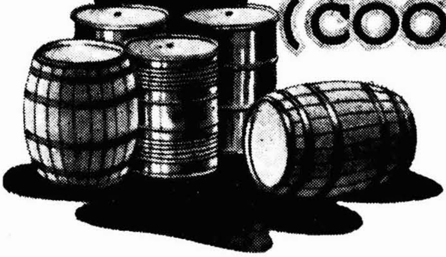
16·[illegible]·9

THE Chemical Age

VOL. LXXI 11 SEPTEMBER 1954 No. 1835

S·GIRLING & SONS (COOPERS) LTD



BARREL & DRUM MERCHANTS
& RECONDITIONERS

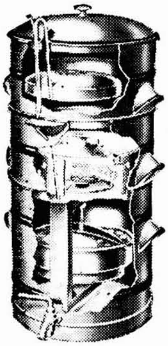
ALL KINDS OF CASKS & VATS MADE TO ORDER · IRON & STEEL DRUMS BOUGHT & SOLD · DRUMS RECONDITIONED

Office & Cooperage :—

59 LEA BRIDGE ROAD · LEYTON · E·10

Telephone :	Telegrams :	Cables :
Leytonstone 3852	Drucasks, Leystone, London	Drucasks, London

WELLS OIL FILTERS



With a Wells' waste oil filter you can use your oil several times over and change it more often. A thoroughly reliable supply of oil is assured with the use of Wells' special filter pads which work in conjunction with Wells' patent syphon feed. The oil delivered from a Wells' filter can be used with complete confidence.

Write for fuller particulars of these filters

Delivery of Oil Filters and special "Wells' Filter Pads from Stock "

Also makers of
OIL CABINETS, BARREL POURERS &
PORTABLE PARAFFIN HEATER PLANTS

A. C. WELLS & CO. LTD.

HYDE · CHESHIRE

Telephone :	Telegrams :
HYDE 953	UNBREAKABLE HYDE

HYDRATED CARBONATE OF POTASH
83/85%
In Polyethylene Lined Barrels

CALCINED CARBONATE OF POTASH
96/98% and 98/100%

CAUSTIC POTASH
Solid Fused
90/92%

POTASSIUM NITRATE DOUBLE REFINED
99/100%

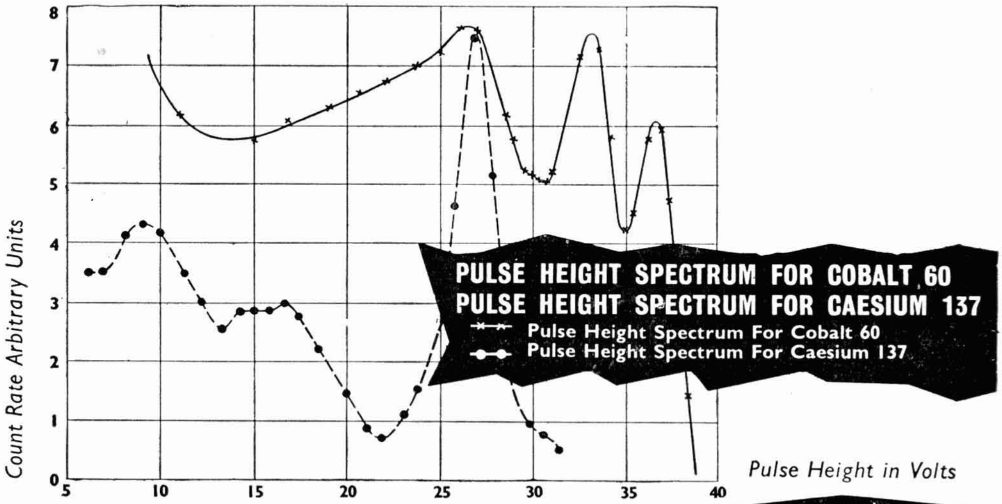
LIGNITE PARAFFIN WAX
52/54°C.

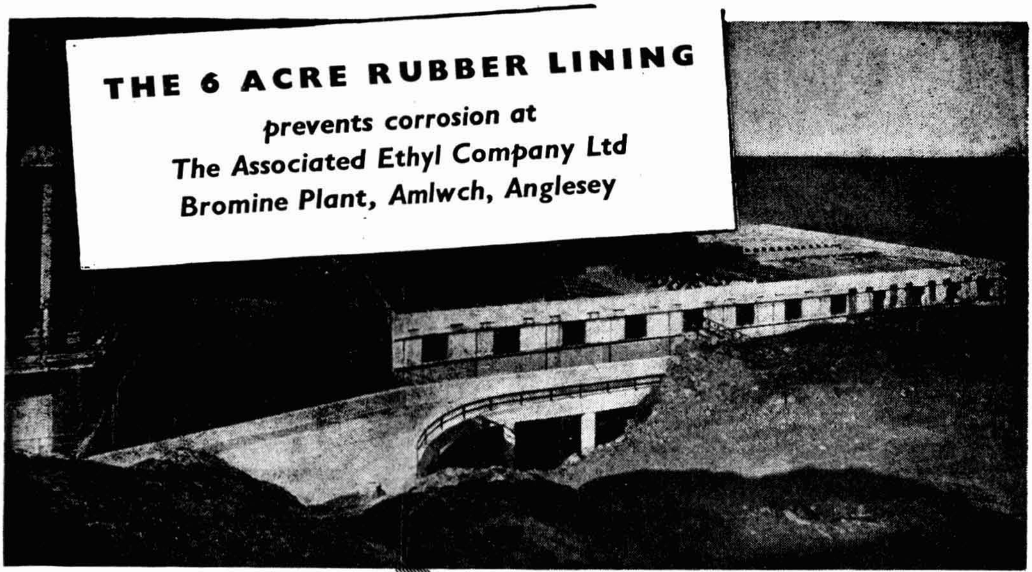
AMERICAN PARAFFIN WAX
130/135 and 135/140°F

Enquiries to

CHEMITRADE LIMITED
17 STRATTON ST. · LONDON · W.1

Telephone :	*Cables :*
GROsvenor 3422	*Multikem, London*


8
7
6
5
4
3
2
1
0
5
10
15
20
25
30
35
40
Count Rate Arbitrary Units
Pulse Height in Volts
PULSE HEIGHT SPECTRUM FOR COBALT 60
PULSE HEIGHT SPECTRUM FOR CAESIUM 137
Pulse Height Spectrum For Cobalt 60
Pulse Height Spectrum For Caesium 137



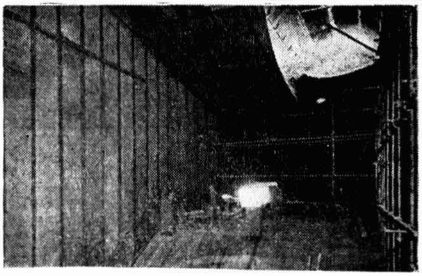
THE 6 ACRE RUBBER LINING

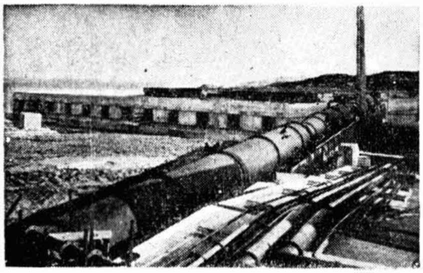
prevents corrosion at
The Associated Ethyl Company Ltd
Bromine Plant, Amlwch, Anglesey

This huge rubber-lining contract completed by the General Rubber Goods Division of the Dunlop Rubber Company represents one of the largest plant-lining assignments ever undertaken. Rubber and rubber-based compounds were the only materials capable of protecting concrete and metal from the constant attack of hydrobromic, sulphuric and other acid mists liberated during the production of bromine . . . a vital element in the manufacture of "additives" for modern fuels.

In the Multi-cell "Blowing-out Tower", 75,000 sq. ft. of rubber sheeting lines the cells. To counter grave risk of fire which attended hot-air vulcanising in the enclosed "cells", air was heated outside the Tower and lining-crews wore rubber boots to prevent sparks. Day and night-shifts worked to synchronize lining-tasks with those of other sub-contractors.

In the Absorber Unit, 30 tons of rubber and rubber compound form a self-vulcanised inner lining and and an "overcoat" of sheet rubber which was vulcanised in situ.



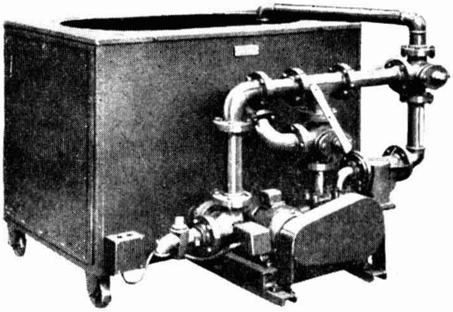


Large-bore pipes such as this sea-water main, storage vessels and ducting throughout the plant are rubber lined, and rubber again covers the huge fan units and 4 miles of steel girders.

rubber and synthetic linings by DUNLOP

DUNLOP RUBBER COMPANY LTD. (General Rubber Goods Division) Cambridge Street, Manchester, I. Tel: CEN 2131

43/A4B



'B-W' PROCESS VATS

In addition to a range of Kettles for Glues, Waxes and Compounds, with or without mixing arrangements, " B-W " also design and manufacture special processing Vats for chemical solutions, etc., incorporating circulating pumps and other features to requirements. *Write for details today.*

OTHER " B-W " PRODUCTS INCLUDE :

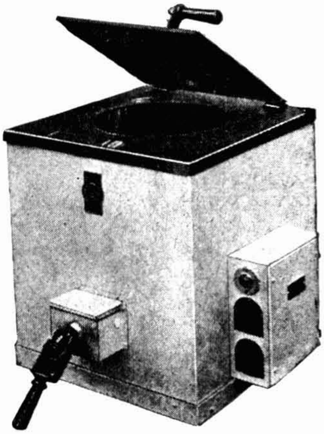
- ✱ OVENS
- ✱ DIP POTS
- ✱ WAX TANKS
- ✱ FURNACES
- ✱ GLUE HEATERS
- ✱ HUMIDITY TEST CABINETS

'B-W' MIXING KETTLES

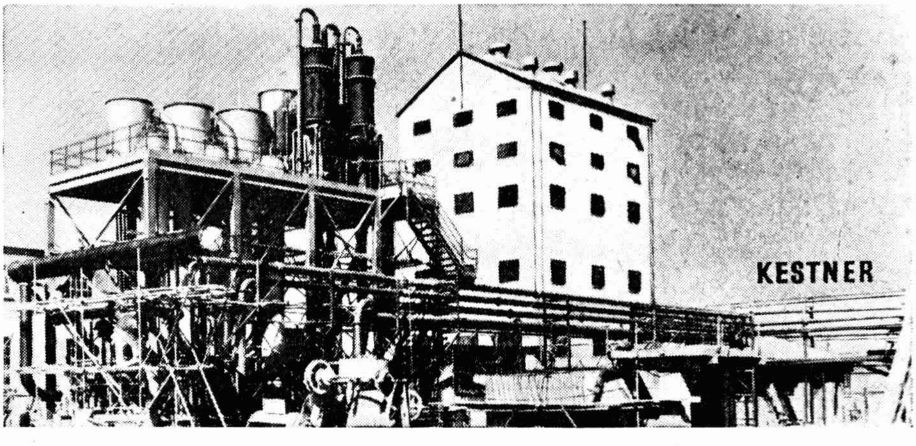
INDUSTRY NEEDS HEAT—YOU NEED 'B-W'

Barlow-Whitney

All enquiries to :
SALES OFFICE. **2 DORSET SQUARE, LONDON, N.W.1. AMBassador 5485**
Works : **NEASDEN & BLETCHLEY**



Triple Effect Evaporator for Distillery Slop



CHEMICAL PLANT AND PROCESSES

The Kestner organisation serves many industries. In fact, wherever chemicals are manufactured or used it is more than likely that you will find some Kestner plant—it may be a stirrer or other small item—it may be a large spray drier or the entire process plant. Whatever it be, large or small, you will find it doing " a good job."

If you are needing new plant, Kestners can help you on any of these subjects :

ACID HANDLING ● ACID RECOVERY PLANT ● DRYING PLANT ● EVAPORATION PLANT ● FLUID HEAT TRANSMISSION SYSTEMS ● GAS ABSORPTION AND REACTION SYSTEMS ● ISOLECTRIC SYSTEM FOR PROCESS HEATING ● KEEBUSH ● LABORATORY AND PILOT PLANTS ● STIRRERS & MIXING EQUIPMENT

Kestner's *Chemical Engineers*
5 GROSVENOR GARDENS · LONDON · S.W.1

Volume LXXI
Number 1835

Established 1919

The Chemical Age

The Weekly Journal of Chemical Engineering and Industrial Chemistry

BOUVERIE HOUSE · 154 FLEET STREET · LONDON · EC4

Telephone : CENTRAL 3212 (26 *lines*) *Telegrams :* ALLANGAS · FLEET · LONDON

CONTENTS . 11 SEPTEMBER 1954

Editor : E. A. Running *Publisher & Manager : John Vestey*

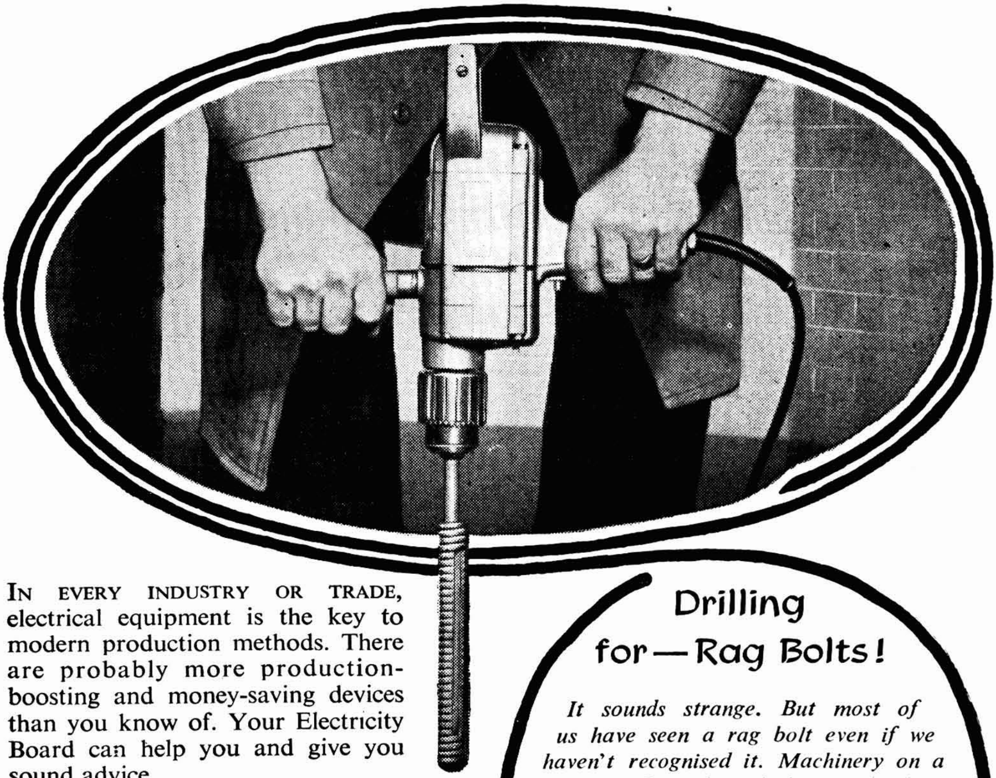
MIDLANDS OFFICE :
Daimler House, Paradise
Street, Birmingham
Phone : Midland 0784/5

SCOTTISH OFFICE :
116, Hope Street,
Glasgow, C.2.
Phone : Central 3954/5

LEEDS OFFICE :
Martins Bank Chambers
Park Row, Leeds, 1
Phone : Leeds 22601

SINGLE COPY 1/- (BY POST 1/3) ANNUAL SUBSCRIPTION 42/-

Having a hand in Productivity



IN EVERY INDUSTRY OR TRADE, electrical equipment is the key to modern production methods. There are probably more production-boosting and money-saving devices than you know of. Your Electricity Board can help you and give you sound advice.

They can also make available to you, on free loan, several films on the uses of electricity in Industry—produced by the Electrical Development Association.

E.D.A. are publishing a series of books on "Electricity and Productivity". Four titles are available at the moment; they deal with Higher Production, Lighting, Materials Handling, and Resistance Heating. The books are 8/6 each (9/- post free) and the Electricity Boards (or E.D.A. themselves) can supply you.

Drilling for—Rag Bolts!

It sounds strange. But most of us have seen a rag bolt even if we haven't recognised it. Machinery on a concrete floor, bolted down. The bolts embedded in the concrete are rag bolts. In the old days it was a case of a man with hammer and chisel—laboriously and slowly chipping the concrete until the holes were large enough and deep enough. Now one man takes an electric drill, and drills *the holes; just like that. (Productivity!) Faster? Fifty times—a hundred! But the electric drill is* **only one of the many aids to Productivity that electricity can bring you.**

The British Electrical Development Association
2 Savoy Hill, London, W.C.2.

