6.74 per cent W, 4.17 per cent Mo) gave a tungstic oxide residue contaminated with 23.7 mg. of MoO_3 .

Antipyrine has been recommended by Moser and Blaustein⁹ and others, and Ellwell¹⁰ has applied it in combination with tannin directly to a steel solution. The recovery is approximately equal to that obtained with cinchonine. An important objection to tannin-antipyrine is the sticky nature of the bulky precipitate, as this increases the difficulty of filtration and of washing out occluded salts. From a manipulative point of view cinchonine and rhodamine B are both superior.

Benzidine Precipitation

Benzidine was first recommended by Von Knorre¹¹ in 1905. Precipitation of benzidine tungstate is quantitative from neutral solution, but a low concentration of sulphuric acid is permissible to promote a mixed precipitate of the amorphous tungstate with the crystalline sulphate. This mixed precipitate is more amenable to filtration than the amorphous amine tungstate. There is partial precipitation of benzidine molybdate under the same conditions.

Benzidine precipitation is applicable to slightly acidified solutions of alkali tungstates, and hence it may be of some value in the analysis of ores or of residues from a previous treatment. It is not directly applicable to steel solutions because of the need for nearly neutral solutions and because the reagent itself is destroyed by oxidation with ferric salts.

Interference Effects.—Tungstic oxide precipitates from hydrolysis procedures are invariably impure, the usual contaminants being silicon, niobium, tantalum (quantitative) and titanium; molybdenum, vanadium, etc., are precipitated in part. In addition, minor amounts of iron, chromium, etc., may be carried down by occlusion.

Sodium carbonate fusion removes some of the impurities, but molybdate and vanadate accompany tungstate in the soluble extract, necessitating further separation, or, more commonly, correction based on a colorimetric determination on a suitable aliquot of the extract.

One of the difficulties attending the use of organic precipitants is that they usually increase the order of contamination, particularly of molybdenum.

The degree of molybdenum contamination which occurs during the separation of tungstic acid by hydrolysis is, in fact, influenced by a variety of factors, e.g. the concentration of the two elements, the ratio of their respective concentrations and the acidity of the solution. In general, conditions which favour a completely quantitative hydrolysis of tungstic acid also favour an increase of molybdenum contamination in the British Standard Method⁷, for example, where use is made of both sulphurous acid and rhodamine B to promote a maximum yield of tungsten by hydrolysis. For example, Table VI shows the order of contamination which arises when the BS method is applied to high tungsten-molybdenum high-speed tool steel.

It should be recognised, however, that the figures shown represent an extreme case. There is no particular difficulty with low molybdenum steels, as the small amount of contamination which occurs can be corrected for by applying a colour reaction on the solution of the residue.

TABLE VI

Tungsten Hydrolysis. Molybdenum Contamination.
BCS No. 220 High Speed Steel
(6.7% W, 4.17% Mo.)

Hydrolysis with Rhodamine B.	
MoO_3 in Residue	Mo equiv.
21.9 mg.	14.6 mg.
22.2	14.8
24.4	16.3

Molybdenum by α -Benzoin Oxime

This method due to Knowles¹² has in recent years largely superseded the older lead molybdate process, and with the exception of the thiocyanate colour method it is the one most commonly applied in steel analysis.

Precipitation of the molybdenum complex is quantitative from ice-cold dilute sulphuric acid solutions. The optimum acidity is about 5 per cent of either sulphuric or hydrochloric acid, preferably the former. Residual nitric acid from an initial oxidation of a ferrous solution does no harm.

Temperature is important. Above 10° there is a small but measurable solubility of the complex, and this increases markedly with further rise of temperature. The occlusion of iron and other impurities is

also minimised by precipitation at low temperatures.

Bromine water is usually added after the first addition of α -benzoin oxime to counteract a tendency for traces of molybdenum to be reduced by the reagent.

The reaction is very nearly specific for molybdenum under the conditions cited. Elements which hydrolyse from the initial acid solution, e.g. tungsten, niobium, tantalum and silicon, cause the most trouble, as their removal occasions some loss of molybdenum, unless the hydrolysis residue is a comparatively small one.

Residual Tungsten

Residual tungsten, not removed by the initial acid treatment, interferes as it is quantitatively co-precipitated with the molybdenum complex. The reaction may, in fact, be used as a means of determining tungsten, but the recovery is only quantitative if an excess of molybdenum is present. The question of further separation, therefore, arises. Because of this the method is usually reserved for the determination of molybdenum in tungsten-free steels, or after an initial separation of tungstic acid. The British Standard Method¹⁹ provides for a separation from residual tungsten (up to 0.5 per cent) by wet oxidation of the mixed tungsto-molybdenum complex and separation of molybdenum as trisulphide from a buffered tartrate solution.

Apart from tungsten, no other elements commonly used in ferrous metallurgy interfere. Vanadium and chromium must be present in their tetravalent and trivalent forms respectively as there is interference from pentavalent vanadium and hexavalent chromium. This condition is easily met by adding ferrous sulphate or sulphurous acid before precipitation.

There are various ways of dealing with the precipitated complex, all of which involve its decomposition. Molybdenum cannot be determined by direct weighing of the complex itself.

It may be ignited to oxide but this requires careful burning conditions to remove the large amount of organic matter, as MoO_3 is volatile above 550° . The time and care necessary in converting the complex to oxide is rather a liability, influencing to some extent the routine value of the method. Further, the ignition product is rarely sufficiently pure for direct computation of molyb-

denum. It is common practice to extract the weighed impure oxide in solutions of ammonia or sodium hydroxide, filter, ignite and weigh the small residue of impurities of iron and chromium, etc., and make the appropriate correction. If there is more than one or two mg. of impurity there may be some loss of molybdenum. The ammoniacal or caustic extract may also be suitably adjusted for precipitation and determination as lead molybdate.

Instead of ignition to oxide the complex can be decomposed by wet oxidation with nitric and sulphuric acids as in the British Standard method.

A most useful application of the α -benzoin oxime procedure is as a means of initial separation from a large weight of steel preparatory to a determination by the thiocyanate colour method. In this way very small amounts of molybdenum can be isolated from as much as 10 gm. of steel and concentrated in suitable solution for the thiocyanate reaction. By this means a very high order of accuracy can be obtained in very low content ranges, e.g. < 0.05 per cent.

Separation as Molybdenum Sulphide

When correctly applied, this is an excellent means of separation, and it is the only one which gives a good separation from tungsten.

The correct acidity for precipitating molybdenum trisulphide is 3.5 per cent by volume sulphuric acid, but there is a distinct tendency for precipitation to be incomplete in a single treatment. This is due to partial reduction of the molybdenum to a lower form and in order to be certain of complete recovery it is necessary to filter off the primary precipitate and to recover the soluble fraction from the filtrate by boiling free of hydrogen sulphide, re-oxidising with bromine water or persulphate and repeating the precipitation with sulphide.

Mainly because of this difficulty the process is not attractive as a primary separation from a steel solution. There is also co-precipitation of copper, tin and other sulphides. While copper, etc., sulphides may subsequently become a nuisance, they do, by acting as carriers, aid the complete separation of molybdenum.

Tungsten is co-precipitated in part if tartrates are absent, but in the presence of sufficient tartrate the separation from tungsten

is perfect. This also gives a good separation from vanadium, titanium, niobium and tantalum.

Probably the most valuable application of the method is as a secondary treatment after a primary precipitation with α -benzoin oxime. By this means it is possible to adopt a modified form of sulphide precipitation which permits a maximum recovery of molybdenum in a single operation. This modification depends on first forming the thiomolybdate by treatment with sulphide in caustic tartrate solution and decomposing it by acidification and further treatment with hydrogen sulphide to complete the precipitation of molybdenum sulphide. This gives an excellent separation from tungsten and is the one used in combination with α -benzoin oxime precipitation in the British Standard gravimetric method.¹³

The trisulphide precipitate is ignited to oxide at 550°. It must be said, however, that complete conversion is not easy or certain at the low temperature imposed by the volatility of molybdic oxide. This is particularly so if the residue is a large one.

Precipitation as Lead Molybdate

This was once the classical procedure for determination of molybdenum, and while it has largely been superseded by the α -benzoin oxime and thiocyanate procedures it still has its adherents.

Molybdic acid, together with tungstic, vanadic, and chromic acids, is precipitated in neutral or weakly acid solution by salts of lead, mercury¹, cadmium, silver, etc. Precipitation with mercurous salts is still sometimes used in the analysis of tungsten and molybdenum minerals. The sample is fused with alkali carbonate, extracted in water, iron, manganese, etc., removed and the mercurous salt applied to the carefully neutralised solution. The composition of the precipitate is indefinite, but ignition results in the volatilisation of mercury leaving a residue of the oxide (MoO_3 , WO_3 , V_2O_5 , Cr_2O_3).

The compounds precipitated are characterised by indefiniteness of composition, the variation being influenced by a number of factors, including acidity, temperature, excess of precipitant, presence or absence of ammonium salts, etc. The chief exception is the lead molybdate which under properly regulated conditions has the theoretical constitution ($\text{PbO} \cdot \text{MoO}_3$).

The precipitate is of ideal physical type; providing ammonium or sodium salts are present in sufficient concentration, it settles rapidly in the form of a dense acicular compound having excellent filtering and washing properties. In the absence of ammonium salts the precipitate is amorphous and difficult to handle.

Formic Acid Solution

Precipitation may be made from formic acid solution and this is preferred to the more usual buffered acetate solution. It prevents contamination from aluminium, tin, etc., and it can also be used to control interference from vanadium.

As applied to steel, precipitation of lead molybdate usually follows a sodium hydroxide separation of iron, chromium, nickel, etc., or it is sometimes applied after a preliminary separation as α -benzoin oximate or sulphide.

Separation with sodium hydroxide gives complete extraction of molybdenum provided a weakly acid solution of the steel is added slowly to a large excess of the alkali. Otherwise there is loss of molybdenum as basic ferric molybdate.

Tungstate and vanadate interfere by forming their corresponding lead salts. It is usual to remove tungsten by hydrolysis from the initial solution prior to the sodium hydroxide separation. Vanadium may be removed as basic manganese vanadate after the sodium hydroxide separation. It can also be rendered non-interfering by boiling with a large excess of formic acid. High phosphorus contents, as in some cast irons, interfere by coprecipitation of lead phosphate. Large amounts of ammonium chloride may be added to suppress this; for high phosphorus irons, up to 35 gm. may be necessary.

The process gives good results on many steels, but above about 1 per cent molybdenum it tends to give a basic precipitate ($x\text{PbMoO}_4 \cdot y\text{PbO}$) giving results which are approximately 3 per cent high. This effect is eliminated by reprecipitation.

Below about 0.2 per cent molybdenum, the results tend to be low, and below 0.1 per cent molybdenum, precipitation is extremely uncertain. Long digestion for 2 hours or more, or overnight standing, may be necessary to promote quantitative precipitation at these low content levels.

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(To be concluded).

Beryl in Rhodesia

LEADING American financial interests are sharing in the development of a lithium-beryllium property near Fort Victoria which has recently been sold for a sum believed to run into six figures. The property is about 45 miles from Fort Victoria, in the Bikita area, where beryl was first found in quantity in Southern Rhodesia only four years ago.

Announcing that options on the property are being exercised, a statement issued in Bulawayo recently by Selection Trust Ltd., which has big holdings in the Copperbelt and in South Africa, says that exploration work undertaken by a subsidiary company has produced encouraging results.

A considerable tonnage of beryl ore and large highgrade deposits of lithium-bearing minerals have been revealed. The statement also says that in addition to Selection Trust Ltd., two American companies, American Metal Company Ltd., and the American Potash and Chemical Corporation Ltd., are sharing in financing the property.

American Metal is regarded as one of the giant companies in the mining world. It has interests in several countries, including Northern Rhodesia, in the Roan Antelope Copper Mine Ltd., and the Rhodesian Selection Trust Ltd.

Plastics Conference

LEADING plastics experts of Government research establishments, aircraft and motor firms and plastics manufacturers recently held a three-day private conference at Stratford-on-Avon on reinforced plastics. The conference was called by the British Plastics Federation, which recently formed a com-

mittee known as the Asbestos and Fibre-Glass Reinforced Plastics Technical Committee to cater for all interests—manufacturers' and users'—in this rapidly developing material.

More than 100 experts, representing four Government departments and 33 firms from all parts of the country, held six discussion sessions in 43 hours. They were asked to disclose the nature of their research and development work and to discuss their problems. The proceedings were strictly private, no report being made even by the secretaries.

At the conclusion of the conference Mr. H. A. Collinson, chairman of the main technical committee of the British Plastics Federation, who presided at the conference, said: 'It is important at this early stage of development that we should exchange information and opinions. I doubt whether there has ever been in any industry such a frank exchange of confidential information as we have had in these last two days, both in session and in conversation.'

Physical Society Exhibition

THE 38th (1954) annual exhibition of the Physical Society will be held at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7, from Thursday, 8 April, to Tuesday, 13 April, 1954. The exhibition will be wholly located in the Physics and Chemistry Departments of the College. Applications for tickets should be made to the Secretary-Editor at the Offices of the Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7. Tickets will not be sent out until the beginning of March, and no order can be acknowledged unless a stamped addressed post card is also enclosed.

Extreme pressure on space has made the 38th exhibition slightly smaller than that of previous years. Particular care has been taken, however, to ensure that the standard of entries is higher than ever before and a large proportion of new or novel equipment will be on show.

As in previous years the comprehensive handbook of the exhibition will be available at the Exhibition and copies can be obtained on application to the Secretary-Editor at the address given above. The price of the publication is 6s. (by post 7s. 3d.).

Atomic Energy in Britain

Some Chemical & Engineering Problems Involved

PUBLISHED last Monday, 'Britain's Atomic Factories' (HMSO, price 5s.), is the first official report to describe in detail the organisation of atomic energy production in Great Britain. It also reveals how the refusal of the United States to allow access to American work (very often developed from British contributions made during the war) has meant that research in this country has had to be carried out from scratch, with many consequent delays.

When in February 1946 the nucleus of the Division of Atomic Energy Production was set up in a former ordnance factory at Risley, in Lancashire, it consisted of 12 men and women, only one of whom knew anything at all about atomic energy. That in eight years three large factories have been put into commission, all within a short time of their provisional dates, is a tribute to the energy of the administration, which is directed by Sir Christopher Hinton.

As the report points out, 'the scientific and technical problems of most importance in the design of these factories were not concerned with nuclear physics so much as with chemistry and metallurgy,' and the

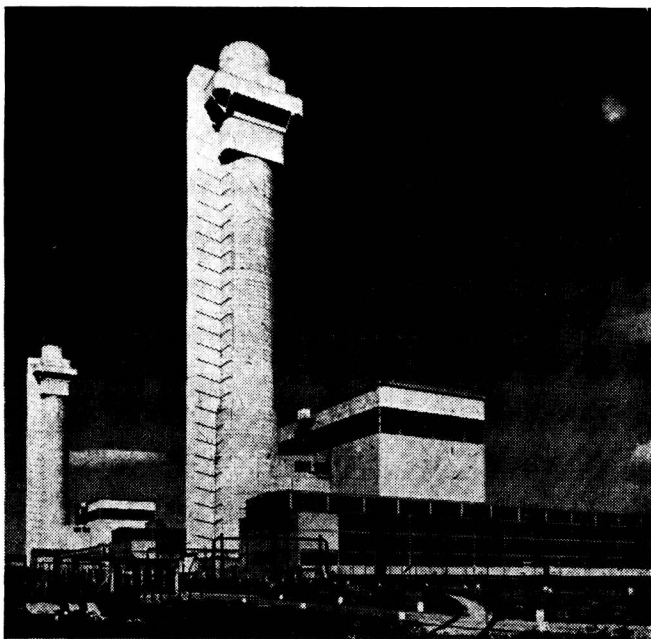
following brief description of the processes carried out should illustrate this statement.

The first job undertaken by Risley was the design and erection of a plant to extract uranium from its ores. Apart from provisions to ensure that workers do not come into contact with dust, and unusual care to prevent contamination of the extracted metal by impurities, the construction of the plant was fairly conventional. A former I.C.I. poison gas factory at Springfields was eventually chosen, and adapted to its new purpose.

The ore arrives at Springfields in large lumps sealed in metal drums; the first stage crushing equipment is standard, except that elaborate auxiliary plant is necessary to remove dust, control liberated radon, and carry out continuous sampling. The crushed product goes to ball-mills, where it is broken down into a powder and slurried with water; from here it is pumped to a batch of cascade dissolvers.

Uranium is dissolved as uranyl sulphate; addition of barium carbonate brings down radium and other metallic impurities, some of them precious. The liquor is filtered and

Windscale: a view of the two completed piles and their stacks. The galleries near the top of the stacks carry dust filter units, and the shafts running up the stacks are for the removal of these units



the precipitate returned to the suppliers of the ore, who are experienced in the extraction of radium. The uranyl sulphate is treated with hydrogen peroxide and ammonia to precipitate uranium oxide, which is removed by filtration.

By ordinary standards the oxide thus obtained is quite pure, but the sensitivity of atomic piles to neutron-absorbing substances is such that these must be removed to give purity higher, it is claimed, than ever before attempted, even for pharmaceutical chemicals. Boron, for example, must be present in a concentration less than 1 ppm.

Further Purification

Purification is achieved by solvent extraction, employing ether. The crude oxide is dissolved in nitric acid, and the solution evaporated under controlled conditions to give uranyl nitrate of known composition. In a typical extraction plant, the uranyl nitrate is transferred to the ethereal phase, leaving the impurities in the aqueous phase; after separation, the nitrate is extracted from the ether again by washing with dilute acid.

The uranium is precipitated from this aqueous solution as ammonium diuranate, which is converted to the metal in two stages. By reaction with hydrogen fluoride in an electric furnace the solid tetrafluoride is formed (this is known as the 'Dryway' process), and is reduced with calcium to give the metal, which is then further purified by casting in vacuum. Finally the rod is machined accurately to size and enclosed in an aluminium can, whose purpose is to prevent the escape of fission products and the oxidation of the uranium.

Plutonium, since it is chemically different from uranium, may be separated from it by purely chemical means, which are generally more efficient and less expensive than physical methods. Thus the transmutation of the widely-occurring ^{238}U to ^{239}Pu and, the subsequent separation from ^{235}U , is more desirable than the separation of the radioactive ^{235}U from ^{238}U . The Windscale establishment at Sellafield, Cumberland, is concerned with plutonium production.

Separation may be carried out in various ways: by precipitation, by selective adsorption, or by solvent extraction. It was recommended in 1946 that the last would probably be the most suitable for use in the United Kingdom. Very little, however, was known, about the chemistry of pluto-

nium, and a chemical group was set up to carry out research in the subject, under the direction of Dr. R. Spence, now head of the chemistry division at Harwell. They began work at the Canadian establishment of Chalk River, with no more than 20 mg. of plutonium available with which to experiment. Nevertheless, they were able to develop a method suitable for application on a large scale at the new works.

Slugs of irradiated metal come from the pile: every ton contains a few ounces of plutonium, about a hundredweight of radioactive fission products, and 19 hundredweights of uranium slightly depleted of the 235 isotope. First, the slugs are dissolved in nitric acid, and then the uranium and plutonium are separated from the fission products by counter-current solvent extraction. The solvent phase is transferred to another extraction apparatus, and the separation of plutonium and uranium carried out there.

The primary separation involves highly radioactive substances and the apparatus must be completely screened from the operators. Moreover, once the plant has been used it is itself extremely active, and therefore cannot be opened for repair or control. It was therefore designed without pumps, valves or filters, and constructed entirely of welded stainless steel. This involved, first of all, the development of a special steel and methods of welding; and, as a consequence, expansion of steel-making plant and the training of special personnel. To ensure that every weld was perfect, the history of each billet of steel was recorded, from first casting to final welding; every joint was inspected on both sides visually, and by X-radiography; and a complete report on each joint, with identification numbers, was filed. Altogether, 50,000 welds and about 10 miles of pipe were involved.

Secondary Separation

The secondary separation involves only low activity, and thick shielding is not necessary. The final stages are carried out in quartz glass apparatus enclosed in Perspex cabinets. The uranium solution is returned to Springfields, where it is put into the production cycle, and the solvent is recovered in the normal way.

Disposal of waste at Windscale is by far the most serious problem, since the works is dealing throughout with high-activity

material. The air employed for cooling the piles is filtered and then passed through the 415-ft. high stacks which have become a feature of the countryside, but disposal of the liquid wastes is more difficult.'