Electricity
a Power of Good for PRODUCTIVITY

Bottles & Tablets

EARLIER this year, when discussing progress in chemotherapy (see THE CHEMICAL AGE, 1954, **70**, 1089-90), we drew attention to the huge cost of drug research that falls in the main upon manufacturers and which must be recovered from profits made in selling the successful products. This is a theme now made sharply topical by the Ministry of Health's attempts to negotiate 'satisfactory' price arrangements with manufacturers. Nationalisation has economic consequences far beyond its fundamental change of ownership. It was once pointed out in a political broadcast by Sir Winston Churchill that the position of workers in nationalised industries becomes less sure and competitive when a number of employers is converted into a single employing authority. The virtual nationalisation of medicine has created a not dissimilar situation. Monopoly buying can be used as a bludgeon just as unfairly as monopoly selling.

According to an exceedingly well-informed report in *The Economist* (1954, **172,** 597), the pharmaceutical industry feels that the present discussions with the Ministry of Health may determine the basic pattern of the industry's economics for many years ahead. 'Decisions on new capital projects are being held in suspense until the outcome of the talks is known.' Bones of contention that have been piling up for at least five years may soon be dissolved. The Ministry urgently seeks a reduction in its total bill for drugs—some £17,000,000 a year for proprietary drugs and £10,000,000 for standard drugs listed in the British Pharmacopœia. It is, of course, the £17,000,000 part of the annual bill that makes the target for economy. A system of costing that can determine the prices of proprietary drugs by some universal formula and which is arrived at by agreement between manufacturers and the Ministry might seem the solution, but can such a system be fairly applied to an industry that is competitively organised and heterogenously composed of large firms with wide product ranges and small firms with specialised interests? This seems most doubtful. Moreover, would the introduction of any system of price fixation achieve durable, worthwhile results? Wartime price control arrangements were based on precisely similar principles. In most cases the Government has now found it better to discard these methods of price regulation and rely instead upon natural mechanisms of competition. Why should an economic operation now dispensed with in most markets be freshly introduced into another?

The Ministry of Health has made some progress in reducing its NHS bill for drugs. The Cohen Committee has barred the prescribing of public-advertised drugs, i.e., the proprietary products that are not regarded as falling in the ethical class. In addition, the shilling charge has been introduced. These two changes in the original scheme should have brought an appreciable lightening of the total NHS bill for drugs. If in fact it has not been appreciable, this is due to the quite separate influence of rising costs, a general influence whose impact cannot be selectively escaped by firms who happen to manufacture drugs or by a buyer who happens to be a government department.

However, the centre of current controversy is the third change that the Ministry, guided by the Cohen Committee's recommendations, now seeks. The various ethical proprietaries have been classified. For those drugs that cannot be replaced by a standard drug, there is freedom of prescription. Placed in lower classes are all those proprietary drugs whose superiority to standard drugs is not in the Committee's view clearly established. Free prescription of these proprietary drugs should be continued only if the Ministry can reach 'satisfactory' price-fixing arrangements with the manufacturers. In addition, some proprietary drugs have been classified as non-prescribable on the grounds that they are definitely not superior to standard drugs.

Can this new gambit of economy actually reduce the annual bill? If it be accepted that many proprietary drugs have their standard equivalents—and it would be less than objective to suppose that this is not often the case—the claim that economy can be achieved rests upon a general assumption that proprietary products cost more than their standard BP equivalents. This assumption is far from wholly sound. A list of 121 drugs that are available both as proprietaries and as standards shows that 43.8 per cent of the proprietaries are cheaper than the standards, 52.0 per cent dearer, and 4.2 per cent are equivalent in price. There are admittedly a small number of cases where the price of the proprietary product exceeds that of its standard equivalent by an unacceptably large amount. The Ministry of Health has an easy remedy to apply in such cases—insistence that doctors prescribe the standard rather than the proprietary product. Such action is said to have been already taken in two cases. It surely does not outrage common sense to suggest that all the other cases, the large majority for which the deviations from standard drug prices are small and almost as often downward as upward, should be left alone. The imposition of a cumbersome scheme of costing and price-fixing will not bring about a major economy, and already 43.8 per cent of the proprietary products are saving money for the NHS. If a tight price control system was agreed and introduced, any economy it provided by bringing down the prices of the 52 per cent group of proprietaries would be appreciably absorbed by the costs of operating the system; such costs would fall both upon the government and the industry, and there is ample evidence from recent history to show that these costs tend steadily to expand.

There is in any case a much deeper danger. The pharmaceutical industry, even more than most chemical ventures, depends upon research, and again even more than for most kinds of chemical enterprise upon research that is costly and slow. If through some tight price control scheme all prices are scaled down to their lowest common level, the profit margins of the industry must fall severely. Ploughing back profits into research will be greatly reduced. The discovery and development of new drugs that are cheaper or more quickly effective than present drugs will be slowed down; and drugs that reduce the necessity for more expensive methods of curing or relieving illness will not become available. The total costs of the NHS in future years could well be made much greater than in fact they need be. The purchase of new drugs from foreign countries, particularly from the United States, will have to increase for the stream of chemotherapeutic progress will become dryer and narrower here while still flowing rapidly and liberally abroad.

Nor is this all. The British pharmaceutical industry has a highly important export trade. It has an annual value of at least £30,000,000. How could this be maintained let alone expanded if the economics of the home trade were bedevilled by price control schemes to suit a monopoly buyer? Any curtailment of research and development must grievously damage the future of British pharmaceutical exports. One ultimate effect of lessened revenue from sales of proprietary drugs abroad would be higher costs and prices for the drugs needed by the home market. Thus, a quest of economy based upon price fixation and rigid state accountancy must in the end add to the NHS bill for drugs.

Notes & Comments

Japan's Chemical Industry

THE post-war production level reached by Japan's chemical industry is higher than that for Japanese industry in general, as an excellent survey in *The Financial Times* of 26 July reveals. The most notable branch for rapid recovery has been that of fertilisers, with heavy chemicals, soda, and sulphuric acid coming next. The output of sulphate of ammonia has broken all past records; by last year Japan was producing the 1,500,000 tons needed at home and also exporting another 500,000 tons. Her nearness to the Asian markets gives Japan an advantageous export position for it is in Asia that the most acute shortage of fertiliser nitrogen exists. However, production costs seem to be seriously higher than costs in Europe and there are signs that more distant competition can be met only if Japan sells sulphate of ammonia at a loss. High cost coal, electric power shortages, and inadequate rationalisation are diagnosed as the main causes of Japan's high costs for sulphate of ammonia, and the government has sought to impose measures of improvement, so far without much success. Calcium cyanamide production has been hit by the rise in sulphate of ammonia and its price has fallen in order to shift stocks. The dye-stuffs industry, before the war the fourth in world size, has made a more difficult recovery; indeed, recovery would not have been achieved but for the Korean war. However, the ban on exports to China has removed the former export market and Japan's dyestuffs industry is more than 90 per cent devoted to supplying internal needs. High production costs and a low standard of quality do not give Japan much opportunity for dyestuffs export trade with other countries. The caustic soda and soda-ash industry has scarcely recovered pre-war production levels; high costs again act as a brake upon expansion, the principal factor being the greater percentage of crude salt imported compared with pre-war conditions. One cure proposed is the transference of salt importing from the government to private enterprise; another is the co-operative development of salt production in South-East Asia so that more of Japan's imports can be drawn from nearer sources. The soap industry has passed through a most critical post-war period and its economics have only recently achieved a reasonable stability. Again the ban upon exports to China has virtually removed the entire export trade and Japanese soap manufacturers must sink or swim on the home demand alone.

Cost High, Quality Low

ALTHOUGH her chemical industry has regained its feet, Japan has a long way to go before she can become a serious competitor for chemicals in world trade. Basic costs are too high, the quality of products is in general too low. Also, the capital requirements for new equipment and processes cannot be met by self-financing out of profits—the main source of additional capital has so far been loans. However, there has been a substantial supply of American technical help and a considerable amount of American investment in Japanese chemical companies. Without this, a post-war recovery based almost wholly upon the home market might not have been possible.

Familiarity Breeds Contempt

THE fact that H_2S is a very poisonous gas is customarily ignored, most of all by laboratory workers. It is self-labelled or self-signalled by its objectionable odour. The nose can easily detect concentrations that are well below the safety level of 20 p.p.m. But higher concentrations are a very different matter for it needs only brief exposure for the olfactory nerve system to be deadened, and then the warning system ceases to operate. At concentrations of as much as 100 p.p.m. H_2S can kill without being 'smelt,' deadening the olfactory nerve immediately and then stopping respiration. It is certainly doubtful whether many analytical chemists or teaching chemists appreciate this; however, the record of Kipps' apparatus as a lethal weapon is remarkably good so we can reasonably assume that in laboratory practice the toxicity of H_2S is indeed thwarted by its 'odour of sanctity.'

Continuous Analyser

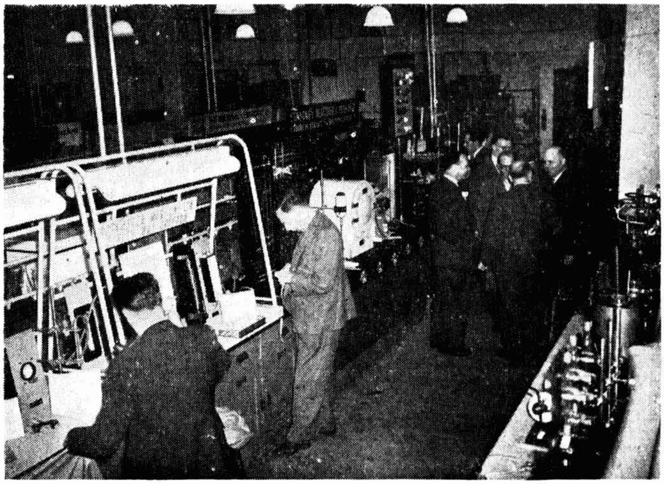
IN industry the hazard is not as surely self-contained; a wide range of H_2S concentrations can turn up in oil refineries and petrochemical plants, and there the danger that a toxic level will make a non-gradual impact upon workers must be guarded against. Spot-test detectors have long been used but these merely show the H_2S level at the random moment of checking. Recently in *Industrial & Engineering Chemistry* (1954, **46,** 11A) a continuous H_2S analyser, the Sorg-Offutt apparatus, has been described. The staining reaction between lead acetate and H_2S is still the basic chemical principle used, but it has been ingeniously developed by using blank cinema film surface-coated with buffered lead acetate. Air samples pass continuously into the exposure hood and the H_2S present reacts with the coated film; light from a constant intensity source is focused on the film and the beam passing through the stain area falls on a photoelectric cell, the current thus generated being proportional to the H_2S concentration. The current is used to operate an electronic unit and as soon as the H_2S concentration passes above 25 p.p.m. an automatic alarm sounds. It is claimed that from 1 to 25 p.p.m. the apparatus is sensitive to changes of 1 p.p.m.; from 25 to 50 p.p.m. to changes of 2 p.p.m.; but between 50 and 100 p.p.m., the sensitivity is down to differences of about 5 parts.

New Dutch Soda Works

AN important new industrial concern was registered last week at Amsterdam under the name of NV Nederlandse Soda Industrie. Established with a capital of 30,000,000 guilders, the new firm has the following investment participation: The Netherlands salt industry, 12,000,000 guilders; the government, on behalf of the Limburg State coal mines, 4,000,000 guilders; MEKOG (company for exploitation of coke-oven gases), 250,000 guilders; Netherlands sulphuric acid factories, 250,000 guilders; Netherlands bank guarantee, 7,500,000 guilders. The balance of 6,000,000 guilders is to be furnished later on, probably by private or public subscription.

The total enterprise is reported to involve a cost of 51,000,000 guilders, the difference between the 30,000,000 capital of the above schedule and the total sum involved to be obtained by loans from institutional investors under a state guarantee for interest and redemption.

Big works to be erected at Denfzijl, Holland, are intended to produce an output of 50,000 metric tons of soda a year, one half of which will be available for export.



At the recent symposium on analytical chemistry staged by the Midlands Society for Analytical Chemistry manufacturers co-operated in an exhibition of laboratory equipment and chemicals of interest to the analyst. Our photograph shows one corner of this exhibition which was well patronised by delegates

Engineering in Industry

Specialist British Team Urges More Competition

THE industrial engineer is described as 'the architect of productivity' with the job of bringing together 'the scientists, technologists and others to promote productive efficiency' in the report of the 67th—and last—British team to visit the USA under the auspices of the British Productivity Council. The team which early in 1953 studied engineering in various industries in America, including the chemical industry, recommends, among other things, that monopolies legislation should be considerably strengthened in this country and its range extended to ensure competitive conditions.

'As a first step,' says the report, 'we recommend Parliament to consider enforcing the law that trade and industrial associations (and trades unions), where they do not already do so, should publish any rules or agreements which bind their members. This, in our opinion, is essential to attain greater efficiency and reduction of costs.' The team found that competition, more than any other factor, provided the drive for the more frequent analysis of costs and the application of industrial engineering techniques in the USA and the constant effort to find the most economical use of men, materials, machines and money.

Industrial engineering is defined in the report as 'The application of basic scientific and engineering knowledge and certain analytical techniques to the methods of operating an organisation in industry and other appropriate fields.' Because of confusion in the various titles used, it is recommended that the British Standards Institution should set up a committee to cover the terminology of the whole field of industrial engineering.

The Drive of Competition

The team found that the influence of costing and financial control was fundamental in the American conception of industrial engineering. The drive of competition meant that detailed costing information was required to cast a searchlight on all forms of waste. Fuller use of cost and performance figures is recommended for British industry. The report says that carbide tools are used wherever possible in America, often in preference to diamond tools on highly-finished light-alloy parts. It suggests that specialised tools and fixtures should be more widely employed in British firms. The close attention given to the demands of production when designs are worked out is given stress. 'One plant visited has tool engineers from the industrial engineer's department present the whole time a new design is being worked out. . . . The design is only made once on the drawing board, but the product is made many times with machines and labour,' says the report.

Planning in Advance

The team recommend that production should be closely controlled to conform to a time-table planned in advance. This, it says, would make it possible to keep exact delivery dates and also to reduce stocks of works in progress. Handling of materials should be considered in relation to the layout and the arrangement of the whole plant. Layout and methods of handling should be directed towards securing the optimum flow of production. Packing ought to be considered as a stage in production.

The report goes into great detail about the human factor in industry. It recommends that employees should be kept fully informed of their company's progress and calls for research into incentive schemes, including non-financial incentives. It also recommends that greater efforts should be made to increase the effectiveness of suggestion schemes in this country. Rewards that are really adequate should be paid on a percentage basis of savings made over a year, and encouragement is required from senior management. An appendix to the report shows that in 11 American chemical and allied firms running schemes, suggestions from employees increased by over 100 per cent between 1950 and 1951. The number of suggestions adopted fell from 33.9 per cent to 27 per cent, but the average award rose from $13.04 to $18.89.

The team found that in the USA safety education was considered more important than safety devices and regulations and suggest that far more safety education is needed in British plants. In a survey of management and supervision, the report recommends that the responsibilities and authority of foremen should be higher than they are in most companies in Britain. They should, it says, be treated 'as part of the management and not merely as a tool of management.' Adoption of the American practice of managerial co-ordination by means of frequent informal committees is also suggested.

Expansion Recommended

Education of the industrial engineer is considered in the report, and the recommendation is that there should be expansion of the educational facilities offered in industrial engineering in Britain. There is a supplementary report addressed specifically to teachers and educationists.

The team recommend closer contact between industry and the technical and industrial Press by means of conferences between executives and editorial staffs which are a feature of American business. 'A problem besetting American publishers equally with British is to provide a guide to the immense mass of current reading matter,' says the report. 'In both countries the average industrial executive has no time to read the large volume of matter that should concern him. . . . Many companies have someone responsible for indicating who should read which articles, but this machinery is not developed in Britain as far it might be. The matter is very relevant to our inquiry, since often ideas for improved methods can be culled from articles in industrial journals. But value is only obtained from them if they are read by the right technicians or managers.'

An examination of American industrial research shows that only a small percentage of funds is spent on basic research. 'The fear is frequently expressed nowadays that the US has hitherto relied too much on the basic research of other countries, particularly Britain,' it is said. On the other hand, far more is spent than in Britain on applied research, but it is concentrated in a few large firms. The aircraft, electrical machinery and chemical industries have the largest research staffs and the greatest research expenditure, the first two receiving very large Government research grants. A thorough analysis of the cost of research expressed as a percentage of sales based on 1951 figures, show that the percentage in the chemical industry was just over 2.5.

'The amount of applied research undertaken in Britain has increased since the war, but we consider there is room for further expansion,' says the report. 'There is also need for wider dissemination of the results of research by means of technical information services, advisory services, etc.'

Thirteen men formed the team, whose report runs to more than 100 pages. They were nominated by the Department of Scientific and Industrial Research, the Engineering and Allied Employers' Federation, the TUC, the British Institute of Management, the Institute of Cost and Works Accountants, the Institution of Production Engineers and the Ministry of Education.

Joint Conference at Aberdeen

A JOINT conference on new developments in the use as food of fish and agricultural products and their by-products is to be held at Marischal College, Aberdeen, from 30 September to 2 October. It is organised by the Aberdeen Section and Food and Agriculture Groups of the Society of Chemical Industry and the Scottish Branch of the Institute of Biology and is open to non-members of these bodies as well as members. The registration fee for members is 5s., and for non-members 10s. This includes the cost of the booklet containing the abstract of papers to be read.