So far, no means has been developed for disposing of the high-activity effluent. It is run into great shielded storage tanks, where it is left indefinitely for slow radioactive decay to take place. The medium active effluent is also run into tanks, but after two or three years its activity is sufficiently low for it to be disposed of as low-activity waste.

Waste with an activity below that prescribed by the Medical Research Council is piped out to sea. The laying of pipelines for this purpose was probably one of the greatest achievements of the Atomic Energy Division; two pipes, each $2\frac{1}{2}$ -miles long and about a foot in diameter, were laid. These were welded into half-mile lengths on shore, and then dragged out to sea by a 12,000-ton tanker, the lengths being welded on each half-mile. Very many difficulties were involved: the pipes must lie in a straight line; the tanker would not steer and had to be guided by three tugs; in order to minimise the effect of strong currents the operation was carried out at neap tide, when there was less depth for the boats to manoeuvre; fine weather was essential—yet the whole performance was completed in five days early in June 1950.

Physical Separation

As was mentioned above, the separation of ^{235}U and ^{238}U requires physical methods, and in view of the difference in atomic weight it was suggested early in the war that gaseous diffusion would be the most suitable means. Uranium hexafluoride which is gaseous at temperatures around 60° , is the only practicable compound; since fluorine has only one isotope, a further advantage is that the molecular weight difference is due solely to the uranium. In 1948, plans were first considered for the erection of a diffusion plant at Capenhurst in Cheshire.

Construction difficulties at Capenhurst were ones of chemical engineering. Uranium hexafluoride is a highly corrosive compound; it solidifies below 56° ; and it reacts readily with many substances, including water. In view of the small difference in molecular weights it was obviously necessary to employ a cascade process; the actual

plant employs seven diffusion stages, and three strip stages on the discard from the first stage. Circulating pumps are required, but the hexafluoride must be kept away from any lubricants; the membranes might be inert and capable of withstanding considerable pressures, and they must have extremely small pores.

Perhaps the most difficult problem of all is to prevent air, particularly moist air, from leaking into the plant. Instruments are installed to detect very slight variations in the concentrations of certain impurities and indicate the occurrence of any leakage. The gas emerging from the diffusion stages is condensed in a 'cold-finger' trap cooled by liquid nitrogen.

At all three establishments analytical services are maintained by the Chemical Inspectorate of the Ministry of Supply; demands have been so great that this branch of the Inspectorate has outgrown its parent. Many specialised techniques are involved, since not only very small quantities are determined, but a number of elements—such as the rare earths—were formerly of little analytical importance and methods of analysis were few. Several hundred good analysts have been specially trained for the work, which involves the use of apparatus such as mass-spectrographs and counters, and a knowledge of special precautions to take against high-activity radiation.

'Britain's Atomic Factories' describes many other features of atomic energy production, particularly the medical services which have made the works among the safest in the country. The book, written by Mr. K. E. B. Jay, of Harwell, is very readable and well illustrated; an appendix gives a short explanation of the physical principles involved, for the benefit of the layman. After reading this description of an entirely new industry, one which may within 20 years be saving Britain 20,000,000 tons of coal per year, it is easy to agree with the author that 'there is even more adventure to come than has been encountered in the past.'

Obituary

MR. JAMES ROBERTS, M.Sc., for more than 20 years a lecturer in inorganic chemistry at the University of Glasgow, has died, aged 82. Mr. Roberts retired from active work in 1939. For many years he was associated with the late Professor John Ferguson.

Induction Heating

Kestner Company's Acquisition

THE well-known Wild-Barfield Induction Heating System has for some while been applied with great success to the heating of metals for forging, billet heating and heat-treatment.

Results of research and development in this system over the last few years have made it possible to apply it efficiently to heating kettles, autoclaves, stills and other process vessels commonly used in the chemical and allied industries. Kestner Evaporator and Engineering Co., Ltd., have acquired the exclusive rights of the system for such applications in the chemical and allied industries.

This patented method of heating employs standard mains frequencies and eliminates the need for complicated frequency changers which have hitherto been associated with induction heating systems. The simplicity of operation and the close control of temperature attainable are among the features which are claimed to put this method of heating ahead for many of the processes carried out in the fields concerned.

With the Wild-Barfield company's research facilities and wide knowledge on the electrical side combined with the chemical engineering experience and pilot-plant laboratories of the Kestner Evaporator & Engineering Co., the best possible advice on the application of this new method of heating is assured. The Kestner company will shortly have available an installation in their laboratories where tests and demonstrations can be made.

All inquiries from the chemical and allied industries should be addressed to Kestner Evaporator & Engineering Co., Ltd., 5 Grosvenor Gardens, Westminster, London, S.W.1.

Pyrene Company's Purchase

THE Pyrene Company Ltd., Great West Road, Brentford, has now completed the purchase of the whole of the share capital of the Pyrene Manufacturing Company of Canada Ltd., at a cost of \$675,000. The purchase was effected from the company's own resources.

The Canadian company, which was previously a wholly-owned subsidiary of the

Pyrene Manufacturing Company Inc., of Newark, New Jersey, has its head office and factory in Toronto. Its business consists mainly of the manufacture, assembly and sale of fire extinguishers and other fire-fighting equipment as well as of non-skid tyre chains. The business in Canada is not so broadly based at present as that of the Pyrene Company, Ltd. Therefore, it is anticipated that it will be possible to increase the scope of the Canadian business by including in its range some of the UK company's products. The latter company also hopes to be able to export to the Canadian company component parts for certain products which are assembled in the Toronto plant.

Industrial Atmospheres

AT a conference to be held by the British Occupational Hygiene Society at the London School of Hygiene and Tropical Medicine on 6 April beginning at 11 a.m., the following papers are to be presented:—'The Investigation of Atmospheric Contaminants in Factories,' by M. W. Goldblatt, M.D., Ph.D., D.I.H., head of industrial hygiene laboratories, I.C.I. Ltd.; 'The Measurement of Dust Exposure,' by B. M. Wright, M.A., M.B., of the Pneumoconiosis Research Unit, Medical Research Council; and 'Permissible Levels of Exposure to Ionising Radiations and Radioactive Materials,' by W. G. Marly, M.Sc., Ph.D., head of the division of health physics at the Atomic Energy Research Establishment, Harwell. The conference fee for non-members of the society is 12s. 6d. Further details and application forms may be obtained from the hon. secretary, Mr. P. C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle-upon-Tyne 1.

Plating Trade Research

The British Non-Ferrous Metals Research Association is establishing an advisory service for electroplaters. Up to £15,000 has been offered to the association, to be spent on research to promote industrial productivity and a large part of this will be used for the advisory service.

Beryllium : Metal with a Future

A Review of Its Production & Uses

METALLIC beryllium was discovered as long ago as 1797, but nearly a century and a half elapsed before this element emerged from the obscurity of the laboratory to become commercially important. As a pure metal, it has long been valuable in X-ray work. Its oxides have contributed significantly to recent advances in ceramics and industrial chemistry. In the field of light materials, beryllium is included in aluminium and magnesium alloys to facilitate their processing and improve their properties. The advantages of beryllium additions to ferrous materials are being widely investigated, while beryllium nickel, combining high physical properties and corrosion resistance, is now a standard casting alloy. Because of its remarkable combination of properties, beryllium copper is extensively used in a wide range of industrial applications. Finally, beryllium is one of the most effective materials for slowing down neutrons and is already established as a material of prime importance in nuclear energy applications.

'No. 1 Headache'

Beryllium is not a rare element, its relative distribution in the earth's crust being 0.005 per cent. Its only commercial source, however, is the mineral beryl, which seldom occurs in sufficient quantity to be mined on a large scale, being obtained mainly as a by-product in the mining of feldspar and mica. Other factors which retarded commercial development for many years were high production costs and difficulties arising from the brittleness and unworkability of the pure metal. Owing to the high fusion point of the metal, and to the high vapour pressure at a temperature not much above the fusion point, beryllium was termed the 'World's number one metallurgical headache.' As a result of increased production of ore and the discovery of many new sources of supply, beryllium has now become relatively plentiful. The problems associated with the production and processing of the metal have been largely overcome, enabling the development of new applications to be vigorously undertaken.

Beryl is a silicate of beryllium and alumin-

ium, a typical formula being $\text{BeAl}_2\text{Si}_6\text{O}_{18}$. The composition varies considerably, however, due to the replacement of beryllium by the alkali metals and to alteration by hydrothermal agencies. The literature generally states that powdered beryl is not attacked by any single acid except hydrofluoric. Consequently, for opening the ore alkaline fluxing is usually adopted, with the accompanying introduction of alkaline metals, which complicate subsequent treatment. Some quite modern processes employ reduction of the anhydrous chloride or double alkali fluoride with magnesium, calcium or sodium.

Two Main Processes

Two main types of process are used for opening up the raw material.¹ In one type of process, the ore is finely ground by ball milling and fused with sodium silico-fluoride at 700-800° in a reverberatory furnace. By leaching the fused mass with hot water beryllium is dissolved out in the form of the double salt Na_2BeF_4 , while aluminium and any magnesium are left behind as insoluble fluorides. The beryllium may then be precipitated from solution either as hydroxide by the addition of caustic soda, or as the sparingly soluble double salt with calcium by the addition of calcium chloride. This process has been used by Alais, Froges and Camargue, and is claimed to be particularly effective for low-grade ores. The Beryllium Corporation of America have employed a similar process using sodium fluoroferrate Na_3FeF_6 for ores containing as little as 2 per cent BeO .

The second method of attack is based on the discovery that beryl ore, which has been heated to its fusion point and then quenched in water, is readily attacked by moderately strong sulphuric acid. Beryllium oxide in powdered raw beryl may be 76 per cent extracted by treatment at 265° with dilute sulphuric acid, but if the raw beryl is given a preliminary heating in a rotary kiln to temperatures above 1,000°, its susceptibility to sulphuric acid is greatly increased.² The higher the temperature of heating, the more ready and complete is the extraction. Beryl which has been heated to its sintering point at about 1,450°, yields 91 per cent of its

beryllium on treatment with 56 per cent sulphuric acid at only 250°. If the beryl is made hotter until melted and then quenched in water, it becomes very reactive with strong sulphuric acid at atmospheric pressure.

After the beryl is quenched in water, it is no longer optically active between crossed Nicols, nor does it give an X-ray spectrum. The original crystalline structure has therefore been destroyed to bring about the accompanying increase in susceptibility to sulphuric acid. The melting point of beryl is variable, but generally lies between 1,500° and 1,600°, which is well within the range of open-hearth melting. Autoclave treatment with sulphuric acid makes it possible to use beryl heated only to the sintering point in a cement kiln. This facilitates subsequent grinding and makes possible the use of beryl which has not been entirely cleaned from its gangue.

Extraction Technique

The Brush Beryllium Company use 100 kVA arc furnaces lined with carbon for the preliminary fusion. After drying, the fused beryl glass is ball-milled and digested with 80-90 per cent sulphuric acid. The beryllium dissolves as the sulphate BeSO_4 , together with aluminium and iron, while a residue of silica remains undissolved. After concentration to almost saturation point in regard to beryllium sulphate, ammonium sulphate is added in slight excess to precipitate the aluminium as ammonia alum. Further concentration of the solution then allows pure beryllium sulphate to be separated by crystallisation. Lithium, caesium and rubidium sulphates may be recovered from the mother liquors by further crystallisation. The beryllium sulphate recovered by this process is fed into a rotary kiln fired by natural gas, in which it is decomposed to beryllium oxide at a temperature of not less than 1,450°.

In a low temperature process developed by DEGUSSA (Deutsche Gold und Silber Scheideanstalt), a complex chloride melt (BeCl_2 and NaCl in equal proportions) is electrolysed, the cathodic product being beryllium flakes. At this stage the metal is about 99 per cent pure. The flakes are pressed hydraulically into briquettes and are melted at 1,400°. The metal can be vacuum cast, or it can be formed to shape by powder metallurgy techniques, extrusion or rolling.

By re-distillation in a high vacuum, purities exceeding 99.9 per cent may be obtained.²

Beryllium owes its industrial importance to its unique combination of such desirable properties as light weight, relatively high strength and modulus, good corrosion resistance, and a melting point of 1,500° or higher.

Its principal use is as an alloying agent to harden and strengthen other materials. Beryllium copper offers the strength and hardness of many steels, yet it is non-magnetic, has good conductivity, and is resistant to corrosion and fatigue. In the heat-treatable condition, this material is ductile, and can be severely formed to meet the most exacting design requirements. A simple low-temperature heat treatment doubles the strength and hardness, at the same time substantially increasing electrical and thermal conductivity. Several beryllium copper alloys are commercially available, each age-hardenable and each offering a different combination of properties. Although generally considered precipitation-hardening, beryllium copper does not age at room temperature but requires artificial ageing in the range of 290° to 500°.

Beryllium copper alloys can be fabricated by standard production methods. Strip can readily be blanked, formed, deep drawn or spun, while rod and bar respond to hot or cold forming methods. Parts can be joined to other beryllium copper components or dissimilar metals by soldering, brazing or welding.

Electrical Uses

Manufacturers of electrical equipment use beryllium copper to impart high mechanical performance to current-carrying springs and contacts. Electronic devices frequently include components posing problems of fabrication which could not be solved without beryllium copper. Instruments and controls rely upon the precise action of beryllium copper diaphragms, bellows and springs. The use of this material in the automobile, aviation and machinery industries is already extensive but is continually being expanded. Among the established applications are ignition parts, terminals, aircraft gauge elements, plug-type connectors, fuel injectors, machine tool components, oil seals and retaining rings. Beryllium copper is readily adapted to sand and other foundry techniques. Its ability to reproduce fine detail accounts for

its outstanding success in pressure cast moulds for plastics and precision castings. Beryllium copper non-sparking hand tools afford protection against fire and explosion in hazardous areas and are claimed to be superior in performance to all other copper alloy safety tools.

When used with aluminium, beryllium acts as a hardener and deoxidiser. The addition of beryllium to magnesium alloys substantially increases the ignition temperature. The Beryllium Corporation supply two types of beryllium aluminium master alloy, one being a composition of 5 per cent beryllium and 95 per cent aluminium and the other consisting of 5 per cent beryllium, 5 per cent magnesium and 90 per cent aluminium. Both master alloys are used to introduce a relatively low beryllium content (usually 0.01 to 0.10 per cent) into aluminium alloys of all kinds.

An alloy nominally 2.6 per cent beryllium with the balance principally nickel offers an unusual combination of strength and hardness. Established applications include mining drill bits, impellers, and miscellaneous aircraft components. When heat treated, beryllium nickel combines high strength (200,000 psi.) and hardness (Rockwell C52) with the inherent corrosion resistance of nickel.

Beryllium is also of increasing interest as an alloy additive in carbon and alloy steels. For applications of this type, the Beryllium Corporation supplies ferro-beryllium master alloy with a nominal beryllium content of 5 or 10 per cent.

X-ray Tube Windows

Among the oldest applications of beryllium is the production of X-ray tube windows. The first beryllium X-ray tube windows were produced by die-forging in 1926. At that time it was already known that beryllium is 17 times as penetrable by X-rays as is aluminium and is not adversely affected by them. These windows, however, were relatively thick, since brittleness and the absence of malleability made it impossible to machine or grind thin sections of beryllium. For many years the only beryllium discs available for X-ray tube windows were produced from vacuum-melted beryllium by grinding small squares cut from plates. The resulting discs were generally used in a thickness of 0.035 in. and a dia. of 0.368 in.³

The lack of malleability of pure beryllium was ascribed to films of material believed to be beryllium oxide. Attempts were made to rid the beryllium of this film by alloying it with numerous elements. It was eventually found that small additions of titanium reacted with the material believed to be beryllium oxide in a specially constructed self-pouring vacuum furnace, and reduced the beryllium oxide to beryllium. When approximately 0.5 per cent of titanium was added, most of it disappeared in the form of oxide, only about 0.15-0.2 per cent remaining in the alloy. The presence of titanium does not appear to affect any of the properties of pure beryllium.

The ingots cast into beryllium-oxide moulds are usually 5 in. long and 1 in. dia. Discs are cut from them and hot-rolled between plates of nickel or stainless steel to avoid oxidation. The usual sheet size is 1 in. by 2 in., the standard thicknesses being 0.020 in., 0.010 in. and 0.004 in. Beryllium of the highest purity is used for this application.

Other Important Uses

Beryllium oxide also has important applications in a number of industries. Electrical manufacturers use it for filament and heating embedding purposes, filament coatings in lamps, electrodes in electron tubes, and as a cathode heating element in radio valves. It is also used in electrical heaters in which the resistance wire is embedded in the refractory. Because of its high resistance to thermal shock it is useful as a radiation shield around graphite crucibles. Special purpose crucibles and other refractories are also made from beryllium oxide.

Highly sintered beryllium oxide is characterised by its great hardness and by good electric insulating and thermal conducting qualities at high temperatures. These qualities are of special importance when this material is used in the form of cores, rods or plugs to prevent heater-cathode leakage in wireless valves. The comparatively light weight of beryllium oxide is also of great importance.

A study of the strength of ceramic materials shows that above 1,400°, beryllium oxide has a higher strength than Al_2O_3 , ZrO_2 , ThO_2 or synthetic $MgOAl_2O_3$. Whereas the highest working temperature for alumina ware of best quality (recrystallised 99.9 per cent pure Al_2O_3) is about 1,900°,

that for beryllia ware (high-fired material) is about 2,400°. The melting point of beryllium oxide is 2,570°, which is approximately 500° higher than that of alumina.

Articles made from beryllium oxide may be extruded or pressed with binders such as nitrocellulose or without binders. In order to increase density and shrinking for some purposes, silica or magnesium silicate can be added to the beryllium oxide, which can then be treated or sintered at about 1,600°.

Secondary Emission Prevented

In the case of gaseous electron tubes, high vacuum and other types of tubes having a control electrode subject to secondary emission, coatings of beryllium oxide are used to prevent secondary emission. A 2 per cent beryllium containing nickel alloy has been used for this purpose. When heated in air this alloy produces a surface layer of nickel and beryllium oxides. Subsequent heating during the exhausting process by high-frequency current reduces or vaporises the nickel oxide and leaves a film of pure beryllium oxide.

The production of crucibles and accessory parts is an important field of applications. In one process, pure unfused beryllium oxide is heated to 1,800° in a graphite container by means of a high-frequency induction furnace. The calcined oxide is heated to about 1,100° in oxygen to remove any carbon and is then broken up and ground in a steel ball mill to pass a 200-mesh screen. This material is treated with chlorine to remove iron and is then washed with distilled water. The crucibles are formed by tamping the material moistened with a solution of beryllium chloride into a graphite mould lined with a layer of paper. The interior of the crucible is formed by drilling while the material is still moist. The mould containing the crucible is heated in air to about 1,100°. It is then placed on a tungsten sheet inside a graphite container and fired to 1,800°.

From the standpoint of possible contamination of high-purity iron by the refractory, beryllia is preferable to magnesia or alumina. It was also found to be preferable in the removal of silica during melting. The silicon content of some sponge iron was reduced from 0.027 to 0.007 per cent by melting in a beryllia crucible, but similar melts in magnesia and alumina retained respectively 0.010 and 0.016 per cent of silicon.

Experiments have shown that beryllium oxide does not volatilise as rapidly in contact with carbon at 2,000° as does magnesium oxide, and that very satisfactory crucibles for high temperature service may be formed from it.

Considerable publicity has been given to the toxic qualities of beryllium compounds, but examination of the available evidence suggests that beryllium's reputation for toxicity is largely based on misconceptions. Some chemical compounds of beryllium are poisonous, but so is any metal or metallic compound when breathed as dust. Many manufacturers have been fabricating beryllium alloys for 15 years or more without a single case of poisoning. It is claimed that the commercial alloys of beryllium are as safe to handle as any other commercial alloys, provided that the same precautions are taken during processing as those commonly observed in any modern plant handling other metals such as copper.

REFERENCES

- ¹ 'Beryllium,' by B. A. Scott (Lecture delivered at Institution of Metallurgy's Refresher Course, 1952).
- ² 'Beryllium Oxide,' by L. David (Beryllium Smelting Co., Ltd.), *Metallurgia*, June 1944.
- ³ 'Beryllium X-Ray Tube Windows,' by L. David, *Metal Treatment*, Spring 1944.