During the conference visits will be made to the Ministry of Food experimental factory and the Torry Research Station in Aberdeen, and the Rowett Research Institute, Bucksburn. Papers will be read on 'The value of certain agricultural, marine and industrial products and by-products in livestock feeding,' 'The vacuum dehydration of foodstuffs,' 'Recent developments in freezing at sea,' 'Recent developments in the fish by-product industry,' 'Distillery by-products; their recovery and use as animal feeds,' 'Seaweeds and their constituents as food for man and animal' and 'The large-scale culture of microscopic algæ as food.'

Canadian Base Metal Exports Up

Exports of base metals from Canada improved considerably in June after a decline in the earlier months of the year. Particularly favourable results were shown by aluminium, nickel and lead, and zinc and copper also improved.

New Ideas in Chemistry

Presidential Address by Sir John Lennard-Jones*

IT is the purpose of this address to describe some of the new ideas that have been introduced into the theory of molecular structure within recent years. These ideas have been drawn from physics, where they have been singularly successful in correlating the properties of atoms. The scope of the theory has been widened so that the physical and chemical properties of both atoms and molecules can be explained by the same unifying hypothesis. As the range of 'explanation' of the facts of nature extends, the more mysterious become the properties to be ascribed to the ultimate particles of which matter is composed.

In the progress of science there are two processes at work. In the one there is the steady accumulation of factual knowledge, and in the other there is an attempt to interpret the facts in terms of unifying principles. It is the interplay of theory and experiment which leads to the most important advances, for often the interpretation of one sort of fact leads to the prediction of new results. The most impressive advances are produced when general hypothesis are put forward which bring different branches of science within the same comprehensive scheme.

UNIFICATION

There has been no more striking example of this than the recent unification of atomic physics and chemistry. When the British Association last met in Oxford in 1926, there seemed little relation between the subjects discussed in the section of physics with those discussed in the section of chemistry. The presidential address in the one dealt with the properties of atoms in absorbing and emitting light, that in the other with the scope of organic chemistry. It did not seem possible at that time that both domains of knowledge might soon come within the same theoretical framework. Yet even during the Oxford meeting there were rumours of a new theory of the atom which was said to be brilliantly original. We did not know then that this new theory was to let in a flood of light on the behaviour of molecules and illumine much that was obscure.

In 1926 electrons in atoms were pictured as rotating in orbits round a central nucleus like a solar system. To fit the known properties of atoms it had been found necessary as well to assume that electrons had a magnetic moment. They were said to have 'spin' and the axis of spin could set itself along or opposed to any applied field. The spin had thus two possibilities only.

BOHR THEORY

On this basis Bohr had made an advance of great importance to the chemist by suggesting how the electrons in atoms should be assigned to the available orbits so that their chemical behaviour might be explained. The striking achievement of this theory was to provide an understanding of the similarities in the behaviour of atoms assigned by chemists to the same groups in the Periodic Table. The Bohr theory was greatly simplified by Pauli when in 1925 he proposed an important new property of electrons in matter. According to this, only two electrons in an atom can follow the same orbit and of these one must have one kind of spin and the other the opposite spin. In other words, no two electrons in an atom can simultaneously have the same spin and occupy the same orbit.

The full significance of Pauli's hypothesis, now universally called the Exclusion Principle, was not fully realised when it was first announced. Its main purpose was to simplify the Bohr description of atoms, or to suggest simple rules by which the same results could be achieved. But it has since become clear that it is of wide validity. It applies not only to atoms but also to the totality of electrons in a molecule, however many atoms that molecule may contain. Though first put forward as a guiding hypothesis in physics, it has become the corner-stone of chemistry. However complex a molecule may be, however large the number of electrons it may contain, there seems to be an 'awareness' by each electron of what all the others are doing and a strict adherence to the rule that no two must play the same rôle at the same time.

---

* The Section B (Chemistry) presidential address delivered on 2 September at the British Association meeting at Oxford.

No theoretical proof has been given of this exclusion principle. It is injected into current theories as a working rule. It represents some deep property of electrons, and indeed of all matter, which is not understood. It implies an intimate interconnection between the constituent parts of molecules and between one molecule and another. The principle suggests that there is a connecting strand running through the material universe, so that strictly no part can be isolated—except in an idealised sense—from the rest. There are always influences at work conditioning the behaviour and properties of the part and connecting it with its environment. These influences are more subtle than forces of repulsion or attraction such as exist between electrical charges of like or unlike kind. These latter are of short range and cease to be effective beyond lengths of atomic dimensions, which are infinitesimally small. But the exclusion principle applies to all the electrons of a long threadlike molecule or a long strip of metal, so that each is influencing the behaviour of the rest over distances which are millions of times greater than the sizes of the atoms which the metal contains. There seems here to be some aspect of nature of great philosophic content beyond the understanding of the physicist. He must be content to accept the implications without hoping to penetrate the mystery which is implied.

NEW IDEAS

The Bohr atomic theory made clear the significance of complete shells of electrons in atoms and explained the tendency of some atoms to lose one or two of their outer electrons and of others as easily to assimilate them. Thus the type of bond known as the electrovalent link became understood in terms of the inner structure of atoms. Physics had successfully invaded the realm of chemistry. But the penetration was incomplete. The theory gave no indication why atoms of the same kind should combine and so the whole field of organic chemistry was left untouched. It was the new theory of the atom which opened the way.

Stimulated by de Broknie's suggestion in 1924 that electrons, indeed that all matter, have wave properties, Schrödinger developed what has now become known as wave mechanics. This is to be regarded as a generalisation of Newtonian mechanics, for it leads to Newton's laws when applied to heavy particles. There cannot be said to be a proof of the wave equation, for it was obtained by analogy and its justification rests only on its success. The wave equation must be accepted as an article of belief or a fundamental postulate. It involves some strange ideas and some processes of calculation which cannot in detail be understood. Thus the solution of the wave equation for any problem is expressed as a function of the co-ordinates of the system and of the time, usually denoted by Ψ, but this function is merely a means to an end. It is not possible to give to it any simple interpretation in terms of observables. It is to be looked upon rather like a ghost which produces material manifestations. One simple connecting link between Ψ and observation is that for a given system the square of the amplitude of Ψ, for a particular set of co-ordinates, gives the probability that a system has a particular configuration, specified by its co-ordinates. Rules have been devised whereby the probable values of dynamical quantities can be derived from Ψ and so the theory can be tested by comparison with experiment. In particular, the theory leads to a set of stationary states with definite energy values for atomic and molecular systems.

The wave theory of atoms was the first new important idea since the Bohr theory to prove of importance to chemistry. It was found possible to use with it the idea of electron spin and the exclusion principle as well. But the new theory brought other ideas in its train.

So far as we know, electrons are indistinguishable from one another. An interchange of any two in a molecule does not produce an observable change. This means that the probability distribution function of Ψ^2 must remain unchanged when the co-ordinates of any two electrons (both as regards space and spin) are interchanged. This places a restriction of vital importance on the function Ψ. Either it must itself remain unchanged or it must change sign.

Two Possibilities

It is now necessary to distinguish between these two possibilities. The exclusion principle provides the answer. It has been found that if the exclusion principle is to apply to the system as well, the wave function must change sign when any two electrons are interchanged. One consequence of adopting this form of wave function is that the possibility of finding two electrons with the same spin at the same point of space is completely excluded. The importance of this to chemistry will appear presently.

THE NEW IDEAS IN CHEMISTRY

It was not long before the new ideas were introduced into chemistry. In 1927 Heitler and London made the first application of these novel methods to the structure of a molecule and showed that the theory successfully accounted for the attraction of two hydrogen atoms for each other. It is true that the calculated value of the energy of formation of the hydrogen molecule differed considerably from the observed value, but it was of the right order of magnitude, and it was evident that for the first time here was a promising start towards an understanding of a covalent bond. The method of calculation used by Heitler and London was similar to that already used by Heisenberg in dealing with the structure of another two-electron system, the helium atom. The secret of success lay in constructing a wave function which had the necessary properties to take into account the identity of electrons and the exclusion principle. The wave function in terms of space and spin co-ordinates was so designed that it changed sign when the two electrons were interchanged. We know now that other wave functions can be devised to have the required properties and that from them also calculations can be made of the energy of formation of the hydrogen molecule. The method used by Heitler and London was not the only one, or indeed the right one, to give a deep understanding of the forces at work in a molecule to produce stability.

One important new idea came out of the Heitler-London approach. Once their method of calculation was generalised by Pauling and others to more complex molecules, it emerged that there were different ways of obtaining a wave function with the correct symmetry properties. Further, it was found that if such wave functions were combined together as linear sums (the symmetry properties thus being preserved), the resulting expression gave a better representation of the system, for when used to calculate the energy it gave lower values and thus indicated greater stability. Now the component parts of the wave functions could each be described (roughly) as typifying a structural formula in the usual chemical sense. Thus emerged the idea that often a molecule cannot be described satisfactorily by any one classical structural formula. It must be regarded as a composite state, best described as a super-position of different structural formulae. This phenomenon was at first called ' resonance,' but the description is misleading for it suggests actual oscillation between several alternative patterns, whereas the true state is intermediate between all of them and simultaneously involves in varying degrees the properties of each. The idea has proved of great value in chemistry in clearing up many phenomena which had previously remained obscure.

One weakness from a theoretical point of view is that the method tacitly assumes that a precise meaning can be attached to each structural formula, and that a single or double bond in different environments has the same significance. Actually it is not possible to describe even the simplest ' single ' bond, viz. the bond in the hydrogen molecule, accurately without having recourse to the idea of superposition of different conceivable configurations, ionic as well as covalent. Nor does the method make clear why it should be necessary to superimpose different electronic structures. It would be helpful if some understanding could be gained of the influences at work in molecules to produce properties which seem sometimes to correspond to one kind of structure, sometimes to another, and in some cases to be intermediate between those expected of two or more structures.

MOLECULAR ORBITALS

It is for this reason that another form of description of molecules has been found to be useful. When several electrons move in the same field of force, the wave function of the system can be expressed accurately as a product of functions of the co-ordinates of the individual electrons, or as a sum of such products. Each such function corresponds to a distribution throughout the field of force and is called an orbital, because this term implies a generalisation of the notion of an orbit.

It seemed natural therefore to begin with molecules on the assumption that the fields of the electrons on each other could be so smoothed out that all electrons moved in the same field. The problem was then soluble in principle, and though it was necessary in practice to make approximations concerning the form of solutions, this did not detract from the essential soundness of the approach. According to this method the electrons could then be assigned in pairs to a set of functions, each of which represented a definite energy. Each such function depended on the space co-ordinates of an electron only and for convenience it was called a molecular orbital. The energy of the system on this simple view was the sum of the energies of the individual electrons.

It should thus become clear that the term 'molecular orbital,' as first introduced, represented any one of the set of solutions of a wave equation of a single electron in a certain averaged field. The term was thus synonymous with a wave function. The orbitals determined in this way had an important property. If two different ones were multiplied together and the product integrated over the whole of space, the result was equal to zero; they were said to be 'orthogonal.' This feature has proved to be a necessary one for the application of the exclusion principle. It is as though in molecules, as in music, nature prefers a form of harmony in which the 'notes' are compatible and the chords are pure.

The method proved to be powerful because the orbitals were found to have characteristic symmetry properties and could be divided into classes. Thus it appeared that if a molecule possessed a plane of symmetry, then some orbitals were symmetric about this plane while others were antisymmetric, that is at corresponding points on either side of the plane the orbital had values equal in magnitude and opposite in sign. One important application of this has been made to conjugated molecules, for they usually have a plane of symmetry through the nuclei.

Extensive Use

It should, however, be noted in passing that while the orbitals have these different symmetry properties, the charge distributions appropriate to all the orbitals are symmetric about the plane of symmetry, for they are obtained from the square of the orbital values.

This simple form of molecular orbital theory has been used extensively and has helped to clarify much that was obscure in chemistry. It was used by the writer for diatomic molecules and applied with great success by Hückel to conjugated molecules. It has been developed and applied to various problems of structure by Mulliken, Coulson, Longuet-Higgins, the writer and their co-workers, and by many others. Recently Dewar has made numerous applications of the method and, in particular, has given a simple treatment of the colour of conjugated molecules in terms of their structure.

The idea that an electron may be distributed throughout the whole of a molecule is at first strange to the chemist, who has been brought up to think in terms of localised bonds. But the principles of the wave theory force us to accept this view. When an electron is removed from a molecule by the absorption of light or by other means, it must be regarded as taken from the whole molecule and not from a localised part. The 'hole' which is left closely related to the pattern of distribution represented by a molecular orbital.

FURTHER DEVELOPMENT

There has been a further development of the molecular orbital theory. In a real molecule the fields of force acting on different electrons are not exactly the same, because the exclusion principle forces the electrons into different orbitals and the effect on one electron of the repulsive field of all the others varies according to the orbital it occupies. For this reason the wave function cannot be expressed accurately as a product, or a sum of products, of functions of the co-ordinates of each electron. Progress can be made if in spite of this the same form of wave function is adopted and individual orbitals determined in such a way as to give the 'best' solution. By this is meant that solution which renders the calculated value of the energy a minimum. This method of calculation automatically introduces a form of averaged field on each electron, but it is different for each. This field is the one that would arise if all the other electrons were smeared out in space according to their orbital distribution. Progress in this stage of the theory has been made mainly since 1949 and it has been found that a new range of problems has come within its scope. Applications of the method made at Cambridge and Chicago hold promise that it will be able to deal not only with structure but also with ionisation potentials of molecules and the interrelation of the one with the other.

There is further room for improvement. It will be necessary finally to take into account the difference between the averaged field, even though this is different for each orbital, and the actual field. It is this difference alone which prevents the theory from being accurate in all respects. Thus this method of calculation makes clear that the complexities of the theory arise entirely from the fields of repulsion between electrons, for these depend on the simultaneous position of two electrons and thus involve six co-ordinates. Successive refinements of the theory represent stages in the process of calculating the effect of one electron on the distribution in space of another. The problem is thus one of finding the effect of electrostatic forces on the spatial correlation of electrons relative to each other.

SOME MODELS OF MOLECULAR SYSTEMS

These complexities can be avoided and the physical significance of the principles determining molecular structure made clear if attention is first directed to some simple systems in which the particles move in the same field. The process of calculation follows closely that used for molecules by the orbital method.

Model 1.—Because it can be used to illustrate some of the properties of butadiene, the first example to be considered is the problem of two particles of the same spin moving in a region of finite length a within which there is no force field. It is supposed that the particles are trapped within this region and that the boundary walls are such that there is no penetration. It is sufficient for a discussion of a problem such as this to concentrate on the behaviour of the particles in the one dimension across the region. To simplify the discussion it will be assumed that the particles do not interact with each other by any direct force field. In this, as in all atomic and molecular problems, it is necessary first to find the appropriate wave representation of the particles. For a single particle moving in such a force-free field the wave function can be any one of a set of *sine* functions, each fitting into the region in such a way that it has zero value at the two extremities. This implies that the half-wave lengths of the functions fit into the width of the region an integral number of times. To each function corresponds a definite energy and the set can be arranged in an increasing sequence, E_1, E_2, E_3, ... As the particles have the same spin, the lowest energy of the two is $E_1 + E_2$, because they must occupy different orbitals. The wave function of the lowest energy is $\sin(\pi x/a)$ and the next lowest $\sin(2\pi x/a)$. These are the two occupied orbitals.

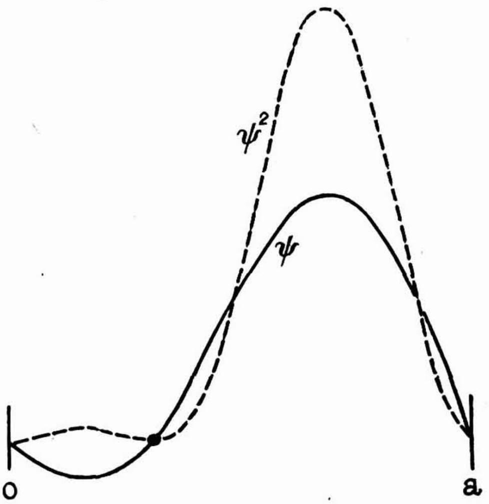


Fig. 1.—The distribution of one particle relative to another due to the exclusion principle

It is necessary now to take into account (i) the identity of the particles, so that each may occupy either orbital with equal probability, and (ii) the exclusion principle. As the particles do not interact with each other directly, the correct wave function is proportional to the difference of $\sin(\pi x_1/a)\sin(2\pi x_2/a)$ and $\sin(2\pi x_1/a)\sin(\pi x_2/a)$, and this is an accurate solution satisfying the necessary conditions.

Once the wave function $\Psi(x_1, x_2)$ has been obtained, it is possible to deduce the properties of the system. Thus the square of Ψ, multiplied by dx_1dx_2, is interpreted as the probability that one particle is between x_1 and $x_1 + dx_1$ with another at the same time between x_2 and $x_2 + dx_2$. From this we can derive the probable distribution of one particle relative to the other. In Fig. 1 is shown the form of the wave function for a given position of one particle and the probability distribution of the second particle relative to the first.

It is evident that the second particle avoids the first and that its most probable position is between the first and the further boundary. It is to be noted that this does not arise from any mutual repulsion of the particles because it has been assumed that none exists. It arises only from the exclusion principle.

As a corollary to this example it is possible to consider the case of four particles moving in the same one-dimensional field, there being two of one kind of spin and two of another. The second pair of particles can also be assigned to the two lowest energy states without conflicting with the exclusion principle. The wave function now consists of products of four sine functions, one for each orbital to which the particles are assigned. In addition it is necessary to introduce factors to indicate the spin to be associated with the particles in each arrangement. The complete wave function is so arranged that it changes sign for any interchange of electrons; it takes the form of a determinant.