Polythene Expansion

PLANS to expand the capacity of its polythene plant at Edmonton by one-third, have been announced by Canadian Industries Ltd. Additional equipment will be installed at an estimated cost of \$1,000,000 bringing total cost of the plant to \$15,000,000. The new installations are expected to be completed by the end of 1954. The plant uses ethane from Alberta's natural gas as its basic raw material. The new capacity will be 16,000,000 lb. of polythene resin per annum, and C.I.L. plans to expand this further as occasion arises.

Construction of the Edmonton plant was started in April, 1952. Now employing 230 persons the plant went into production in November, 1953 and initial shipments to customers will be made in January, 1954.

Polythene was developed by Imperial Chemical Industries Limited, in England, and the first commercial plant began production there in 1939. Two United States suppliers started manufacture in 1943, and C.I.L.'s plant is the first in Canada. Until now all Canadian polythene requirements have had to be imported.

Industrial Instruments

Specialist Service Offered

A NEW company—Electrofact, Ltd., Winchester House, Old Broad Street, London, E.C.2—has been formed to manufacture and distribute a range of industrial instruments, of which the pH equipment deserves special mention.

Working in close co-operation with the Continental Electrofact Group, who are very well known in this field, Electrofact Ltd. claim to introduce a new standard of precision and reliability for this type of instrument. The use of a novel circuit and improved electrodes eliminate all drift and the need for frequent bufferchecks so that pH measurement and control become a reliable industrial tool for quality or process control.

Complete Range Offered

A complete range of instruments is offered covering laboratory pH meters (including a high-precision instrument for redox measurements), as well as industrial indicators, recorders and recorder-controllers.

The group has pioneered many new applications for pH measurement and has undertaken a number of pH instrumentation projects for leading industrial concerns in this country, Western Europe and the United States. A wide experience, accumulated over many years and backed by extensive laboratory facilities is available for those who wish to investigate the application of pH measurement and control to specific problems, relating to quality standards, corrosion, analytical procedures (redox) or optimum process conditions.

The company's activities should be of interest to water and effluent treatment plants, the dairy and food industry (including fermentation products), paper mills, electroplaters, sugar refiners, the textile industry, rayon and nylon manufacturers, the leather industry, manufacturers of soap and synthetic detergents, the laundry industry, oil refineries, the chemical and pharmaceutical industries and other users of water.

The company offers a specialist service and all technical inquiries should be addressed to George Lewi and Partners, Industrial Consultants, Hanover Court, Hanover Square, W.1.

New Anti-Cancer Drug

A NEW drug that seems to slow down the effects of the most malignant form of cancer is reported by Dr. Sidney Farber of the Children's Cancer Research Centre and Harvard Medical School, at Boston, Massachusetts.

The drug is triethylenephosphoramine (known otherwise as TEPA). It is related to the nitrogen mustards, used in treating Hodgkin's disease. Dr. Farber has used TEPA on patients suffering from malignant melanoma, a dark growth that starts on the skin and spreads rapidly to inner parts of the body. He reports that TEPA has given a doomed melanoma victim more than a year of life. It eradicated all symptoms of the disease for a time, he says, but later they recurred. The drug has been used on a dozen other victims, some of whom obtained marked improvement for a short time.

While TEPA is not a cure, Dr. Farber says, it may serve as a wedge against melanoma. Studies are now aimed at learning how it works in the hope of creating better chemicals in this family of drugs.

Pharmaceutical Research

The cost of research in the British pharmaceutical industry is now between £2,000,000 and £2,500,000 a year, Mr. S. M. Lennox, M.P.S., president of the Chemists' Federation, stated at a dinner given by the National Pharmaceutical Union to the Chemists' Federation and the Council of the Pharmaceutical Society on 6 January. Research, he said, was the life-blood of an industry which now employs over 50,000 people and produces pharmaceutical products to the value of over £90,000,000 a year.

German Address Book

The 'Adressbuch Deutscher Chemiker 1953/4,' giving the names, qualifications and addresses of all members of the Gesellschaft Deutscher Chemiker, has recently been published by GDCh and Verlag Chemie (Weinheim-Bergstrasse). Chemists' names are given in alphabetical order, and indexed under towns or, in the case of foreign members, under countries. There are 448 pages and an extensive advertisement index, and the price is DM. 11.

HOME

Key Industry Duty

The Treasury have made an Order under Section 10(5) of the Finance Act, 1926, exempting ethylene glycol monobutyl ether, 5-methylheptan-3-one, phthalic anhydride, *iso*-quinoline and sodium 4-aminosalicylate, from Key Industry Duty for the period 18 January to 18 February, 1954.

New Solvent Standard

The British Standards Institution has just issued a further standard in the series for solvents and allied products. A British Standard for acetic anhydride was not included in the original series for standards for solvents, but the increased demand for a material of reliable quality for a variety of industrial uses justifies the preparation of BS. 2068. Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, British Standards House, 2 Park Street, London, W.1, price 2s.

BISOL Acetic Anhydride

With effect from 18 January, the price of 'BISOL' acetic anhydride has been reduced by £8 per ton throughout the schedule. For deliveries carriage paid, in packages returnable at seller's expense, the new schedule ranges from £128 per ton for 10 tons and £130 per ton for 1 ton (spot or contract over a calendar year) in 90-gal. drums, to £162 per ton for single carboys and £166 per ton for single demijohns. Allowances for bulk delivery in tank wagons, and extra charges for large deliveries in small containers, remain unchanged.

Price Reduction of PVC Gloves

Although market trends indicate that raw material prices are going up, James North & Sons Ltd., Godley Mills, Hyde, Cheshire, manufacturers of the famous North PVC fabric supported, industrial protective gloves, chemical, and foul weather clothing, have reduced the prices of North PVC gloves by 12½ per cent from 1 January. A North spokesman stated: 'this price reduction has been made possible by a recent streamlining of production to meet increased demands for their products from many industries throughout the world. The policy represents this company's contribution to the reducing or stabilising of prices.'

Costly Fire

Damage estimated at about £70,000 has been caused by fire at the Middlesbrough chemical works of Sadler and Co. The fire gutted the firm's naphthalene refining plant.

Barium Prices Increased

We have been informed by Laporte Chemicals Ltd. that since the last publication of British Chemical Prices in THE CHEMICAL AGE, barium prices have been increased and are now as follows:—barium sulphate (dry blanc fixe): 4-ton lots, £42 10s. per ton, 2-ton lots, £43 per ton; barium carbonate precipitated: 4-ton lots, £39 per ton, 2-ton lots, £39 10s. per ton.

Long Service Recognised

Two hundred employees of Monsanto Chemicals Ltd. with more than 25 years' continuous service received the congratulations of Mr. F. A. Singleton (managing director) at a dinner given in their honour, at the Ruabon factory recently.

Steel Production Record

The United Steel Companies Ltd. announce a record steel ingot production of 2,374,687 tons in 1953. This is the highest ever produced in the British Commonwealth by a single company in one year and beats United Steels' previous best of 2,216,427 in 1952 by about 160,000 tons. Pig iron production also reached a record level of 1,374,554 tons during the past year. Each of the company's branches made a handsome contribution to the total for the group and Appleby-Frodingham became the first British steelworks to make more than 1,000,000 tons of steel in one year.

Search for Natural Gas

Latest developments in the Gas Council's search for natural gas in Britain are beginning in Sussex this week. The programme is to drill a series of shallow geological holes in a rough line from a point near Wych Cross to Ticehurst to improve knowledge of the underground contours of this area, which it is thought, may contain natural gas. Following this investigation, a site will be chosen in the area for the drilling of a deep well. Drilling at Cousland, near Edinburgh, is expected to begin at about the end of the month.

OVERSEAS

More Oil in Alberta

A third oil accumulation has been indicated in Alberta's newest oilfield—the Pembina field about 65 miles south-west of Calgary. It is now considered that the field may prove to be an even greater source of oil than was at first believed.

Oil from Bituminous Shale

An American firm is reported to have signed a contract with the National Petroleum Council of Brazil to construct a distillery to produce 10,000 barrels of oil a day from bituminous shale. The distillery will use shale from deposits located in the Taubate-Tremembe region between Rio and Sao Paulo. It is estimated that Brazil will save up to US\$16,500,000 a year in exchange when the distillery is working to capacity.

Australian Insecticides

A new biological laboratory which Imperial Chemical Industries of Australia and New Zealand Ltd. is establishing at Melbourne, Victoria, will be supervised by Mr. F. J. D. Thomas, British discoverer of Gammexane. This insecticide has saved Australian sugar growers more than £A2,500,000. The new laboratory will seek to develop additional pest control chemicals for Australia's agricultural and stock industries.

Eucalyptus Oil in Indonesia

Production of eucalyptus oil in Indonesia in 1953 was estimated at nearly 8,000 litres, and sales at approximately 15,000,000 rupiahs. Production in 1954 is expected to increase to 25,000 litres, giving a profit of nearly 23,000,000 rupiahs. Over 58,000,000 rupiahs will probably be spent on production this year.

Sugar-Cane Wax

Cuba is expanding and consolidating production of sugar-cane wax, a new and potentially important by-product of the sugar industry now in the experimental stage. 'Cachaza' (first froth on the cane juice when boiled), the raw material for the production of this type of wax, has a wax content of from 0.59 to 12.8 per cent, depending on the variety of cane ground. The average yield is 1-5 lb. of wax per ton of ground cane. The country grinds an average of 40,000,000 tons of sugar-cane a year.

Canadian Synthetic Latex

Six weeks ahead of schedule, the Dow Chemical Co. of Canada has put its new synthetic latex plant into operation at Sarnia, Ontario. Erection of the plant was announced last May.

New Finds Predicted

The discovery of new oilfields in Australia was predicted by a professor of geology. Professor Eric Rudd, of Adelaide University, when he addressed a meeting of scientists at Canberra recently. He also forecast 'equally important' discoveries of natural gas and the development of 'important' uranium mines.

Canadian Pipeline Functioning

The first delivery of Alberta crude oil through the recently completed pipeline from Edmonton arrived at Sarnia, Ontario, on 12 January. Previously crude oil had been transported by tanker from the head of Lake Superior to Sarnia through the Great Lakes. The 1,700-mile pipeline is the longest in the world, with a daily capacity of 300,000 barrels. At present Edmonton is sending only about 180,000 barrels a day. The crude oil takes about two months to travel the full length of the line to Sarnia, where it will be refined.

Polystyrene now Made in Australia

Monsanto Chemicals (Australia) Ltd. has announced the successful manufacture of polystyrene in Australia at a newly completed plant at West Footscray, Victoria. The plant's capacity of 3,000 tons a year will fully meet the present demand from the local plastics industry. Previously the industry was compelled to rely upon imports of polystyrene.

Chilean Sulphide Plant

The Council of the Chilean Development Corporation has agreed on the expenditure necessary to install and exploit a sulphide plant with a sufficient capacity to permit the use of lixiviation in the working process of oxidised copper minerals. Lack of this reactive has intermittently paralysed the copper industry in the Antofagasta province. The production capacity of the plant has been estimated at 30 tons a day of 98 per cent acid. The cost will be Ch.\$36,000,000.

PERSONAL

MR. B. A. ROBINSON, M.I.E.E., M.I.Mech.E., who has been with the Cambridge Instrument Company for 41 years, and has been their district representative for 32 years in the Newcastle-on-Tyne area, has now retired. He is succeeded as district representative by his son, MR. W. E. ROBINSON.

The following paragraph appeared in the *London Gazette* dated 12 January, 1954, under the heading of 'Honours':—

'Her Majesty the Queen has been graciously pleased to sanction the following admission to the Grand Priory in the British Realm of the Venerable Order of the Hospital of St. John of Jerusalem in recognition of his service in connection with First Aid:—

Admitted in the Grade of Officer (Brother)

Sir W. Arbuthnot Lane, Bt.,
Commandant-in-Chief.'

Sir W. Arbuthnot Lane is managing director of Kaylene (Chemicals) Ltd. as well as being Commandant-in-Chief of the Metropolitan Special Constabulary.

In January last year the chairman of Kestner Evaporator & Engineering Co. Ltd., MR. J. ARTHUR REAVELL, M.I.Mech.E., M.I.Chem.E., F.Inst.F., F.I.M., visited South Africa in connection with the activities of Kestners (South Africa) Pty. Ltd., of which he is also chairman. He is, we have just learned, now leaving for a further three months' visit to the Union and also to Southern Rhodesia. The activities of Kestners (S.A.) (Pty.) Ltd. have continued to increase during the past year and during his visit not only will Mr. Reavell be visiting many old friends in the process industries where Kestner plants have been installed and put into commission, but he will also visit plants which are under construction.

PROFESSOR F. H. GARNER, O.B.E., Ph.D., M.I.Mech.E., M.I.Chem.E., F.R.I.C., F.Inst.F., F.Inst.Pet., F.S.A., professor of Chemical Engineering at Birmingham Uni-

versity, has been reappointed a part-time member of the West Midlands Gas Board.

DR. MYRL E. MILLER has been named manager of process development for the Engineering Planning Department of the Chemical Research and Engineering Division, Mathieson Chemical Corporation, it was announced recently by DR. L. K. HERNDON, Director of Research. He will make his headquarters in the corporation's Baltimore offices.

The first appointments to United States (FOA) Research Fellowships have been made by the National Academy of Sciences, Washington, on the nomination of the Royal Society. One of these was the appointment of MR. S. H. PARKER, B.Sc., of University College, Leicester, to carry out research in physical organic chemistry at the Massachusetts Institute of Technology under Professor Gardner Swain. The Fellowships were instituted in 1953 with funds provided by the United States Government, through its Foreign Operations Administration. They are intended to enable a number of outstanding young scientists from Europe to work in the United States for up to two years in order to study and gain experience in American research institutions.

MR. ROBERT CLARK, A.R.I.C., F.I.R.I., general superintendent of the mechanical goods division of the North British Rubber Co. Ltd. of Edinburgh, has retired after 43 years' association with the company and the industry. Mr. Clark joined the laboratory of the North British after graduating in chemistry from the Heriot-Watt College in Edinburgh in 1911. He became assistant superintendent of general mechanics in 1926 and general superintendent in 1934. He was first secretary of the Scottish Section of the Institute of Rubber Industry and chairman from 1939 to 1945. Mr. Clark is being asked to continue to act as a consultant and at a farewell party was presented with a television set by Mr. R. L. Chatterson, general works manager.

CHARLES W. ENGELHARD, chairman and general manager of the companies composing the Engelhard Industries Group, has announced that he has relinquished his duties as president and that GORDON V. RICHDALÉ has been elected to that position, since 1 January. Engaged primarily in refining and working precious metals, the Engelhard Industries constitute one of the world's largest houses in this field.

Born in Bath, England, in 1908, Mr. Richdale began his business career in 1927 with the Bank of England, and from 1934 onwards he advised governments of various countries on currency problems. In 1938 he was a member of the Bledisloe Commission in South Africa. For the past 14 years he has been in the gold mining industry of South Africa.

The companies of which he became president include American Platinum Works, Amersil Company Inc., Baker & Co. Inc., Charles Engelhard Inc., East Newark Realty Corporation, Hanovia Chemical & Manufacturing Co., Irvington Smelting & Refining Works, and Nieder Fused Quartz Co., all of which are located in the Newark area; also the D. E. Makepeace Co., Division of Union Plate & Wire Co., of Attleboro, Mass., and the National Electric Instrument Co. Inc., of Elmhurst, L.I. This group includes Baker Platinum Ltd. of London, one of the principal refiners and workers of precious metals, and subsidiaries in Paris, Copenhagen, Zurich, Milan, Johannesburg, Melbourne, Tokyo, Rio de Janeiro and Toronto.

DR. ALEXANDER B. STEWART, deputy director of the department of soil fertility at the Macaulay Institute for Soil Research, Aberdeen, has been appointed Professor of Agriculture at Aberdeen University. He will take up his new duties on 1 July and will succeed PROFESSOR T. L. BYWATER, now of Leeds University. Dr. Stewart has been on the staff at the Macaulay since 1932 and is a graduate of Aberdeen University, with first class honours in chemistry.

MR. JOHN C. HAMILTON has been appointed general superintendent of Canadian Resins & Chemicals Ltd., Shawinigan Falls, Quebec. In charge of all the company's plants, he succeeds MR. W. C. HEIDENREICH, works manager for the past six years, who is returning to Carbide & Carbon Chemicals Co. in the United States.



Mr. A. L. Abel, B.Sc., M.I. Biol., photographed at London Airport prior to his leaving for Japan on business. Mr. Abel, who is now in Tokio, is technical development director of Pest Control, Ltd.

The 1954 Paul Ehrlich prize—a gold plaque—has been conferred by the Paul Ehrlich Institute at Frankfurt on DR. E. B. CHAIN, F.R.S., scientific director of the International Institute for Chemical Microbiology. Dr. Chain was joint winner, with Sir Alexander Fleming and Professor Florey, of the 1945 Nobel prize, for the discovery of penicillin.

It was announced last week that Messrs. P. J. C. BOVILL, S. C. TYRELL and K. E. WALKER had been appointed assistant managing directors of Newton Chambers & Co., Ltd. Mr. Bovill will be responsible for the Chemicals Branch, Mr. Tyrell for the Excavator Branch and Mr. Walker for the Engineering Branch. The company is also strengthening its London organisation by giving MR. R. F. A. SAMPSON, a local director and general sales manager of the Chemicals Branch, special responsibility for London interests.

Educated at Cheltenham College, Mr. Bovill graduated in fuel technology at

Sheffield University and joined the company in 1922 as assistant manager of Thorncliffe



Coal Distillation Ltd., then newly-formed. Two years later he was appointed assistant manager of the Chemicals Department and in 1928 became works and sales manager of the tar distillation works. In 1933 he was appointed joint manager of Coke Oven Products Ltd. and from there went

in 1939 to the Rother Vale Collieries branch of the United Steel Companies as commercial manager of chemicals.

He returned to Thorncliffe in February, 1942, as a local director and general manager of the chemicals branch, which has steadily developed and progressed under his direction. Mr. Bovill was appointed vice-chairman of the board of local directors in November, 1951.

He is a member of the Joint Industrial Council governing wages and conditions in the chemicals industry and a member of the executive board of the Association of Chemical and Allied Employers.

Mr. Walker was initially trained in chemistry in the Public Analyst's Laboratories in Newcastle. After working as Power Station Chemist to the North Eastern Electric Supply Company at Dunstan-on-Tyne for a period, he entered the foundry industry as a steel foundry metallurgist.

Mr. Walker has been chairman of the British Cast-Iron Research Association Vitreous Enamelling Panel and is an assessor for the Diploma Examinations of the National Foundry College. He is a member of the Institute of British Foundrymen and has served on its Technical Committees.

Obituary

The death has occurred at Stockton-on-Tees of MR. CECIL M. HELYER, former wharfs manager for Imperial Chemical Industries Ltd., Billingham. He was 51 years old and retired from work some time ago on account of ill-health.

Market Reports

LONDON.—Trading conditions for industrial chemicals have continued active and the tone of the market is helped by the increasing interest shown by home buyers in covering future requirements. Most of the soda products are moving well with chlorate of soda, nitrate of soda and bichromate of soda in steady call, while caustic soda and soda ash are in good request. Potash compounds are firm on an active inquiry, while in other directions there has been a fair business in the non-ferrous metal compounds with lower quotations ruling for white lead, red lead and litharge. The basis price of white lead as from 20 January is £119 5s. per ton, and the latest basis price for red lead and litharge is now £113 10s. per ton, also from 20 January. From the pharmaceutical section of the market it is reported that potassium and sodium bromides and ammonium bromide are dearer, while lower prices are ruling for potassium oxalate and binoxalate. As from 18 January the new schedule of prices for acetic anhydride ranges from £128 per ton for ten tons and £130 per ton for one ton to £166 per ton for single demijohns, delivered and carriage paid, in packages returnable at sellers' expense. This is a reduction of £8 per ton on the previous prices. There has been a steady absorption of supplies of the coal tar products with pitch in good call on home and export account.

MANCHESTER.—Prices on the Manchester chemical market during the past week have maintained a steady to firm front. Among the outstanding changes since the last report is, exceptionally, a cut of £8 a ton in acetic anhydride, while on the other hand, precipitated carbonate of barium is about £4 a ton dearer and balance fixed at about £4 10s. up. Home-trade users continue to draw steadily against contracts and a fair weight of new business has been placed. The call for fertilisers generally has again shown a slight improvement and the leading tar products are steady.

GLASGOW.—Trading during the past week in general chemicals has been steady with a good demand for the usual run of materials. Prices on the whole have remained steady with the exception of some solvents which have eased a little and, generally speaking, a good week's trading has been conducted.