For this system it is found that the distribution of one particle relative to another of the same spin is the same as before. One avoids the other. On the other hand, particles of opposite spin can move independently of each other. There is no correlation between them. The probability distribution of one relative to the other has a constant value across the region. This represents a feature which appears in all molecular systems. The exclusion principle does not itself require any correlation between electrons of opposite spin. Whatever correlation exists arises from other causes.

Model 2.—A model which can be used to illustrate some of the properties of the benzene molecule is that of six particles moving in a ring of constant potential, three particles each of opposite spins. Again it is supposed that the particles do not interact with each other by force fields.

As in the first example, it is instructive to consider first the case of particles of the same spin. The wave function consists of three factors, each of which is a solution of the wave equation for a single particle moving in the ring. The solution of lowest energy has a constant value round the ring, say C, and the energy is zero. There are two solutions of next highest energy and they are sin ϕ and cos ϕ, where ϕ is an angular co-ordinate determining position. The wave function of the three-particles system is made up of a linear sum of terms such as

$$C(1)\ \sin\phi_2\ \cos\phi_3,$$

indicating that one electron is assigned to each orbital. When this linear sum is arranged to change sign for any change of electrons, it proves to be proportional to sin $(\phi_1-\phi_2)$ + sin $(\phi_2-\phi_3)$ + sin $(\phi_3-\phi_1)$ and this vanishes whenever two of the coordinates are the same. No two particles ever occupy the same place in the ring simultaneously.

The maximum value of the wave function occurs when the three particles are disposed at equidistant intervals round the ring. Thus the system tends to adopt trigonal symmetry and this property arises solely from the wave representation of the particles and the exclusion principle. The probability distributions of one particle for given positions of the others are shown in Fig. 2. Again we see the tendency of the particle to take up a position midway between the other two.

When there are three pairs of particles of opposite spin, each set of three of the same spin has the properties just described. In particular each system tends to arrange itself so that the three particles are equidistant round the ring. But there is no correlation between the two systems. They move round the ring independently of one another.

Model 3.—Because of its interest in illustrating some of the properties of carbon and complete octets of electrons, it is profitable to examine in a similar way first a system of four particles, each of the same spin, confined to move on a spherical surface, and then a system of eight particles.

Treatment on similar lines to that given above shows that the four particles of a given kind of spin tend to arrange themselves symmetrically on the sphere so that the lines joining them form a regular tetrahedron. This represents the most probable distribution. Other arrangements can occur, though with less probability.

[*continued on page 528*

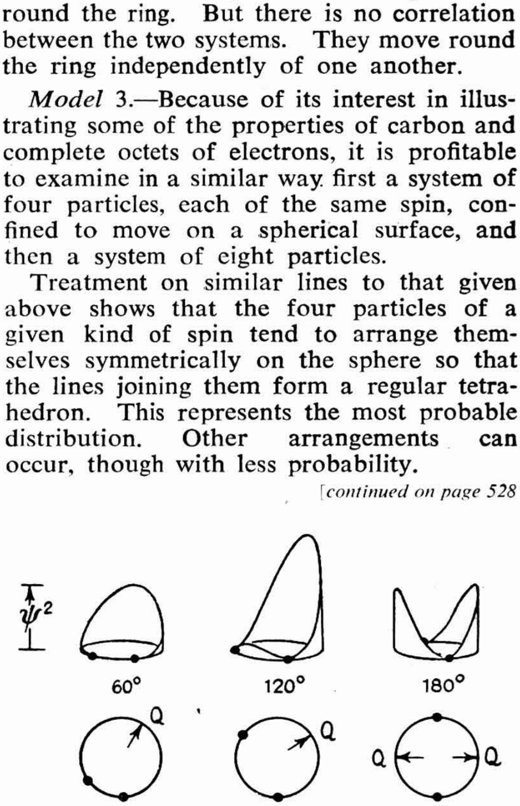


Fig. 2.—The distribution of a particle relative to two others

Methyl Mercaptan — Yesterday's Bane, Tomorrow's Boon

by PETER W. SHERWOOD

METHYL mercaptan, the petroleum refiner's bane of yesterday, may well turn out to be the boon of tomorrow. With an important new market assured in the synthesis of methionine, and new outlets in the plastics industry being developed, methyl mercaptan may be expected to continue some time into the future the strong upward trend which has characterised its growth during the past two years.

Already the list of manufacturers is growing. In the United States, the most recent addition is Pan American Refining Corporation, which is now building a plant for the synthetic production of 5,000,000 lb. per year of methyl mercaptan near Texas City. Houston's Index Chemical Company, the only other synthetic producer in the field, began its full-scale operations in early 1954.

These two plants will bolster the supply of this raw material of new importance which was, until a few months ago, obtained entirely by recovery from petroleum fractions. Actively engaged in operations of this type are Brea Chemicals Inc., Dow Chemical Co. and Universal Mfr. Co.

Synthesis of the amino acid, methionine, is entirely responsible for the upswing which methyl mercaptan sales have experienced recently. Involved in its production is the intersection of methyl mercaptan with acrolein. (Fig, 1),

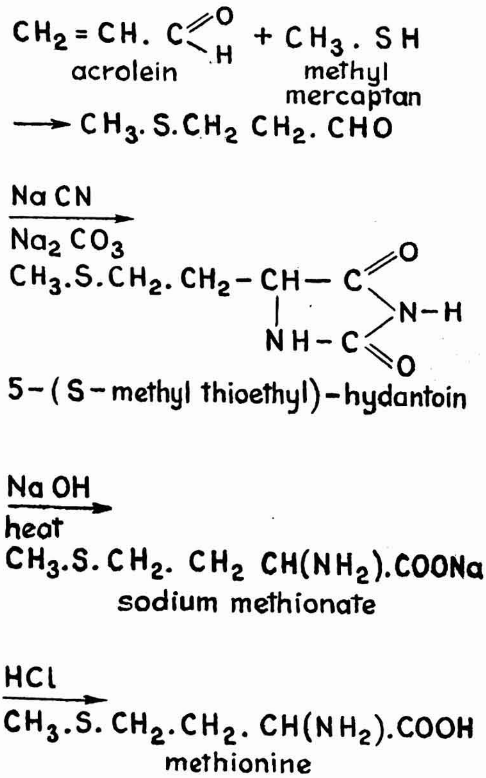


Fig. 1

Poultry Industry Main Consumer

The poultry industry is, at this time, the most important consumer of methionine. It is found that this amino acid, added to feed formulations, will result in more efficient conversion of feed into meat. At the same time, the methionine-fed bird will develop a growth of predominantly large feathers which require less handpicking labour. These and other biological and therapeutic benefits have boosted US demand for methionine to an estimated 2,000,000 lb. during 1954 and a forecasted 4,500,000 lb. in 1955.

Methyl mercaptan, the raw material for methionine, occurs in the gasoline fraction of petroleum. Its content varies widely, depending on the sulphur content of the crude and on whether the gasoline has been obtained by straight fractionation or by cracking operations.

Because of their objectionable odour, the mercaptans must be eliminated from the petroleum fraction. Extraction processes and chemical conversion methods, such as doctor sweetening, are employed (note that the latter approach changes mercaptans to less troublesome disulphides but does not lower total sulphur content).

Illustrative of processes designed for the recovery of methyl mercaptan from gasoline is the method developed by McCormick and Lazar for Tide Water Associated Oil Co. (USP. 2,263,043). The basis of the process is the distillative concentration of methyl mercaptan in the butane fraction, followed by extraction with an aqueous alkali solution.

Using cracked gasoline as feed material, the first step involves stabilisation for the overhead removal of light gases (methane and ethane) together with the bulk of contained hydrogen sulphide and some mercaptans. Operations of this kind are most commonly carried out at elevated pressures. In a pilot plant run, the stock was fed to a nine-plate column at 205 psi. Feed temperature was 183° and the bottoms were held at 175°. The treatment permitted reduction in H_2S content from an initial 0.30 g. per l. to 0.9 g. per l. in the bottoms.

Fed to Column

The stabilised gasoline fraction is next fed to a 30-plate column, where a light fraction is taken overhead containing practically all of the residual hydrogen sulphide and methyl mercaptan. Operating pressure is 40 psi. and bottoms temperature is 190°. The heavy ends are substantially free of hydrogen sulphide and are returned to the refinery.

The overhead of the primary fractionation is cooled and the condensate is separated from permanent gases. The liquid product is joined by the overhead of the stabiliser column. This combined fraction must first be freed of contained H_2S, since this acidic component raises chemicals consumption and interferes with the efficiency of the alkaline scrubbing step which is eventually employed for mercaptan extraction.

Further H_2S-stripping is achieved in a second stabilising operation, in the course of which residual methane, ethane, and most of the propane are also removed. This may be achieved at 245 psi. with a bottoms temperature of 149° and overhead controlled at 49°.

The stabilised bottoms obtained in this tower are finally passed to a 24-plate butane column (80 psi., 49° on top plate), in which a cut of commercial butane is taken overhead. This is the mercaptan-rich fraction (containing as much as 0.35 per cent) which serves as feed to the extraction system.

In the scrubbing step, advantage is taken of the faintly acidic character of methyl mercaptan which permits conversion to water-soluble sodium mercaptide by treatment with caustic soda:

$$NaOH + CH_3SH \rightarrow CH_3SNa + H_2O$$

The extraction medium is a caustic soda solution of 5° to 12° Bé strength. About 1.2 volumes are used per volume butane fed to the extraction stage. Operation is carried out at 0-5° since the equilibrium is moved strongly toward sodium mercaptide formation as the temperature is decreased. The extraction is suited for countercurrent operation with its inherently higher efficiency.

Absorbed methyl mercaptan is steam-stripped from the alkaline solution at atmospheric pressure. This step achieves, at the same time, the regeneration of the absorbent which may be recycled to the extraction stage. The amount of mercaptan depletion taken determines steam consumption and it is found that the use of 1.8 lb. steam per 5 lb. caustic solution in a 7-plate column permits reduction in mercaptan content from 40 g. per l. to 6 g. per l.

The vapours leaving this column are freed of entrained caustic and are then water-scrubbed for the removal of higher mercaptans. Methyl and ethyl mercaptan pass through this stage in gaseous state. They are condensed by refrigeration and purified by fractionation.

Methods of Synthesis

With the significant impetus given to methyl mercaptan sales by methionine acceptance, its large-scale synthesis is now becoming a reality. Of the several methods of synthesis, particular interests attaches (a) to hydrogenation of carbon disulphide, and (b) to the reaction between methanol and hydrogen sulphide. The latter process is reported to be the basis of Pan American Refining Corporation's synthetic mercaptan unit which is now under construction at Texas City.

The hydrogenation of carbon disulphide leads to the predominant formation of methyl mercaptan and dimethyl thioether, together with by-product hydrogen sulphide:

$$\begin{array}{c} CS_2 + 3\ H_2 \rightleftharpoons CH_3SH + H_2S \\ \upharpoonleft\!\downharpoonright \\ 2\ CS_2 + 6\ H_2 \rightleftharpoons (CH_3)_2S + 3\ H_2S \end{array}$$

A number of other compounds are formed in lesser amounts.

The reaction may be carried out in the presence of catalysts of the Friedl-Crafts type. Bell (USP. 2,565,195) describes operation in both liquid and vapour phases. Use of various promoters is indicated.

Some degree of super-atmospheric pressure is of advantage in facilitating product recovery without refrigeration. However, pressure shifts the reaction equilibrium from mercaptan to thioether formation, thus introducing a severely limiting factor.

A typical catalyst employed for hydrogenation of carbon disulphide in the liquid phase consists of 89.3 parts by weight anhydrous aluminium chloride and 41.6 parts copper powder. The mixture is charged to a reactor provided with good agitation. 304.5 parts carbon disulphide are introduced and reacted with a stream of hydrogen. The reaction is carried out at 100 psi. and 100° for 4 hours. In the course of this operation, up to 35 per cent of the carbon disulphide is converted, principally to methyl mercaptan and dimethyl thioether in a conversion ratio of 2:1.

Vapour-Phase Operation

Vapour-phase operation is preferably carried out with a solid catalyst. Included among the more important catalysts usable at such conditions are activated alumina, silica gel, or fuller's earth impregnated with aluminium chloride. Again, various promoters may be used. If high-temperature operation is selected, supported aluminium chloride must be modified by inclusion of an inert vapour pressure depressant such as sodium chloride.

For preferential production of methyl mercaptan, the reaction is best carried out at slightly super-atmospheric pressure. Operating temperature is determined by choice of catalyst and space velocity (which, according to USP. 2,565,195, may range from 50-500).

Using a fused catalyst such as $AlCl_3$-$CuCl$, containing 10 per cent finely divided copper metal, a temperature range of 175-275° is given. Excess hydrogen is used. Carbon disulphide is converted to methyl mercaptan and dimethyl thioether in the approximate ratio 3:1. Accompanying formation of other organic sulphur compounds and methane is small (up to 4 per cent).

Means for recovery and purification of methyl mercaptan include (a) low-temperature liquefaction and fractionation; (b) removal of residual hydrogen sulphide by scrubbing with sodium carbonate, followed by low-temperature fractionation of the H_2S-free vapours; (c) absorption of organic components in hydrocarbon oil, followed by fractionation of the sorbate.

Production of methyl mercaptan from H_2S and methanol is a new and improved commercial application of a reaction which has served in earlier years for the industrial manufacture of butyl mercaptan.

$$ROH + H_2S \rightarrow RSH + H_2O$$

Reported work indicates that thoria on pumice is the best catalyst for this reaction. This catalyst is gradually fouled and may be regenerated by steam and nitrogen peroxide at 380°, which is also approximately the optimum reaction temperature for mercaptan production.

Thoria also promotes the dehydrogenation of alcohols. In the production of methyl mercaptan by this route, the principal by-product is therefore formaldehyde. Mercaptan formation rises with increasing temperature but, at the same time, side reactions become more extensive. For the production of methyl mercaptan, Kramer and Reid (*J. Amer. Chem. Soc.*, 1921, **43**, 887) obtained best results at 370°. At this temperature, 41.6 per cent of the alcohol was converted to the desired product and 14.3 per cent was dehydrogenated to formaldehyde, at flow conditions which left 44.1 per cent of the organic feed unconverted. Conversion rises to an assymptotic value as contact time is raised. Little is gained by lowering space velocity below 5-6.

While some excess hydrogen sulphide appears not to be harmful to the reaction, its presence imposes additional demands on the recovery system. Use of excess alcohol, on the other hand, raises the extent to which this raw material is consumed by side reactions. The optimum ratio of reactants is therefore found to be close to the stoichiometric relation of 1:1.

Plastics Firm Grows Up

Winston Plastics Ltd. plans to build a new 28,000 sq. ft. plant in Toronto's suburban Scarborough Township. The company will expand its premises about two-and-a-half times in the move from its present location, in the same municipality. It is engaged in injection moulding of plastics, specialising in houseware. A private company with Mexican financial backing, it began business in 1951. Management is Canadian.

Team Visits I.C.I.

Scots' Productivity Committee Scheme

THE first event arranged by the Falkirk, Grangemouth and District Productivity Committee, under their Circuit Scheme, took place on 20 August, when a team from Allied Ironfounders Ltd., visited I.C.I. Ltd., Grangemouth, and Linlithgow.

Mr. J. B. Kitchin, assistant works manager, Grangemouth, said that they could not claim at I.C.I. to make a 100 per cent success of everything they did; they would show the guests their actual methods of working and invite criticism of these methods from the visiting team. The aspects mainly demonstrated were materials handling, production and quality control and inspection. Members of the visiting team were encouraged to discuss the operations with staff at all the points inspected.

Special Features Demonstrated

Among the features of the Grangemouth plant demonstrated were: a rubber-wheeled diesel tractor is used to operate all wagon shunting work and also acts as a trailer-tractor; suction elevation of coal from wagons is used to take fuel to a hopper 150 ft. above ground level, the descent being by gravity fall to automatic stokers; ash is dropped to a quenching trough and carried by belt conveyor to a hopper which drops it straight to trucks and so to the tipping point.

Specially designed bogies were shown in use lifting carboys, casks and other loads; Behind this policy is a programme of work study which is designed to determine the scope of mechanical handling equipment in relation to given weights, distances and types of loads. The visitors saw one man using a delicately balanced two-wheeled 'barrow' to handle carboys easily, smoothly and without energy for delivery to a precise point.

At the Regent Works—which manufactures pharmaceuticals—special counting and weighing machines were shown, together with the material handling methods appropriate to this type of work. A simple idea for employee identification is used here whereby workers engaged on filling and related work wear green caps; leading hands wear white caps and inspectors red caps. Dr. W. G. Reid, works manager, Grangemouth, presided at the luncheon and Mr. A. P. Cattle, chairman of the local Productivity Committee, thanked both companies for making a start to their work locally; success of the scheme would depend on the success of the Circuit Scheme.

New Ideas in Chemistry

continued from page 524]

Thus we see in this example the emergence of some of the tetrahedral properties of carbon, for in its tetravalent state it can be regarded as having four electrons somewhat in the way described, though the problem is more complicated because of electrostatic forces.

As in the other example considered above, the two sets of four particles each of the same spin tend to adopt tetrahedral configurations among themselves but the exclusion principle does not cause any correlation between the two sets.