Next Week's Events

MONDAY 25 JANUARY

Chemical Society

Leicester: University College, 5 p.m. Joint meeting with University Chemical Society. Professor D. H. R. Barton: 'Some Recent Progress in Natural-product Chemistry.'

Cardiff: University College, 5.30 p.m. Professor F. S. Dainton: 'Radiation Chemistry.'

TUESDAY 26 JANUARY

Institute of Fuel

London: Institution of Mechanical Engineers, Storey's Gate, 5.30 p.m. F. H. Cass, Dr. N. L. Franklin and Professor A. L. Roberts: 'Refractory Recuperators.'

WEDNESDAY 27 JANUARY

Chemical Society

Dublin: Trinity College (Chemistry Department), 7.45 p.m. Professor T. S. Wheeler: 'Studies in the Chemistry of Flavones.'

Society of Chemical Industry

London: Chemical Society's Rooms, Burlington House, Piccadilly, 6.30 p.m. Nutrition Panel meeting. Dr. L. J. Harris: 'Vitamins and Newer Concepts.'

Royal Statistical Society

Cardiff: University College, Cathays Park, 7 p.m. South Wales Group meeting. Professor G. A. Barnard: 'Non-parametric Tests, Old & New.'

Pharmaceutical Society

London: 17 Bloomsbury Square, W.C.1, 7.30 p.m. A. G. Fishburn 'The Formulary of the British Veterinary Codex'; D. C. Garratt: 'Standardisation of the Drugs and Galenicals of the British Veterinary Codex.'

THURSDAY 28 JANUARY

Chemical Society

Manchester: The University, 6.30 p.m. Joint meeting with RIC and SCI. Professor F. S. Dainton: 'Polymerisation & Its Reversal.'

Nottingham: The University, 4.45 p.m. Joint meeting with University Chemical Society. Professor E. E. Turner: 'Structures & Configurations.'

Sheffield: The University (Chemistry Lecture Theatre), 7.30 p.m. Joint meeting

with University Chemical Society. Dr. L. E. Sutton: 'Electron Diffraction in Gases Applied to Inorganic Chemistry.'

Institute of Fuel

Nottingham: Gas Showrooms, 6.30 p.m. East Midland Section meeting. D. Hicks: 'The Coal Problem.'

Birmingham: James Watt Institute, Great Charles Street, 6 p.m. Midland Section meeting. A. M. Lehmann: 'Industrial Drying, with Particular Reference to the Problems of the Paint & Foundry Industries.'

Royal Statistical Society

Sheffield: Grand Hotel, 6.30 p.m. Sheffield Group meeting. E. D. Van Rest: 'Quality Control as Practised in the USA.'

FRIDAY 29 JANUARY

Chemical Society

Cambridge: The University (Chemical Laboratory), 8.30 p.m. Dr. R. S. Cahn: 'The Chemical Society, Present & Future.'

Society for Analytical Chemistry

London: Sir John Cass College, Jewry Street, Aldgate, E.C.3, 7.15 p.m. Microchemistry Group meeting. Film, 'Old Masters of Microchemistry,' and two papers, 'Organic Ion Exchange' (L. Saunders) and 'Inorganic Ion Exchange' (G. H. Osborn). Exhibition of microchemical apparatus, beginning 3 p.m.

Plastics Institute

Manchester: Grand Hotel. Annual dinner and dance.

SATURDAY 30 JANUARY

Institution of Chemical Engineers

Birmingham: The University, Edmund Street, 2.30 p.m. Midlands branch annual meeting, followed at 3 p.m. by G. B. Edington: 'Some Aspects of Biochemical Engineering.'

Society for Analytical Chemistry

Manchester: Engineers' Club, Albert Square, 2 p.m. Annual general meeting, followed by ordinary general meeting, with paper presented by Dr. D. W. Kent-Jones.

Society of Leather Trades' Chemists Ltd.

Manchester: College of Technology (Reynolds Hall), 2 p.m. D. Grimwade: 'Performance Tests of Shoe Leathers'; C. W. Tod: 'Phosphates in the Tannery.'

Publications & Announcements

AN ALPHABETICAL list of 5,000 members' names, giving trade descriptions and telephone numbers, and a classified trade index, comprising 13,000 entries under 1,000 main headings, are the principal features of the newly-published directory of the Manchester Chamber of Commerce. This is the first issue to be published since the war, and, with its numerous advertisement entries, it comprises an extremely useful buyers' guide to all the industries of Manchester. Copies may be obtained, price 10s., from Ship Canal House, King Street, Manchester 2.

* * *

NEW uses for aluminium are described in the latest issue of *Aluminium News*, sent us by the Aluminium Union Ltd., The Adelphi, Strand, London, W.C.2. One of these is for the storage of ice-cream. The Iraqi Ministry of Health has recently legislated that all commercially sold ice-cream must be prepared in aluminium containers. Aluminium, it is pointed out, resists corrosive attack and is easily kept in a sanitary condition. All copper containers previously in use are to be replaced.

* * *

LATEST report to be published by OEEC is that of the Technical Assistance Mission No. 78 on 'Galvanising Techniques in the USA.' The mission, which visited the US at the end of 1951 to investigate practice in hot dip methods, was asked to investigate methods of obtaining greater productivity in sheet and strip, tube, wire, and finished products; economy in the use of zinc, and the use of substitutes such as aluminium; treatment of pickling baths; special methods such as coil galvanising; new possibilities of galvanised strip; and finishing processes. The report is the work of 29 experts from 12 European countries, and is intended to meet the diverse needs of the firms, varying widely both in process details and efficiency, which comprise the Western European galvanising industry. It is obtainable through the agency of HMSO, Stamford Street, S.E.1.

* * *

THE Winter 1953-4 issue of the *Bulletin of the Institute of Metal Finishing* is taken up largely with reports of the annual meeting of the Institute, including the presidential address on 'Education and Research in the Metal Finishing Industry,' by J. W. Cuth-

bertson. There are, however, two technical papers: on 'Tin-Nickel and Nickel-Chromium Coating,' by S. C. Britton and R. M. Angles; and on 'Reducing Costs in the Paint Shop,' by A. Rice-Williams.

* * *

THE latest number of the *Review of Coal Tar Technology* to be published is Vol. V, Part 1, continuing the valuable wide surveys of the literature carried out by the Coal Tar Research Association. Altogether 546 references are discussed, in sections covering coal tar products, organic chemistry, catalytic chemistry, inorganic and physical chemistry, analysis and various modern techniques. Copies are obtainable from the Coal Tar Research Association, Oxford Road, Gomersal, nr. Leeds.

* * *

NEWLY published by Hilger & Watts Ltd., 98 St. Pancras Way, London, N.W.1, is a 44-page booklet describing spectrographic equipment for metallurgical and general analysis. This includes a specification for a spectrographic laboratory, details of apparatus and accessories, and a select bibliography. Also obtainable are brochures describing Schwarz thermopiles, which are claimed to be unusually sensitive and responsive, without sacrificing robustness; equipment for Raman spectrography; and controlled source units designed to overcome difficulties in the use of DC arc or condensed high-voltage spark.

* * *

NUMBERS 19 and 20 of the *BCURA Gazette* (published by the British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey) are concerned, respectively, with a review of the third quinquennium of the Association (1948-53), and with the open day on 24 June last.

* * *

A RECENT brochure, in English, French, German and Spanish, describes the services of the Power-Gas Corporation Ltd., Stockton-on-Tees, in the research, design, manufacture and erection of chemical plants. Accompanying pamphlets describe the work of the associated companies of Ashmore, Benson, Pease & Co., and Rose, Downs & Thompson Ltd., particularly in the construction of factories and the erection of sulphuric acid plant.

Law & Company News

Commercial Intelligence

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

Mortgages & Charges

Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

BABCOCK & WILCOX LTD., London, E.C., engineers. 9 December, 1953. £4,000,000 debenture stock with a premium of up to 1 per cent in certain events, secured by a trust deed dated 7 December, 1953; general charge. *Nil. 11 June, 1953.

LEDA CHEMICALS LTD., London, W. 11 December, 1953, mortgage, to City Prudential Building Society securing £1,900 and any other moneys, etc.; charged on 114 Hall Lane, Chingford. *£6,132. 22 December, 1952.

R. A. CLEMENTS (LONDON) LTD., chemical manufacturers, etc. 14 December, £1,000 debenture, to Mrs. S. Clements, London; general charge. *£2,227. 5 May, 1950.

Satisfaction

BRITISH CELANESE LTD., London, W. Satisfaction, 19 December, 1953, of debenture stock registered 2 October, 1943, and deed supplemental thereto registered 8 November, 1944, to the extent of £3,380.

Company News

William Briggs & Sons Ltd.

Net profit of £100,551 for the year ended 30 September last is announced by William Briggs & Sons, Ltd. The directors recommend a final ordinary dividend of 22½ per cent less tax, making 30 per cent for the year. The company's contribution to the Employees' Pension and Superannuation Fund during the year amounted to £18,454. To mark Coronation Year, a special additional bonus of £10 is being paid to each employee who was in the company's service on Coronation Day, likewise to all the company's pensioners. The total number parti-

cipating in this distribution is about 1,200.

British Industrial Plastics Ltd.

A marked recovery in group profits for the year ended 30 September last, following the 1951-52 setback, is announced by British Industrial Plastics Ltd. Group profit for the period under review is shown as £441,987, as compared with £270,908 for the previous year, and net profit is given as £104,120 (£33,489). A final dividend of 12½ per cent is now recommended, to make 20 per cent, less tax, for the year on the £831,392 equity, against a first and final payment of 12½ per cent the previous year.

Powell Duffryn Ltd.

Powell Duffryn Ltd. announce the following dividend:—Interim dividend of 3 per cent actual, less income tax at 9s. in the pound, on the £9,660,471 ordinary stock in respect of the year ending 31 March, 1954. Payment to be made on 27 February to holders registered on the books of the company at close of business on 8 January.

Power-Gas Corporation

During the year ended 30 September, 1953, orders booked by the Power-Gas Corporation group totalled £6,250,000, or slightly less than the previous year's peak figure. At the same time the value of orders received from the iron and steel industry was the highest in the company's history, shareholders are informed in the annual report.