Some correlation is produced by electrostatic forces but it is weak compared with that just described. Calculations show that these forces increase the probability that four electrons of the same spin will take up a tetrahedral arrangement. Correlation between electrons of opposite spin is so slight that a complete octet of electrons may be described as consisting of two loosely coupled tetrahedra. Of course it must be emphasised that while a tetrahedron represents the most probable configuration of each set of four there is considerable flexibility about that arrangement.

THE PHYSICAL SIGNIFICANCE OF THE EXCLUSION PRINCIPLE

These models bring out a property which holds for all electronic systems, whether they are atoms, molecules or solids: Electrons of like spin tend to avoid each other. This effect is most powerful, much more powerful than that of electrostatic forces. It does more to determine the shapes and properties of molecules than any other single factor. It is the exclusion principle which plays the dominant rôle in chemistry. Its all-pervading influence does not seem hitherto to have been fully realised by chemists, but it is safe to say that ultimately it will be regarded as the most important property to be learned by those concerned with molecular structure.

(*To be continued*)

Monsanto Canada Limited*

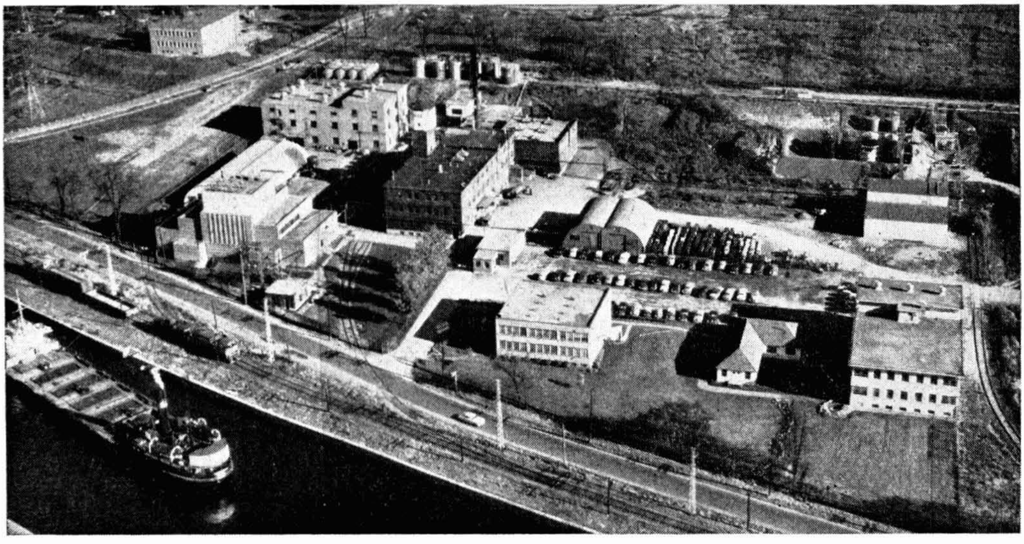
Rapid Growth From Mere Sales Outlet to Major Producer

THE Canadian subsidiary of Monsanto Chemical Company of St. Louis, Missouri, was organised in 1932 to serve as a sales outlet for Monsanto Chemicals Limited of Great Britain and a short time later it undertook to sell the organic chemicals made by the parent American company. The ever-growing demand of Canadian and export markets led to a decision to commence manufacture of certain chemical products in Canada, however, and today Monsanto Canada Limited ranks as one of the Dominion's fastest growing chemical manufacturers. Approximately 85 per cent of all the products sold by the company are made in Canada.

Monsanto Chemical Co., was founded in 1901 by John F. Queeny, then purchasing agent for a wholesale drug company. Mr. Queeny was convinced that saccharin could be profitably manufactured in the US and with a $5,000 investment he started a chemical works in a rented building in St. Louis. The staff consisted of a chemist and one assistant. In 1902 production of saccharin was commenced, in 1905 the company made its first profit and in the following year the first dividend was paid to stockholders. The company made rapid progress and in 1920 a one-half interest in R. Graesser Limited, at Ruabon, in North Wales, was acquired. This was the forerunner of Monsanto Chemicals Limited, and complete ownership was acquired in 1928.

At the time of the formation of the Canadian company, sales of Monsanto Chemicals Ltd., had been mainly vanillin, phenol and salicylates.

As both the British and American concerns continued to grow both horizontally and vertically, sales volume steadily expanded and on 1 January, 1945, Monsanto Canada Ltd., purchased the present plant site at Ville LaSalle, a suburb of Montreal, and production of the alkaloid caffeine commenced soon afterwards. The first major expansion, however, was the erection of a new producing unit for manufacture of



Monsanto Canada's works at Ville LaSalle, Montreal

---

* *The second of a short series of articles on Canada's chemical industry, written by the Editor following a recent tour of the Dominion. The first of this series appeared in our issue of 28 August. The author is grateful to officials of Monsanto Canada Limited for the kindness shown to him during his visit to the company's plant at Ville LaSalle and to officials of Monsanto Chemicals Limited in London for arranging for him to visit this works.*

polystyrene moulding powder, which began operation in September, 1946.

In 1944 the parent company acquired the I.F. Laucks Corporation, an important US producer of industrial adhesives. Two years later Monsanto Canada acquired the two Canadian subsidiaries of Laucks with plants at Vancouver, British Columbia, and Stanbridge, Quebec. These were finally merged with Monsanto Canada on 1 January, 1948. The Vancouver plant supplies the well-known Lauxite synthetic resins and protein glues to the large plywood industry on the West Coast. It also manufactures a wide range of wood sealers and preservatives, industrial paper adhesives, insecticides and herbicides.

Operations Transferred

In 1946 the operations carried on at Stanbridge were transferred to Ville LaSalle where the Adhesives Department of the company now produces a complete line of synthetic resins and protein glues to serve the Eastern Canadian hardwood, plywood and furniture industries. Lauxite and Resinox phenolic industrial resins, also made there, have a wide range of important industrial uses, including the bonding of rock wool in the production of insulating batts for the building trade and the production of laminates.

A further important step in the company's development was the construction at Ville LaSalle of a flexible plant for the large-scale production of organic chemicals. This plant came into operation in August, 1949, the first product being sodium benzoate. Phenacetin was added to the 'made-in-Canada' items in November, 1950. In the same month the production of polyvinyl chloride resin was commenced.

Other big developments took place during 1950. Modern plant for producing adhesives and resins were erected to replace the original facilities and provision was also made for the production of butylated melamine resins. At the end of the year a new organic mercurial known as Slimicide MSC, developed in the firm's Montreal laboratories, had found wide acceptance in the pulp and paper industry for slime control.

A modern office building was erected at Ville LaSalle in 1947 and two warehouse buildings were added in quick succession. In 1949 a fire-proof building for the storage of inflammable substances was completed and a second storey added to the office building. A modern canteen was built in the same year. Purchase of additional land adjacent to the LaSalle property in 1951 increased the total plant area to 62 acres. In the autumn of 1952 a new research and pilot plant building which doubled original research facilities was opened and in December of 1953 a large new oil additives plant went on stream producing several types of detergents and inhibitors.

In 1953 production began of several important plasicizers including diotcyl phthalate, di-*iso*-octyl phthalate, dioctyl adipate and di-*iso*-octyl adipate used in the manufacture of extruded vinyl plastics.

The Western Division of Monsanto Canada has also expanded since the acquisition of I. F. Laucks in 1948. A new site was purchased at Marpole, a suburb of Vancouver, and a resin and wood preservatives plant with the necessary administration buildings was completed in 1949. In 1953 a new research laboratory and office was erected and all operations have since been transferred to this site.

Vinyl Film Firm Acquired

In early 1952 all the outstanding common stock of Barringham Rubber and Plastics in Oakville, Ontario, was purchased by Monsanto Canada Ltd., and recently it was announced that the company name had been changed to Monsanto Oakville Ltd. This company manufactures a wide range of vinyl film, sheeting and coated fabrics. It occupies a 20-acre site.

Mr. L. E. Ryan

The executive vice-president of Monsanto Canada Ltd., is Leo Edward Ryan, who was born in Montreal, and who has been associated with the company since it started manufacturing in 1945. Responsible for all the operations of the company, Mr. Ryan is the son of Monsanto Canada's chairman and founder, Mr. Leo G. Ryan. Assisting Mr. Ryan as vice-president is Mr. A. Monsaroff, a Russian-born Canadian, who like Mr. Ryan is also a graduate chemical engineer. Both men are in their early 40s and are representative of the young men moving up into executive positions in one of Canada's fastest-growing industries.

Monsanto Canada Ltd. is not Canada's largest manufacturer of chemicals and probably does not rank much higher than tenth in capital outlay. On the other hand it is a company which is typical of Canada's chemical industry as a whole. It is very young, very ambitious, very energetic and, most characteristic of all, growing like a prairie fire. The company's brief history is one of continuous planned growth to keep pace with the demands of the country's expanding markets. Officials of the company assured the writer that this trend would continue in the future.

Plans for new manufacturing units are now well advanced; new products, especially formulated for Canadian requirements, and better ways of making old products are being thoroughly investigated by a first-class research team. At the present moment a new synthetic detergent, 'All,' especially designed for automatic washing machines and to overcome the problem of excess foaming, is being marketed in Canada on behalf of the American parent company. It would not surprise the writer to learn some day that Monsanto Canada were building a plant at Montreal to produce the raw materials for this popular product, for the development department of the company is constantly studying the changing market, alert to the possibility of profitably making a new product.— E. A. R.

Sulphuric Acid Plant

New Unit for Stanlow Oil Refinery

THE latest addition to Stanlow Oil Refinery, Cheshire, a plant capable of making 33,000 tons of sulphuric acid a year, and costing £200,000 to erect, began operating on 6 September. With this plant and the two-year-old sulphur recovery plant, Stanlow becomes the only refinery in the United Kingdom which is entirely self-sufficient for supplies of sulphur and sulphuric acid. All the acid produced will be used in the refinery for treating and improving lubricating and white oils and in the manufacture of detergents and petroleum-based chemical derivatives.

Sulphur is a constituent of almost all crude oils and must be largely removed from its products before they can be marketed. Some sulphur recovery was carried out before the war in the USA on a small scale, but it was the post-war shortage of natural sulphur that gave an impetus to the development and installation of these processes in oil refineries throughout the world. In the UK there was the added stimulus of the need for dollar saving.

In 1952, Shell built a plant at Stanlow to recover sulphur from hydrogen sulphide and this plant is now producing about 15,000 tons of sulphur a year. Until recently, in the interests of the national economy, all of this production went to meet the needs of consumers in Britain. Now, however, with the easing of the sulphur supply position, some of it is to be used for the manufacture of Stanlow's own requirements of sulphuric acid.

Hydrogen-sulphide produced in the refining processes, together with some elemental sulphur, is burnt to produce sulphur dioxide. This is then passed into the sulphuric acid contact plant, which is of conventional design. The sulphur dioxide stream is dried in a tower by use of 93 per cent acid and then fed to a four-stage converter. Here the sulphur dioxide is converted to sulphur trioxide over a vanadium pentoxide catalyst and subsequent absorption of sulphur trioxide is carried out in two towers which produce 98 per cent sulphuric acid and 20 per cent oleum respectively.

New Primer Beats Corrosion

A NEW primer which helps to overcome corrosion has been developed by the laboratory division of Evode Ltd., of Stafford. Known as Evo-Led, it is a primer for use under strong solvent based finishing paints, such as chlorinated rubber and bituminous paints. It contains a high proportion of vegetable oils together with red lead powder, so that there is complete soap formation and consequent rust inhibition.

A major accomplishment is that it can be applied to moist surfaces without, when dry, being subsequently affected by moisture. The primer displaces the moisture from the surface, absorbs it and then allows it to escape with the solvents during the process of drying. That process takes place by a combined physical and chemical reaction in the film during drying and is irreversible, which means the dry film cannot absorb water.

War Declared on Ants

Five-Year Project in Australia

THE Argentine ant has become such a menace in Perth, Western Australia, that a five-year project costing £A100,000 has been decided on in order to control it.

Dieldrin, a comparatively new, and highly lethal insecticide manufactured exclusively by Shell, is to be used when spraying operations begin in a few weeks. Being potent to insects in minute quantities, although harmless to plants and humans, it provides an effective and economic method of control. By using dieldrin the area to be treated will need only one spraying instead of two or more as has been the case with other insecticides in the past.

The insecticide is sprayed in a lattice pattern so as to divide the area into a series of squares which the ants cannot leave without crossing the dieldrin-treated strips. In addition all gutters and pavements are treated. As dieldrin kills, but does not repel, the 'worker' ants going in search of food will cross these bands and so die without being able to return to their nests. Ultimately the entire ant colony, including the 'queens,' will be killed or starved to death.

Spraying operations will begin on the north side of the Swan River, on which Perth is situated, as this is the most heavily infested area. Later the outskirts of Perth will be treated. By this means the ants will gradually be squeezed into a small central area where they can be easily eliminated.

During the last few years dieldrin has proved effective in many countries against a number of public-health pests including the mosquito carriers of malaria and elephantiasis, the vector of Chagas disease, and the common housefly; in the UK for example, its efficiency was demonstrated against seaweed flies at Brighton at the end of last year.

DCL Show in Glasgow

THE Distillers Company, Ltd. (Industrial Group) stand at the Scottish Industries Exhibition, Kelvin Hall, Glasgow, houses half a dozen showcases devoted to the ever-growing interests of the group. It is the smaller and less prominent of the two DCL stands at the exhibition.

One display, on the curving back wall of the stand, emphasises the four features underlying the group's work—research, development, construction and operation. Among the individual exhibits, pride of place is given to the activities of British Petroleum Chemicals Ltd. (jointly owned by DCL and The Anglo-Iranian Oil Co., Ltd.), whose plant at Grangemouth has been in operation since 1951 producing industrial ethyl and isopropyl alcohols. Other show-cases include simplified molecular models of the company's range of alcohols, examples of the use of Bisol industrial chemicals, finished plastics made from polystyrene and some Geon PVC products.

The DCL also has interest to those who visit the Engineering stand, where one of the displays is devoted to the new CeDeCut process in which liquid carbon dioxide is used to cool the cutting edge of machine tools. Next to this are exhibited Elektron magnesium alloys. The DCL Yeast and Malt Extract Department and The Distillers Company (Biochemicals) Ltd., are also represented at the exhibition.

Chemistry of Cosmetics

A THREE-YEAR part-time course on 'The Chemistry of Cosmetics' has been arranged to start at Acton Technical College, High Street, Acton, London, W.3, on Wednesday, 22 September. It is intended primarily for junior chemists, laboratory technicians, research assistants, etc., engaged in the industry, but it will also have a wide appeal to others engaged in associated industries using similar raw materials. In 1954-55 it is intended to hold course C.1 First Year and also Course C.2 Second Year, to allow students who completed First Year elsewhere in 1953-54 to continue their work.

There are to be two sessions (theoretical and practical) a week, each of two hours. The course will include the essential organic chemistry, including selected aliphatic and aromatic classes of compounds used in cosmetics, together with some physical chemistry. The subject matter will also include raw materials and reagents used in cosmetics, detergents, oils, fats and waxes, soaps, essential oils, special soaps and creams, perfumery, principles of dermatology, hair preparation and dyes, permanent waving, essentials for, product control, packaging and presentation, etc.

Recovery of Sulphur in the Textile Industry

OEEC Chemical Products Report

SEQUEL to a brochure on sulphur, published in 1952, is a report by an OEEC Working Party on the recovery of sulphur in all its forms in the textile industry. The principal portions of this report we publish below:—

Sulphur is used in the artificial and synthetic textile industry in the form of carbon disulphide, sulphuric acid and, to a lesser degree, sodium sulphide and sodium sulphite, which enter into the manufacture of cellulose substances by the viscose process (rayon and staple fibres, viscose, cellulose film, artificial cellulose sponge) and vinylic fibres.

Consumption of carbon disulphide, including the amount used in making cellulose film and artificial sponge, amounted to about 170,000 tons in member countries in 1952. The textile industry (including wool and cotton) consumed nearly 680,000 tons of sulphuric acid (monohydrate) in 1952, most of which was probably used for artificial and synthetic textiles.

In the viscose process the sodium is converted into sodium sulphate while most of the sulphur content of the viscose is set free in the form of carbon disulphide and sulphuretted hydrogen and a small proportion of the sulphur is precipitated in the spinning bath or on the regenerated cellulose. The sulphur content of the regenerated cellulose products is removed by the action of sodium sulphide, producing polysulphides or sodium sulphite with the formation of thio-sulphates.

In the manufacture of vinylic fibres the carbon disulphide is used in association with acetone, as a solvent of vinyl chloride. The solvent is evaporated in a heated atmosphere at the spinning stage and recovered. As no chemical change takes place in the carbon disulphide, there is no particular difficulty in recovering this product.

The remainder of this memorandum will therefore deal with the question of sulphur in the viscose process only and will discuss the problems arising from the use of carbon disulphide and sulphuric acid, as the recovery of the sulphur derivatives released during the desulphurisation of filaments or fibres does not seem possible, owing to the small quantities involved.

The alkali cellulose is converted by the action of carbon disulphide into cellulose xanthate which in turn results in viscose, in which the carbon disulphide is in combination with the cellulose molecules.

The amount of carbon disulphide used for sulphuration depends on the quality of viscose required and varies from 25 to 34 kg. per 100 kg. of fibre output (moisture content 13 per cent). The clearing of the xanthation plant after each operation and the degassing of the viscose while it is maturing causes the loss of one to three kg. of sulphur. The above figure therefore becomes 22 to 31 kg. of carbon disulphide per 100 kg. of fibre output at the passage of the viscose through the spinning orifice.

During coagulation the viscose is decomposed in the spinning bath and an approximate analysis can be made of the sulphur products, the presence of which varies according to the product manufactured and the process employed.

A large proportion of carbon disulphide (up to 25 kg.) is carried off with the filament, the remainder being released either direct into the atmosphere or in the spinning bath in the form of carbon disulphide, sulphuretted hydrogen or sulphur precipitate.

Recovery from Filament or Fibres

In 'parallel' (bobbin-spun) viscose rayon, the CS_2 is recovered when the spools are washed on leaving the spinning machines. The bobbins are treated with hot water in an enclosed tank. The carbon disulphide held in the filament comes off as a vapour which is drawn off and delivered either to a water-cooled condenser in which the carbon disulphide is collected after condensation, or to a recovery plant using active carbon. By condensation, it is possible to recover 25 per cent to 30 per cent of the carbon disulphide used, as against 40 per cent to 45 per cent with active carbon.

The treatment of the acid rayon with hot water presents a number of drawbacks which may, in certain cases, alter the quality of the filament obtained; this treatment is therefore not widely used.

In the 'centrifuge' (box-spun) viscose rayon process, the filament is delivered from the coagulation bath to a high-speed spinning box. The draining of the bath by centrifugal action causes almost all the carbon disulphide to be carried off with the fibre. The carbon disulphide is drawn off in the ventilation hood above the spinning machine. There does not appear to be any likelihood in this process of any recovery direct from the filament.

The rayon viscose 'continuous spinning' process is still too recent to have provided any practical solution to the problem. Experiments are in progress.

In rayon staple fibre, all filaments from the spinning orifices of the same machine are collected together in one tow which is subsequently cut into short lengths. The fibre is treated as parallel spun rayon either before or after cutting the tow. In certain cases there is a risk that the hot-water treatment may impair the quality of the fibre, and some producers consider that the uses of this process are therefore limited.

The carbon disulphide comes off as a vapour which is either separated by cold water condensation from the water vapour, or absorbed by active carbon. In certain plants about 40 per cent can be recovered industrially by condensation and 45 per cent with active carbon.

Recovery from Gases

As already mentioned, a far from negligible volume of carbon disulphide is drawn off in the form of exhaust gases through: (a) the ventilation of comparatively hermetic equipment (churns, vacuum, enclosed spinning machines, de-gassing tanks); and (b) general shop ventilation. The throughput of air is, in this case, so large that the sulphide content is very small.

The gases drawn off in this way contain carbon disulphide and hydrogen sulphide in varying proportions, depending on the origin of the gas. In certain conditions the carbon disulphide can be recovered by absorption by active carbon. But if such a process is to be used, the hydrogen sulphide must first be removed from the gas.

Hydrogen sulphide can be released by various processes.

(1) *Absorption of hydrogen sulphide by caustic soda solutions.*—By this process up to 70-80 per cent of the hydrogen sulphide contained in the gases can be absorbed. Diluted lyes of sodium sulphide or disulphide are obtained as a by-product, part of which can be used for the desulphurisation of rayon. The rest can either be evaporated to obtain crystallised or fused sodium sulphide or decomposed in order to remove the H_2S in a sufficiently concentrated form for conversion into sulphuric acid by the contact process. Instead of caustic soda lye, other agents can be used such as soda ash, phenolate solutions, or organic alkaline solutions with an amine base.

(2) *Oxidation by the dry process using ferric hydroxide.*—This new process has been applied for the last few years, and has given good results. It allows the recovery of 14 to 15 per cent of the sulphur used in xanthation and is based on the gas purification process used in coke ovens. It has been adapted to fit the special conditions existing in viscose rayon factories so as to recover hydrogen sulphide released in the spinning process. By this method the sulphur content of the gas is deposited in elemental form on the iron hydroxide.

The plant can work with an average efficiency of 95-98 per cent. Normally the iron hydroxide is charged with sulphur up to its own dry weight; then the hydroxide is taken out and the flower of sulphur extracted. After extraction the iron oxide can be used again.

(3) *Oxidation by ferric solution.*—Process by which sulphur is recovered as foam, which is of no value at present.

To sum up, even if it is technically possible to recover sulphur, none of these processes offers any possibility of economic operation on its own. They are used—at a loss—in cases where the public authorities require the gases to be purified before their discharge into the air. In practice, such cases only arise in the manufacture of staple fibre where factories handle very large tonnages. In rayon factories the gases are usually sufficiently diluted for them to be discharged without prior purification.

The gases from which hydrogen sulphide has been released are sent to active carbon plants, after making sure the concentration is sufficiently far enough from the lower explosive limit of 32 g. per cu. m. The carbon disulphide contents used industrially are between 5 and 20 g. per cu. m. The hydrogen sulphide content must be as low as possible, but may reach even 50 mg. per cu. m. If the carbon disulphide amounts to 10 per cent of the weight of activated carbon the absorption is in practice complete.

During the subsequent desorption, the oxygen content must be reduced below the explosive limit by introducing a buffer gas. The vapours are released in a condenser and then separated by physical means in a separation tank. The small quantities of H_2S remaining are retained by the activate carbon and converted into sulphuric acid by oxidation through the catalytic action of the active carbon. Above a certain concentration this acid can be extracted merely by washing with water.

Recovery as Sodium Sulphate

The two principal ingredients used in the spinning bath are sulphuric acid with a content varying from 100-150 g. per litre, according to the particular mill, and sodium sulphate with a content of 200-350 g. per litre. The bath may also contain a smaller proportion of zinc sulphate, and other metallic salts.

Viscose, which is a soda solution of cellulose xanthate, represents a constant source of water and caustic soda, the latter uniting with the free acid to form sodium sulphate. Sulphuric acid has to be added to restore the solution to its original composition.

Theoretically, the added sulphuric acid and the water and caustic soda supplied by the viscose should increase the volume in the bath. Actually, this only happens if the extra quantities are greater than those carried off by the filament. In the latter case, the volume must be reduced and this can be done in three ways: the excess may be removed, with a loss of sulphuric acid which may be considerable; the excess water brought in with the viscose may be evaporated and an amount equivalent to the excess sodium sulphate formed may be drained from the bath; or the excess water may be evaporated and the excess sodium sulphate removed by crystallisation.

The first method has long since been recognised as uneconomic. Mills use the second or third methods according to the manufacturing conditions. The volume of water introduced, the consumption of sulphuric acid, the amount of sodium sulphate formed and the consumption of other chemical products (zinc sulphate, etc.) depend on the formulae used for the viscose and the coagulation bath; these formulae are adapted to the type, quality and count of the filament or fibre produced, as well as to the manufacturing processes.

Krebs Process

The Krebs process is based on the reaction whereby crystallised sodium chloride can be obtained directly by treating $Na_2SO_4 . 10H_2O$ with hydrochloric acid, with the simultaneous formation of sulphuric acid saturated with hydrochloric acid. The combined use of chlorine and sulphur dioxide first of all provides the necessary gaseous hydrochloric acid and subsequently increases from 32 per cent to 57 per cent the primary concentration of sulphuric acid produced (starting from $Na_2SO_4.10H_2O$). The chlorine is extracted in a Krebs sodium chloride mercury cell, which is the fruit of 40 years' experience in this special field. The sodium chloride evolved during the process returns directly to electrolysis as raw material.

The following three separate operations may be distinguished:—

(I) Treatment of sodium sulphate with the hydrochloric acid released in operation III. This yields 32 per cent sulphuric acid and sodium chloride.

(II) Electrolysis of the sodium chloride obtained from I in the mercury cell. This produces a caustic soda solution (viscose quality), chlorine and hydrogen.

(III) Treatment of the 32 per cent sulphuric acid from I with the chlorine from II and sulphur dioxide; a 57 per cent sulphuric acid is then formed and the gaseous hydrochloric acid released.

The use of sulphur dioxide thus helps to make good the sulphur losses incurred during the process. The concentration may be increased, as is often desired, to 75 per cent for example, by evaporation. Nevertheless, if additional quantities of sulphuric acid are required by the same plant and if a 75 per cent concentration is sufficient, the acid may very easily be strengthened by means of SO_3 produced in a contact plant.

A stronger acid may also be obtained immediately by using partially dehydrated sodium sulphate. If a mixture consisting of equal parts of decuple hydrate and dehydrated sulphate is treated with chlorine and SO_2, sulphuric acid in the region of 75 per cent is obtained directly and its hydrochloric acid content can be completely eliminated by blast.

A daily throughput of 30 tons of sodium sulphate yields 7.4 tons of caustic soda in solution, 177 kg. of hydrogen and 18.2 tons of sulphuric acid (calculated at 100 per cent), which would require power supplies amounting to about 29,000 kWh. and three tons of sulphur.

Should the concentration be increased by means of contact acid, a further 21.7 tons of sulphuric acid will be obtained (calculated at 100 per cent), which would require an additional seven tons of sulphur.

As this process calls for a large amount of power, it can only be used in countries where the KWh. is cheap.

Anhydrous Sodium Sulphate

The crystallised sodium sulphate is melted in its water of crystallisation at between 40° and 50° and 41 per cent of the sodium sulphate is precipitated in anhydrous form, the rest remaining in solution in the water of crystallisation. The precipitated salt is separated from the mother liquor by centrifuging and then dried in a hot air draught. The product obtained contains 99.95 per cent of Na_2SO_4 and complies with the normal specifications for extra-pure sodium sulphate.

This process may be economically advantageous if the anhydrous sodium sulphate fetches a high price. The position may therefore differ considerably from one country to another, according to the amount of sodium sulphate coming on the market from hydrochloric acid production and the export difficulties encountered as a result of, for example, fairly high customs tariffs.

It was once possible to convert this residual sodium sulphate into ammonium sulphate on an industrial scale, with calcium sulphate as an intermediate product, but this practice was abandoned when it became uneconomic as a result of the development of the market for ammonium sulphate.

Conclusions

In the present state of rayon manufacturing techniques, it does not seem possible to expect any substantial recovery of sulphur. About 80,000 tons of CS_2 was used in 1952 in making rayon.

On the other hand, staple fibre mills are mostly equipped for recovering the carbon disulphide from the fibre. Although some producers are not yet equipped for recovery, they are at present devoting large sums to promote research on this subject.

Some of the plants designed to recover hydrogen sulphide and carbon disulphide from ventilation gases function normally from the technical point of view but are not economic. They are therefore confined to removing the proportion of injurious products in the waste gases in excess of the legal limit.

It may be claimed that, in a staple fibre mill, 40 per cent of the sulphur used is at present recovered as carbon disulphide, and very small quantities of sulphur are recovered as sulphuric acid or sodium sulphide. The Working Party considers that it will be possible, in the near future, to raise the proportion of sulphur recoverable in sound economic conditions to 50 per cent, compared with a technically possible figure of 65 per cent.

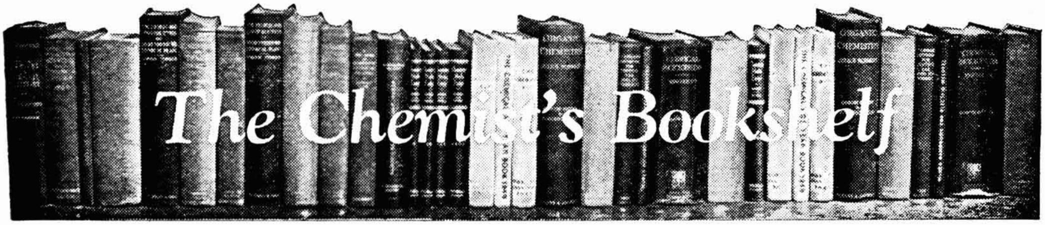
The other 35 per cent is lost, either as precipitate on the fibre or in the spinning bath or because it is impossible to seal off the manufacturing equipment hermetically. The quantities involved seem to be too highly dispersed for any recovery process to be economic.

In 1952 staple fibre manufacture accounted for about 115,000 tons of CS_2, about 30,000 tons of which were recovered by the staple fibre mills.

Almost all artificial textile mills using the viscose process possess evaporation plant and most of them are equipped with crystallisation plant. No technical difficulty arises in this connection and the amount of sulphuric acid saved is already very near the maximum that can be expected from the manufacturing processes used.

The amount of crystallised sodium sulphate produced corresponds more or less to the figure for artificial textiles production. In 1952, 510,000 tons were produced by the viscose process. The Working Party considers that the use of such plant represents a saving of sulphuric acid of about 50 per cent.

To reduce consumption of sulphuric acid by this amount involves the production of large quantities of crystallised sodium sulphate, which in most cases has no market value. Accordingly there is a large quantity of sulphur which cannot be used, as there is no economic process for converting sodium sulphate into a usable product. The Working Party hopes that the European Productivity Agency may take up this question and arrange that research should be directed towards evolving such a process.



The Chemist's Bookshelf

THE ACTINIDE ELEMENTS (Vol. IV-14A of the National Nuclear Energy Series). Edited by Seaborg & Katz. McGraw-Hill, New York. 1954. $11.75.

The National Nuclear Energy Series consists of 'A' volumes, containing review articles specially written for the series; and 'B' volumes, collections of research papers from the published literature, assembled so as to document the corresponding 'A' volumes. Volume IV-14A has only just come out, although Vol. IV-14B appeared in 1949. Volume IV-14A is the first integrated monograph on the chemistry of actinium, thorium, protoactinium, uranium, and the transuric elements to be published. It will be welcomed as a compact source of much information only otherwise obtainable from rather inaccessible original papers.

The justification for the name 'actinides' for this group of elements is explained in a chapter by Seaborg, setting forth the evidence for and against the view that a second 'inner transition series,' in which the $5f$ electron shell is filled up, follows actinium (element 89). It is difficult to be quite sure whether the filling of this shell begins with thorium (element 90), protoactinium (91), or uranium (92), but it is reasonably certain that the post-uranium elements contain $5f$ electrons corresponding in number to the number of the places they occupy after actinium, just as the lanthanides' or rare earths contain $4f$ electrons in number corresponding to the numbers of their places after lanthanum in the series of increasing atomic number.

The chemistry of the actinides is thoroughly reviewed. The immensely rapid progress made in a few years in the systematic chemistry of this group is well illustrated by the fact that eighty pages are devoted to the oxidation states, oxidation potentials and oxidation-reduction reactions of the plutonium ions. The nuclear properties of the elements are covered, and there are valuable chapters on the experimental aspects of their radio-chemical separation and assay by α-particle and fission counting. The treatment throughout is extremely detailed and fully documented.

Since good monographs already exist on the chemistry of thorium, protoactinium, and uranium up to the years 1928-40 (the appropriate volumes of Gmelin's 'Handbuch der anorganischen Chemie)' the present work makes no attempt to cover the same ground again. It deals with developments in the chemistry of these elements during and since the Second World War, but some of the earlier work is critically discussed in the light of newer findings. In general, the literature coverage has been thorough, though work on the transuranics published outside the United States seems to have been overlooked in a few instances. The arrangement of chapters is somewhat haphazard, but this does not interfere with the use of the book for reference.

This book gives the same kind of compendious and critical treatment as Gmelin's 'Handbuch,' and one can only regret that no similar works in English exist for most of the remainder of the Periodic Table.—H. G. HEAL.

MANUAL OF COTTON SPINNING. Volume I, Raw Cotton Production and Marketing. Edited by A. W. F. Coulson. The Textile Institute, Manchester. 1954. Pp. 222. 12s. 6d.

This, the first volume of a series intended to provide a comprehensive survey of cotton spinning, is primarily intended for students seeking technological and scientific information. It consists of three sections, each contributed by an expert. The first is devoted to the history and structure of the cotton industry, the second to the cotton crop, being concerned with problems determining the quantity and quality of raw cotton, and the third to marketing processes. The book provides a great deal of information useful to both the student and the practising technologist.—W.R.M.

INTRODUCTION TO NUCLEAR ENGINEERING. By R. Stephenson. McGraw-Hill Publishing Co. Ltd., New York and London. 1954. Pp. xii + 387. 57s. 6d.

In his preface to this book the author points out that although the original development of nuclear energy was carried out almost entirely by theoretical scientists, now that the fundamental principles have been established, the further use of nuclear energy is falling more and more into the province of the engineer. He points out too that the younger engineers must be willing to undertake such problems as radiation shielding, radiation damage, chemical processing of radio isotopes and the engineering design of nuclear reactors.

The book is intended as an introductory survey of the nuclear energy field for engineers who are taking or who have completed a conventional curriculum. In the United Kingdom, so far as the reviewer is aware, only one university has, up to the present, included the study of nuclear engineering as part of an engineering degree course. The present book should prove of considerable interest to engineering students and engineers who have some knowledge of modern physics, and should provide a useful background for those whose future interests might lie in nuclear engineering. The book deals mainly with the basic principles of nuclear fission, nuclear chain reactors and reactor theory, radiation shielding, materials of construction, reactor instrumentation and control, the separation of stable isotopes and so on. A selection of problems is included at the end of each chapter but as seems to be usual in American books the answers to these are not provided.