Group trading profits of £758,694 compare with £720,870 and the net profit attributable to the parent company amounts to £167,972, against £192,521. The annual distribution is 12 per cent on £1,000,000, against 14 per cent previously on £650,000.

Royal Dutch/Shell

Both the Shell Transport and Trading Company and the Royal Dutch Petroleum Company have declared unchanged interim dividends in respect of 1953.

The Shell declaration is 5 per cent, tax free, on the Ordinary capital of £54,514,696. A final of 10 per cent was paid to make 15 per cent, tax free, for the year ended 31 December, 1952.

Royal Dutch declares a 4 per cent (cash) interim for 1953. A 12 per cent final, also in cash, brought the 1952 total to 16 per cent.

CLASSIFIED ADVERTISEMENTS

BUSINESS OPPORTUNITIES

SMALL CHEMICAL PLANT FIRM (London Area), having opportunity to purchase Premises and Works on which it is dependant, requires finance approx. £30,000. Private investor. Alternatively might suit larger Chemicals or Plant firm requiring low-overheads works for M.S. (and Stainless) welded fabrication, piping, repairs, overflow design or development work, etc. **BOX No. C.A. 3291, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

A LARGE Engineering Concern in Manchester, of long and well-known repute, has capacity, large and small, to manufacture complete machines, units or installations. Available capacity for immediate use includes Iron Castings, Brass or Aluminium, Fitting and Erecting and Machining. Please communicate with **BOX No. C.A. 3289, THE CHEMICAL AGE, 154, FLEET STREET, LONDON E.C.4**, when technical men will be available to discuss any requirements or problems.

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.

HER MAJESTY'S COLONIAL SERVICE

A VACANCY exists for a **CHEMIST** in the Geological Survey Department, Federation of Malaya. Candidates, under 35, must possess as a minimum qualification an Honours Degree in Chemistry from a British University. Duties involve the analysis of minerals, rocks and metallurgical alloys.

Appointment is on probation to the pensionable establishment. The consolidated salary scale (basic salary plus expatriation allowance) is £820-£2,044 per annum approximately. Candidates who possess experience in the analysis of rocks, minerals and metallurgical alloys would be allowed to enter the scale at a point higher than £820 per annum, dependent upon length of experience. A variable cost-of-living allowance, according to family commitments, is also payable.

Quarters, when available, at a rental of between £21 and £84 per annum; free passages for officer and wife and up to three children under the age of 10; free medical attendance for officer and family whilst in colony; vacation leave four days for each completed month of resident service.

Apply, in writing, to the **DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, LONDON, S.W.1**, giving briefly age, qualifications and experience. Mention the reference number **CDE 105/60/02**

A **ANALYTICAL CHEMISTS** of Inter. B.Sc. standard, are required for the Works Laboratory and Process Control Laboratories at Thomas Tryer's Works at Stratford. Some experience of industry is preferable. Annual salary will depend upon qualifications, age and experience. Applications should be addressed to: **THOMAS TYRER & CO., LTD., CANNING ROAD, STRATFORD, E.15.**

SITUATION VACANT

THE following vacancy has occurred in a **SUBSIDIARY COMPANY** situated in **BERKSHIRE** of medium large light engineering concern.

Applicants should be aged 30-35, should possess an Engineering Degree or its equivalent, and also have a good knowledge of Organic Chemistry up to H.N.C. standard. He should have a good background and education.

The object of making this appointment is to provide a suitably trained person who will in time act as understudy to the Manager.

The prospects of this position are excellent, and the remuneration will be commensurate with training and qualifications, but will not be less than £800 per annum.

Apply: **P.M., BOX No. C.A. 3280, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

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CCHARCOAL, 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.**

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 3—5-roll **REFINERS** by Baker Perkins.
 1—No. 1A Water-cooled **CIRCULAR MILL**.
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 1—Very Fine **GARDNER SIFTER and MIXER**, trough 5 ft. 9 in. by 24 in. by 28 in. deep, with wood-built hopper, elevator, A.C. motor and starter.
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C.I. FILTER PRESS by JOHNSON, washing type, having 35 pyramid surface plates and 36 frames, forming cakes 22½ in. by 22½ in. by ½ in. thick. Side feed and discharge. Capstan type closing gear.

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STAINLESS STEEL CRYSTAL DRIER by MITCHELL, 3 ft. 6 in. diam. by 1 ft. 6 in. deep. **STEAM JACKETED** flat bottom with two S.S. paddles underdriven through bevel gearing from direct-coupled 1 h.p. 400/3/50 geared motor. Jacket working pressure, 15 lb per square inch.

M.S. SPIRIT EXTRACTION PLANT, comprising 3 ft. diam. by 5 ft. deep extractor with dished bottom jacketed for 5 lb. per square inch working pressure, condenser, separator, storage tank.

KESTNER HORIZONTAL TUBULAR EVAPORATOR, having six turns copper tube 1½ in. bore by 6 ft. long, complete with copper reception pot.

STEAM JACKETED COPPER STILL, 150 gallons capacity. Fitted swan-neck, sight and light glasses, etc., and complete with copper coil condenser. Jacket working pressure 40 lb. per square inch.

STEAM JACKETED COPPER BOILING PAN, 100 gallons capacity. Bolted-on cast-iron jacket suitable for 40 lb. per square inch working pressure.

DOUGH MIXER, having "U" trough 1 ft. 5 in. by 1 ft. 7 in. wide at top by 2 ft. deep. Sheet brass trough, cast-iron ends, G.M. agitator. Belt driven and arranged for hand tilting.

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Cast-iron **VACUUM DRYING OVEN** by TAYLOR, 4 ft. by 2 ft. 10 in. by 4 ft. 6 in. front to back, having ten steam-heated M.S. platens pitched at 3 in. Hinged door at each end. Steam working pressure 15 lb. per square inch.

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ECONOMIC BOILERS, 10 ft. Danks. 12,000 lb. evap, 250 lb. pressure; 8 ft. diam. by 14 ft. Paxman. 180 lb. w.p. Twenty others, all sizes.

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Micro **Twin REFINING MILL** by Torrance, with steel rolls, 9 in. by 6 in. diam., and 9 in. by 4½ in. diam. Fast and loose pulley drive.

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Also all other types—Petrol, Oil and Water Tanks from 100 to 10,000 gallons.

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500g. Jacketed **AUTOCLAVE** with detachable cover. 150 lb. in jacket.

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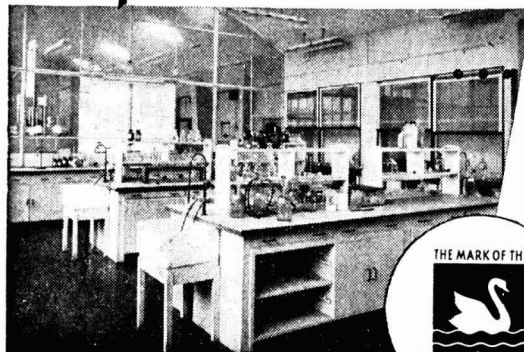
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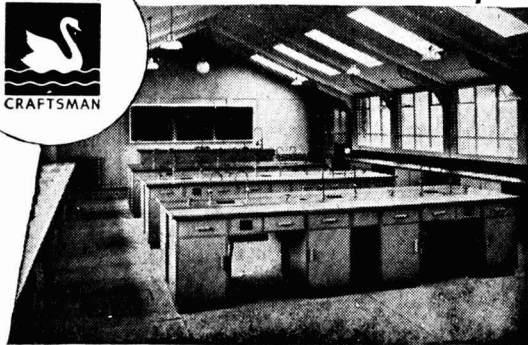
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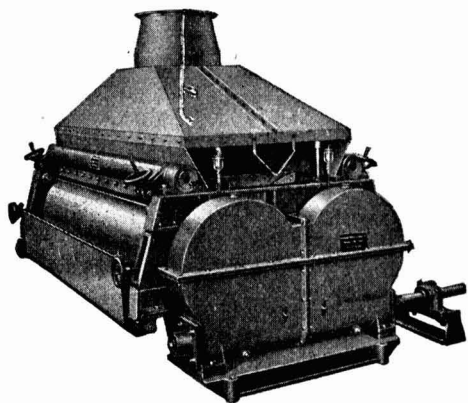
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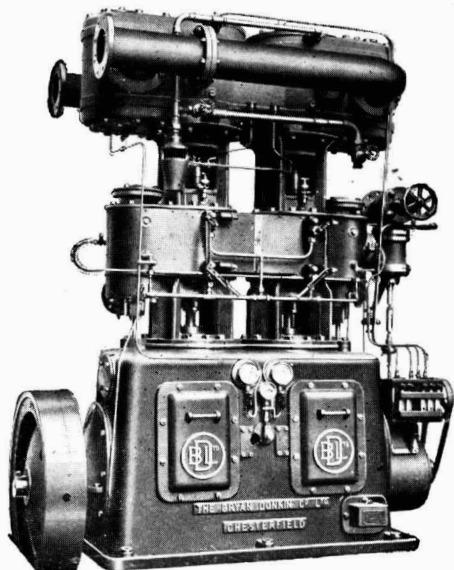
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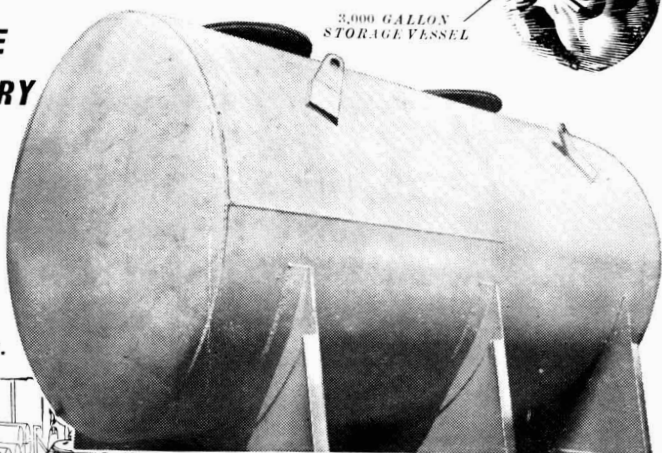
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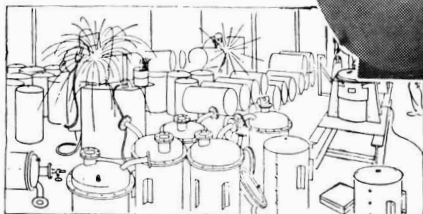
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