It seems rather anomalous that the book should be included in the well-known McGraw-Hill Chemical Engineering Series when those parts of the subject perhaps of most interest to chemical engineers, such as the separation of isotopes, have been treated rather briefly. However, this is not the fault of the author for he points out that practically no design data have been released on the gaseous-diffusion process. The enormous amount of engineering knowledge and skill which must have been devoted to the design of the Oak-Ridge gaseous-diffusion plant, however, becomes obvious when one is told that the cost was approximately $500,000,000.—R.L.

A GENERAL SURVEY OF THE BRITISH PHARMACOPŒIA. 1953. The Pharmaceutical Press, London. 1954. Pp. 44. 4s. 6d.

This booklet consists of five lectures by the secretary, T. C. Denston, and members of the BP Commission—Professors W. H. Linnell, H. Berry, A. D. Macdonald and A. A. Miles—on general, chemical, pharmaceutical, pharmacological and biological aspects of the new BP respectively. The five lectures seem to have been composed independently for there is much repetition. Reasons are given for the various additions, eliminations and modifications of standards, assays, tests, etc. Occasional hints are thrown out about the shape of the next BP which is already in active preparation. Explanations are even included of such small items as the new method of assaying sodium aminosalicylate and why cascara tablets have been so long in obtaining official sanction.

All this disclosure is to be warmly welcomed. It meets a long felt want. In the past there has been too much reticence. Decisions about such matters as selection of official substances, nomenclature, preparation, dosage, methods of assay, tests, etc., after having been made, have been placed before users of the BP without discussion or comment. Explanations have been difficult to find and are vitally important to teachers and students. Perhaps someday the BP will be accompanied by an official 'Guide for Users' incorporating not only reasons for changes but much general explanatory material as well.

Referring to gamma benzene hexachloride on p. 19 there is the curious statement that 'of the 16 possible transforms only four distinct forms are likely to occur.' It is not obvious what 'transforms' applies to. Classical stereochemical theory demands eight possible isomers one of which is resolvable into optically active isomers so making a total of nine. So far only five of these are known of which one has been obtained in optically active form.—M.C.

THE SPECTRUM OF STEEL. By John Convey and J. K. Hurwitz. Ottawa. Department of Mines and Technical Surveys. 1954. Pp. 55.

Tables of the ultraviolet spectrum of alloy steel are compiled. The book is intended to help spectrographers engaged in steel works. —V.K.

· HOME ·

Awarded Contract

Costain-John Brown Ltd. has been awarded a contract, valued at about half a million pounds, by the Wales Gas Board for the laying of gas pipelines in North and South Wales. These pipelines are scheduled for completion in 1956.

Glasgow Research Exhibition

An exhibition 'Research in Industry' was opened at Kelvingrove Museum, Glasgow, on Saturday, 4 September. It is planned as a complement to the Scottish Industries Exhibition and has been organised by the director, Dr. Stuart A. K. Henderson, and staff of the Glasgow Museum in conjunction with the Department of Scientific and Industrial Research. The exhibition, which is to run for a total of two weeks, is staged with the aim of drawing the attention of industry to the possibilities of scientific research today.

New Aspro Factory in Slough

The building of Aspro's new factory, near their playing fields in Bath Road, Slough, will start in the spring of next year and will be completed in about 18 months. Dr. Francis Chilson, American consultant on the building of pharmaceutical factories, has been called in by Aspro to design their new home. He will make several more visits before the work is done. Dr. Chilson has designed factories all over the world and is an acknowledged authority in his own country.

Bid for Fullers' Earth

As a result of recent negotiations an offer will shortly be made by Laporte Industries to acquire the whole of the capital of Fullers' Earth Union. The terms are: Five Laporte 5s. ordinaries for every four Fullers' Earth 5s. ordinaries; one Laporte £1 5½ per cent cumulative second preference for every £1 FEU 5 per cent cumulative preference share; and one Laporte 5½ per cent cumulative second preference for every 10s. FEU 11 per cent non-cumulative preferred. Fullers' Earth ordinaries are quoted at 14s. 6d., and Laporte ordinaries at 17s. 3d. The offer is subject to consent by the Treasury and shareholders to the necessary alterations to Laporte's capital.

Scientific Glassware

Chemical, medical, surgical and bacteriological glassware exports totalled £64,146 in July. Other scientific glassware exports reached a value of £15,517.

Polythene Yarn Price Cut

The price of monofil and multi-filament Courlene yarns in all forms in which they are sold was reduced by 3d. a lb. on 6 September, it has been announced by Courtaulds Ltd. The price of polythene was reduced by the same amount by I.C.I. last week.

Visit to Esso Laboratories

Ninety members of the Chemistry Section of the British Association visited the Esso European Laboratories at Esso House, near Abingdon, Berks, on 6 September. They were received by Dr. E. B. Evans, chief chemist, and after a short introductory talk toured the laboratories, inspected a wide selection of the most modern apparatus and saw various types of fuels and lubricants undergoing engine-tests. The laboratories, which are controlled by Esso Development Co. Ltd., are the principal research centre for the Esso Group of companies in Europe.

Steel Imports Down

Imports of steel fell to a weekly average of 10,800 tons in the first six months of this year, compared with 23,900 tons in the same period of 1953 and 28,500 tons during 1937. Crude steel production reached its highest figure of 366,300 tons (weekly average) in the same period. This compares with a figure of 338,600 tons during 1953, 309,800 in 1952 and 249,700 in 1937. Exports at 54,600 tons a week were higher than in the 1953 period but less than the figure of 56,200 tons for 1937.

Tungsten Ores Price Increase

The Government's selling price for standard grade tungsten ores was raised by 2s. 6d. on 7 September, bringing both wolframite and scheelite to 190s. per long ton delivered United Kingdom consumers' works. The price reflects a steadier wolfram market quotation at 172s. 6d. to 180s. per long ton c.i.f. European ports, against 170s. to 177s. 6d. previously.

· OVERSEAS ·

South African Convention

The convention of the South African Chemical Institute was opened last week by Mr. Louw, Minister for Economic Affairs, who said it was not the intention of the South African Coal Oil and Gas Corporation or its only shareholder, the Government, to establish its own subsidiary industries using its by-products as raw materials. He said that it was expected that at least one-third of the corporation's sales would come from by-products.

Improved Sheepskins

A new process for pickling sheepskins has been developed by the New Zealand Leather and Shoe Research Association. Skins were found to deteriorate in proportion to the amount of acid in the pickle liquor, but as the acids strengths were designed to stop mould growth, ways had to be found to stop the mould developing. Various fungicides were tested with less acid strength, and one has been found to keep the skins in better condition.

Liquid Shine for Canada

Thrifty Products Ltd., affiliated to Continental Ventures Inc., of Detroit, has been formed in Toronto to take part in the Canadian market for aerosol spray products. This market, now about four years old, is buying a total of 50 products at the rate of 15,000,000 units a year. The new company will introduce a leather shine spray which, it claims, requires 30 seconds to apply and will last three weeks. The liquid shine—acrylic resin—will be imported from the US and packed in Canadian-made containers by Aerocide Dispensers Ltd., Toronto.

More Cement for Israel

A new step in the direction of economic self-sufficiency and a free market in Israel for cement will be taken shortly, when the Shimshon cement factory gets into full stride. The factory, which is now doing experimental work and employing 200 workers for the purpose, will by the end of this month be producing 750 tons of cement daily, and employing an additional 100 workers on the job. With other plants, the total Israel cement output will come near to 850,000 tons a year, which is much more than local demand.

Chromium Industry Booms

Peak levels of supply and demand were attained in many phases of the chromium industry during 1953, according to the US Bureau of Mines. Despite a generally sluggish market in the latter part of the year, US total annual consumption imports and stocks of chromite increased 13 per cent, 30 per cent and 35 per cent respectively.

Japan Produces More Chemical Fibres

Japanese output of chemical fibres during the first half of the year totalled a post-war record of 318,400,000 lb., but exports of rayon yarn were less than in the same period last year. Of the chemical fibre and textile exports, the sterling area took 55 per cent, the dollar area 23 per cent and the open account area 22 per cent. Exports of chemical fibre in the second half of this year may be more than the total for the first half.

New Bitumen Plant at BP Hamburg

Various grades of bitumen required by the German market are now being produced at Anglo-Iranian's BP refinery at Hamburg, where a bitumen plant with a capacity of 50,000 tons a year has been commissioned. The new plant uses as feedstock residue oil from the vacuum distillation unit commissioned earlier this year. Adjacent to the plant is barrelling and other ancillary equipment. The bitumen will be distributed in bulk in rail and road tankers, and also in drums, blocks and sacks.

Canada Has New Spray

A chemical spray which prolongs the storage life of potatoes, onions and similar crops is being offered for general use for the first time in Canada this year. It is MH-40, a formulation of maleic hydrazide made in Canada by Dominion Rubber Co. The new chemical has been tested in the US for some years. It is sprayed a few weeks before harvesting, absorbed by leaves, works its way to the root and halts further cell division. Thus, sprouting is prevented. It is claimed that it also stops shrivelling or wrinkling and has no effect on flavour or colour.

· PERSONAL ·

Sir Robert Robinson, O.M., M.A., D.Sc., LL.D., F.R.I.C., F.R.S., was elected president for 1955 of the British Association for the Advancement of Science at its Oxford meeting on 1 September. He is Waynflete Professor of Chemistry at Oxford University, a past-president of both the Royal Society and the Chemical Society and a past vice-president of the Union Internationale de Chimie. He won the Nobel prize for Chemistry in 1947. When 26, Sir Robert became the first Professor of Pure and Applied Organic Chemistry in the University of Sydney, Australia, and subsequently held university chairs at Liverpool, St. Andrews, Manchester, University College, London, and Oxford, with a break of one year when he was a director or research to the British Dyestuffs' Corporation. During the war he was closely connected with investigations into the constitution of penicillin. He is the author of numerous scientific papers, mostly in the *Journal of the Chemical Society*.

The wedding took place at St. Paul's Church, Shepley, near Huddersfield, on 4 September, of **Mr. John Garnett Hopkinson**, elder son of Mr. George G. Hopkinson and the late Mrs. Hopkinson, of Wilmer Field, Heaton, Bradford, and **Miss Shirley Anne Wood**, only daughter of Mr. and Mrs. Frank S. Wood, of One Acre, Shepley. The bridegroom is a director of Hopkinson & Shore Ltd., dyers and finishers, Brighouse, and is hon. secretary of the Society of Dyers and Colourists, of which his father is a past president. During the war he was an officer in the RNVR. Later at Trinity College, Oxford, he took his M.A. degree and was a running Blue. The bride, who gained a B.A. degree and Diploma in Social Science at Leeds University, was recently theatre manager for Leeds University Theatre Group.

Among new Fellows elected by the Textile Institute last month is **Mr. E. P. Sharman**, M.C., M.A., B.Sc., of 21 Lime Avenue, Northampton, senior research chemist at Courtaulds Ltd., Coventry. Educated at Northampton Grammar School, Exeter College, Oxford and Coventry Technical College, he joined the research staff of Courtaulds Ltd. in 1938. During the war he was an infantry officer and was twice decorated for gallantry in Burma. In 1947 he returned to Courtaulds Ltd. and did research work on such problems as wet spinning cellulose acetate to staple fibre and the methylene chloride process for acetate manufacture. In 1952 Mr. Sharman was awarded a Mutual Security Agency Fellowship, one of four such awards to the industry in that year, which enabled him to carry out more research work at the Textile Research Institute, Princeton, New Jersey, USA. He is a joint holder of three patents, and has had papers published in the American *Textile Research Journal*.

Mr. Herbert Edgerton, a research photographic chemist, of West Street, Warwick, has left for the Argentine, where he will supervise the setting up of new photo-film and paper factory.

Mr. W. A. Hartop, works director of George Kent Ltd., left England on 9 September for a two-month stay with the Kent subsidiary in Canada, Kent-Norlantic Ltd., Horner Avenue, Toronto. The main object of his visit is to assist the production organisation of Kent-Norlantic towards full operation and also to investigate further valuable export prospects for George Kent products. He will be visiting Kent-Norlantic agencies in various provinces, covering the whole of Canada to the Pacific seaboard.

MR. DONALD MCDONALD, B.Sc., F.R.I.C., M.I.Chem.E., F.I.I.A., F.I.M., chairman of the executive committee of the board of Johnson, Matthey & Co. Ltd., since 1950, retired on 31 August after 44 years' service with the company. Mr. McDonald joined the company direct from University College, London, in 1910 as a junior chemist—having gained his B.Sc. with First Class Honours—and as soon as 1920 was appointed manager of the refineries at Hatton Garden. He assisted in the design and construction of the new electrolytic silver refinery, and later turned his attention to the development of the chlorine process of gold refining and the installation of the necessary equipment. In 1939 he was appointed to the board as director of the bullion department and of research, adding to his duties in ensuing years the directorship of labour management and mechanical production. Mr. McDonald has published an authoritative account of the life of the founder of the company, Percival Norton Johnson, and has recently been engaged upon the compilation of a detailed history of platinum from its discovery until the 1880's. At a brief ceremony in the recently completed Hatton Garden office block—in the construction of which he was closely associated—Mr. McDonald was presented with a cheque and a bound book of signatures of his colleagues and friends.

The British Standards Institution announces that DR. G. H. BEEBY has been appointed chairman of its Chemical Divisional Council, and has, therefore, at the same time become a member of the General Council and the executive committee. Dr. Beeby, who is the chairman of I.C.I. Salt Division at Winsford in Cheshire, has spent all his working life in that organisation. Born in Leicestershire, and educated at Loughborough College and London University, he joined the Billingham Division of I.C.I. as a chemist in 1928. Subsequently he spent thirteen years in I.C.I. sales offices before taking up his present duties in 1952. Nor is Dr. Beeby a stranger to the BSI. He first joined the Heavy Chemicals Industry Committee in 1945, and has been its chairman, as well as chairman of the BSI sub-committee for international work on chemistry, since 1948.

The opening meeting of the British Association for the Advancement of Science at Oxford on 1 September was preceded by a Convocation of the University at which honorary degrees of Doctor of Science were conferred. Among the recipients were SIR BEN LOCKSPEISER, K.C.B., D.Sc., F.R.S., Secretary of the Department of Scientific and Industrial Research, and SIR JOHN LENNARD-JONES, K.C.B., D.Sc., F.R.S., Principal of the University College of North Staffordshire. Of Sir John the Public Orator said that chemists might possibly congratulate themselves on a danger removed by his appointment as Principal of University College, for Sir John had deduced atomic laws by mathematical processes, and his new work would leave him no time to go proving that chemistry was simply a department of mathematics. But really, he said, the chemists were most grateful to him, and science was split up into departments, only to prove its unity in the end.

MR. G. E. BEHARRELL, Dunlop's managing director, is at present on a visit to the Dunlop factories in Buffalo and Toronto.

Obituary

The death has occurred of MR. JOHN S. HILL, of Dumfries, a former chief chemist at the I.C.I. factory there. Recalled from the Services in the first world war to take charge of the Gretna munitions factory, Mr. Hill retired from his position with I.C.I. shortly after the second world war. He leaves a widow and a daughter.

Oil Gas Contract

The Australian Gas Light Company of Sydney, New South Wales, has signed a contract with the newly-formed Petroleum & Chemical Corporation of Australia Ltd. for the supply of oil gas from a new plant, being erected in Sydney. The contract is for 20 years, but the company will not commit itself wholly to oil gas if it is found that the product from coal is cheaper.

Publications & Announcements

THE third British Iron and Steel Research Association's 'Survey,' like its predecessors, brings to the industry's notice some of the researches in which laboratory and works experiments have been brought to the point, or almost to the point, of application. It also describes some work of a different kind, dealing with such subjects as work on chemical analysis and development of high-duty steels for steam power plant, as examples of the way the industry is adapting itself to changing needs. Among other articles is one which deals with research into accidents at an iron and steel works. There is also a discription of the application of results of research to improving the efficiency and output of sinter plants.

* * *

A MEMORANDUM, 'Diffusion Flames in the Laboratory,' has just been published by the Advisory Group for Aeronautical Research and Development, Paris. One of a series of four, it is an entire reprint of a paper which John Barr, lecturer in mechanical engineering at the University of Glasgow, read before the AGARD Combustion Panel during its meeting in May. The other three memoranda will shortly be available. AGARD is a NATO agency.

* * *

A NEW type of epoxide resin now being made at Southampton by Leicester, Lovell & Co. Ltd. will further extend the use of this remarkably versatile class of resins. Applications range from the gluing of precious stones in their settings to the making of massive castings weighing ½-ton or more, which are so hard, tough and stable that they can replace metal tools for pressing sheet steel; from the manufacture of durable chemical-rèsistant structures with glass fibre reinforcement to low-cost, long-wearing and accurate foundry patterns cast cold in plaster moulds. Specific advantages claimed for the new epoxide resin (known as Epophen M-777), are absence of inconvenient exotherm even in large masses, greater strength and toughness of castings, and lower cost. As a contact adhesive that will bond wood, metals, glass, plastics, leather—indeed practically any ordinary material—without pressure, Epophen comes very near to being the universal glue. There are so many potential uses of Epophen that Leicester, Lovell anticipate many inquiries for small quantities. To meet this expected demand and to facilitate initial small scale testing by industrial users, a compact test kit has been brought out which provides suitable quantities of resin, catalyst and filler together with complete instructions and equipment for measuring and mixing the adhesive. This test kit (price 7s. 6d.) and further information are obtainable direct from the manufacturers, Leicester, Lovell & Co. Ltd., North Baddesley, Southampton.

* * *

A VISITOR to their factory remarked that Accles & Pollock seemed able to do everything to a tube except turn it inside out; they sent him one the following week. The incident is described in two languages—English and French—in the firm's recently produced booklet called 'All in a day's work at Accles and Pollock' ('Une journee de travail chez Accles and Pollock'). The attractively-produced booklet contains a number of original illustrations. It summarises in 32 pages the work of the firm ('La quintessence des activites tubulaires d'Accles & Pollock').

* * *

HYDROGEN peroxide is used effectively in bleaching ground wood pulp. A source of difficulty has been the contamination by trace amounts of metallic ions such as iron, copper and manganese which act as catalysts causing hydrogen peroxide breakdown. These contaminating trace metals may come from several sources such as the water, chemicals, or equipment and from the ground wood pulp. The Tetrines, chelating and sequestering agents, are used to combine with the metallic ions to make them unavailable for further chemical reaction or catalytic action on the hydrogen peroxide. The full effective bleaching power of the hydrogen peroxide is therefore made available. The amount of Tetrine used varies due to the variations in metallic ion concentration under different conditions in dfferent plants. The use of 0.5 per cent sodium Tetrine liquid based on the weight of the ground wood pulp is suggested. Experimental samples and literature on the Tetrines can be got from Glyco Products Co., Inc., Brooklyn, 1, New York.

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.)

DIAC LTD., Croydon, plastic manufacturers. 28 July, agreement (supplemental to a charge dated 11 March and registered 12 March and an agreement dated 5 May and registered 19 May, 1954) to Westminster Bank Ltd., varying the amount secured by said charge and agreement from £14,000 (not ex.) to £24,000 (not ex.); charged on company's interest in certain agreements. *Nil. 18 June, 1953.

HALLAM METALS LTD., London, W. 29 July, £4,250 mortgage to S. H. Burdwood, London, and another; charged on land and buildings at north side of Selinas Lane, Dagenham. *Nil. 14 January, 1954.

Satisfactions

MARCHON PRODUCTS LTD., London, W., chemical manufacturers, satisfactions 6 August of Trust Deed registered 30 August, 1949, and supplemental deed registered 21 May, 1954.

Changes of Name

The following changes of name have been announced:—GEL-PLASTICS SPECIALITIES LTD. to GEL CHEMICALS LTD., on 30 June; BUSINESS & DOMESTIC UTILITIES LTD., to L. A. GILL (SURGICALS) LTD., on 16 July.

Increases in Capital

The following increases in capital are announced:—R.H.C. RECLAMATIONS LTD., from £15,000 to £50,000; YARDLEY & CO. LTD., from £1,500,000 to £2,425,000; SOLWAY CHEMICALS LTD., from £300,000 to £650,000; HENRY PILKINGTON LTD., from £15,000 to £55,000; J. H. SHIMWELL LTD., from £5,000 to £6,000.

Company News

Shawinigan Water & Power Co.

J. A. Fuller, president of the Shawinigan Water & Power Co., reporting on chemicals division of the controlled companies, declared sales and earnings of Shawinigan Chemicals Limited, for the first six months of this year were somewhat lower than in the corresponding period of 1953. Competition in the export markets was becoming more severe, he said, but strenuous efforts were being made to increase the company's sales in these and domestic markets. Business of the associate company, Canadian Resins and Chemicals Limited, had been at about the same level as last year, added Mr. Fuller. The company's new printing and embossing plant at St. Therese, Quebec, came into operation at the end of July. Business of Shawinigan Products Corporation, New York City, and its associated companies in the United States, had been well maintained.

Lawes Chemical Group

Gross profits of the Lawes Chemical group for the past year were £110,041, against £119,938, and the net profit was £49,477 (£48,702). Total assets of the group expanded from £732,573 to £786,406 with fixed assets at £212,021, £24,684 higher and current assets showing an increase of £29,149 at £568,385. The latter is chiefly as a result of a large rise in stocks, and both debtors and cash balances show small decreases.

Stream-Line Filters Ltd.

Net trading profit, including income from investments, of Stream-Line Filters Ltd. for the year ended 31 December, 1953, was £293,336, compared with £181,254 in 1952. A bonus of 20 per cent on the ordinary shares of the company is recommended for approval at the annual general meeting on 25 September.

Boots Pure Drug Co. Ltd.

Boots Pure Drug Company is again paying an interim of 5 per cent, less tax, on the £5,120,000 ordinary capital. For the year ended 31 March, 1954, two interims of 5 per cent and a final of 12½ per cent, making a total of 22½ per cent were paid.

[*continued on page 546*

Company News

continued from page 544]

British Industrial Plastics Ltd.

Combined turnover of British Industrial Plastics Ltd. and its subsidiaries for the first nine months of the current financial year shows an advance of 40 per cent on the same period of last year, according to the interim report. There has been a steady flow of orders for moulding powders and resins. At an extraordinary meeting of the company on 18 August resolutions were approved for increasing the company's capital from £1,000,000 to £1,500,000 by the creation of 5,000,000 new ordinary 5s. shares and for the capitalisation of £415,696 (part of the company's share premium account) by a one-for-two scrip issue.

Ozalid Co. Ltd.

A higher profit for the year, caused by the greater demand for the company's products in a number of industries, was reported at the annual general meeting of Ozalid Co. Ltd. on 2 September. A total dividend of 30 per cent (as against 25 per cent) on the Ordinary shares for the year was approved. Mr. C. A. G. Hewson, chairman and managing director, pointed out that business would become more competitive as time passed. He also said that the time had come when steps must be taken to concentrate the whole of the company's home interests at one centre, and the site at Debden, Essex, now used for the manufacture of chemicals and special products, would be used for the purpose.

Badische Anilin- & Soda-Fabrik

Badische Anilin- and Soda-Fabrik AG (one of the successor organisations to the IG Farbenindustrie) reports a gross surplus, after settlement with associated companies, of DM. 328,649,131 for 1953. Net profit is DM. 23,382,781, before crediting the balance brought in. After the proposed dividend of 7 per cent on the DM. 340,100,000 share capital, the balance to be carried forward is DM. 412,519.

Farbenfabriken Bayer Leverkusen

The annual report of Farbenfabriken Bayer Leverkusen, a successor to the former IG Farbenindustrie, says that the company spent during the year the equivalent of about £3,400,000 on research and employed 317 research scientists.

Market Reports

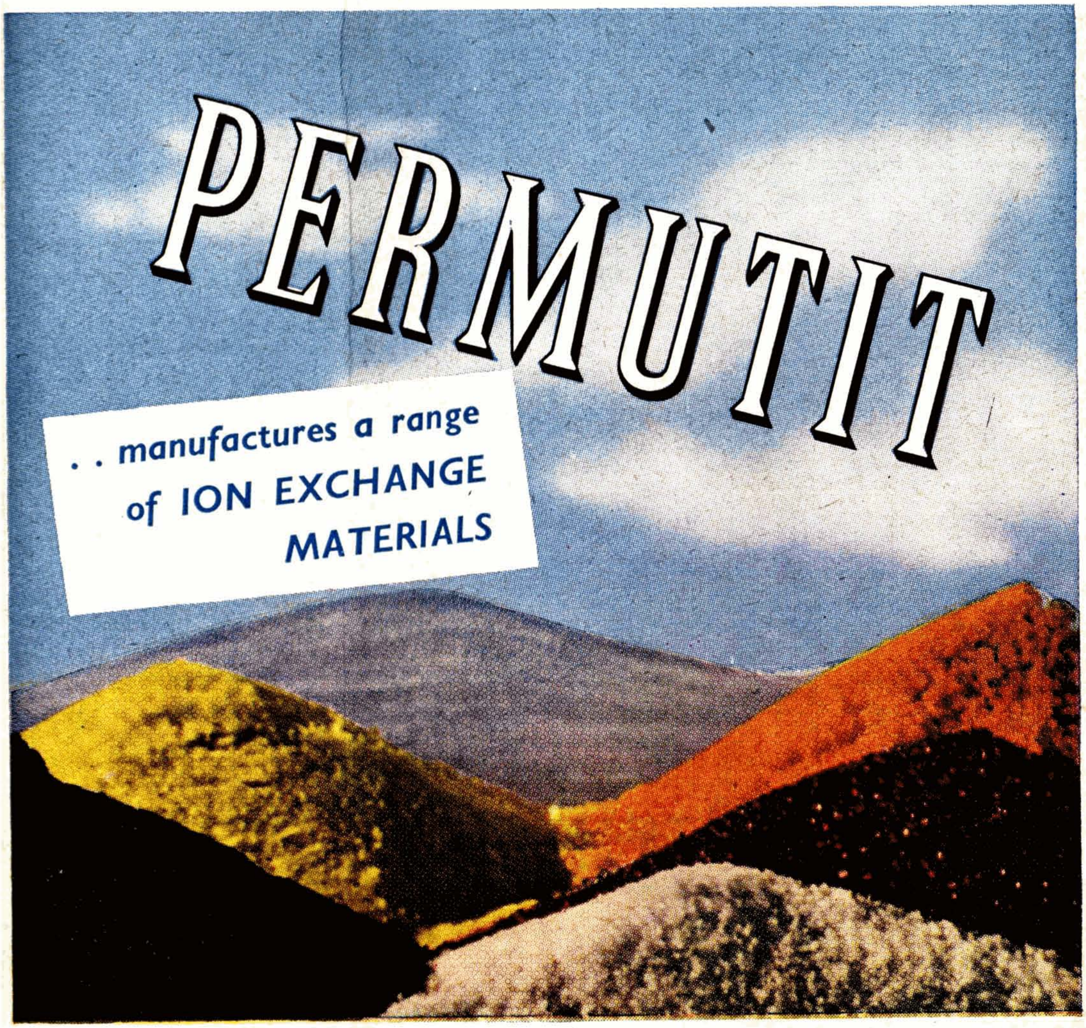
LONDON.—Active trading conditions have been reported from most sections of the industrial chemicals market with the volume of export business maintained at satisfactory level. The only important price changes announced were those for dry white lead which went up by £2 15s. per ton, dry red lead and litharge (both up £3 5s. per ton). A good seasonal demand for fertilisers has not yet developed but a fair movement is taking place. Apart from the recent increases in the prices of the refined benzoles values on the coal tar products market are unchanged and steady. The call for most products remains good with rather more inquiry for pitch on both home and export account.

MANCHESTER.—Steady pressure for contract deliveries of heavy chemicals from leading consumers in the Lancashire and West Riding areas, including fair quantities absorbed by the textile and allied industries, has been reported on the Manchester market during the past week. A fair number of additional inquiries for the soda and potash compounds have also been dealt with. Little change of any consequence in the general price position has to be recorded. Except in one or two sections the demand for fertilisers has continued on the quiet side, but a steady movement of supplies of most of the tar products has been reported.

GLASGOW.—There has been a decided improvement in the demand for all classes of chemicals, with the result that the past week has been one of the busiest experienced for some time. Prices have been mainly steady with a fair volume of business booked for forward delivery. This increase for the home market has been accompanied by a little more activity with regard to orders and inquiries for overseas.

Breaking the Ice

Moncton, N.B., holds the distinction of being the first Canadian city to experiment with a new chemical treatment, EC 999 AN, designed to give ice-free roads. Ice Free Roads Ltd., Bathurst, owners of the Canadian patent, has presented the city's board of works with a gift of 100 gallons of the chemical for use on a stretch of paving.


PERMUTIT
. . manufactures a range
of ION EXCHANGE
MATERIALS

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

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

A. BOAKE, ROBERTS & CO., LTD., require the services of **SHIFT CHEMISTS** for Plant Control work. Academic qualifications will be an advantage, but are less essential than industrial experience.

The work is interesting and varied, and the appointments will be progressive. There is every opportunity for advancement. Initial salary will be in the range of £600 to £700 per annum.

Applications, plainly marked **SHIFT CHEMISTS,** to **PERSONNEL MANAGER, A. BOAKE, ROBERTS & CO., LTD., 100, CARPENTERS ROAD, E.15.**

ANALYTICAL CHEMISTS of Inter B.Sc. standard, or equivalent, are required for the Works' Laboratory of Thomas Tyrer & Co., Ltd., Stratford, E.15. Some experience in industrial works laboratory or process control laboratory is essential. Annual salary will depend upon qualifications, age and experience. The Company which is a subsidiary of Albright & Wilson Ltd. has a non-contributory superannuation scheme. Applications should be addressed to **WORKS MANAGER, THOMAS TYRER & CO., LTD., CANNING ROAD, STRATFORD, E.15.**

NORTH WESTERN GAS BOARD
LIVERPOOL GROUP
SENIOR INSTRUMENT ENGINEER

APPLICATIONS are invited for the above pensionable appointment, at the Central Laboratory, Wavertree Works, Liverpool, at a salary within Grades A.P.T.11 or 12 (£715-£840 or £765-£890 per annum) according to qualifications and experience.

Applicants should possess suitable technical qualifications in Physics or Electrical or Mechanical Engineering, minimum standard Higher National Certificate, and should have a wide experience of installation, maintenance and calibration of all types of industrial instruments. Ability to supervise an Instrument Section covering all the works in the Group is essential.

Apply by letter to the **CHIEF PERSONNEL OFFICER, NORTH WESTERN GAS BOARD (LIVERPOOL GROUP), RADIANT HOUSE, BOLD STREET, LIVERPOOL,** within fourteen days.

Applications are invited by a South African paint company for the following vacancies :—

(1) **CHEMIST** with practical experience in the manufacture of Polyvinyl Acetate and Acrylic emulsion paint. Salary £1,200 to £1,500 per annum.

(2) **CHEMIST** with wide experience in the manufacture of Alkyd resins. Salary £1,200 to £1,500 per annum.

Both posts offer excellent prospects for ambitious and energetic men.

Apply, by letter only, giving full details of experience and enclosing copies of testimonials, to **"TECHNICIAN," C/O J. A. EWING & CO. (LONDON), LTD. FINSBURY COURT, FINSBURY PAVEMENT, LONDON, E.C.2.**

ASSISTANT ENGINEER required by Chemical Engineering Company in London. Qualifications; degree or degree standard; age about 30; good knowledge physics, mathematics and chemistry; experience in office routine and technical sales advantageous. Position offers excellent opportunities. Write giving full details, including age, qualifications, and salary required, to **BOX. NO. C.A. 3349, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

SITUATIONS VACANT

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, BERKSHIRE, requires **YOUNG CHEMISTS** for duties connected with the supply of potable water, disposal of radio-active solid and liquid waste, control of pickling and plating shops and many other industrial chemical processes. Qualifications: British nationality, age maximum 32 (regular Forces service may be deducted from age); Honours Degree in Chemistry of Chemical Engineering or A.R.I.C. or A.M.I.Chem.E. Posts graded Technical Assistant, salary £430 (at 21) to £742 (less for women). After successful training candidates are regraded Chemist III, salary £620 (at 25) to £960, with good prospects of further promotion. Posts pensionable. Apply to the **ESTABLISHMENT OFFICER, A.E.R.E.,** by September 24th, quoting 2/103/140.

APPLICATIONS are invited by the VACUUM OIL COMPANY, Limited, for the position of **ASSISTANT CHIEF CHEMIST** in their Laboratory at Coryton Refinery, Essex. Applicants should have B.Sc., A.R.I.C., or equivalent qualifications and experience in a petroleum laboratory, preferably in a refinery. The work entails the supervision of a analytical testing section control of refinery processes involved in the production of petroleum products and all the ancillary problems arising therefrom. The successful applicant will be eligible for consideration in obtaining the tenancy of certain houses available to the Company. Conditions of employment include a Pension and Life Assurance Scheme, generous sickness plan, social club and other benefits. Applications, giving full details of qualifications and experience and quoting reference "A.C.," should be addressed to the **INDUSTRIAL RELATIONS SUPERINTENDENT, VACUUM OIL COMPANY, LIMITED, CORYTON REFINERY, CORYTON, ESSEX.**

Opportunities for **TECHNICAL MEN** with experience of fluid flow and allied subjects and with general training up to 4th or 5th year of National Certificate studies. Permanent and interesting appointments in connection with the sale of standard equipment for the Chemical Engineering Department of the **A.P.V. COMPANY LTD., WANDSWORTH PARK S.W.18.** Apply in writing to the **MANAGER.**

PRODUCTION MANAGER required for long established Chemical Manufacturers. Mainly Tar Distillation and Acid Production. Salary according to experience. Candidates must have appropriate University qualifications. Seat on Board may be offered after agreed probationary period. Apply **MANAGING DIRECTOR, SADLER AND COMPANY LTD., CARGO FLEET ROAD, MIDDLESBROUGH.**

QUALIFIED **PAINT TECHNOLOGIST** required to occupy position as Chief Chemist. Candidates must have experience in decorative and industrial fields, and in all branches of Government specification work. The position is pensionable and a salary commensurate with the ability of the man to fill the vacancy is offered.—Apply in confidence to **ADSHEAD RATCLIFFE & CO., LTD., BELPER, DERBYSHIRE.**

FOR SALE

SACK AND BAG MERCHANTS AND MANUFACTURERS. New and reconditioned for Home and Export. (Use **JUTEX** for sack repairing). **ALTRINCHAM JUTE LTD., WRIGHT STREET, BROADHEATH, ALTRINCHAM, CHESHIRE.** ALTrincham 4360.

FOR SALE

C. BARBER, LTD.

SEVERAL HORIZONTAL JACKETED TILTING MIXERS, 25 gallons capacity. New and unused.

500-gal. Over-driven M.S. **MIXING VESSEL.** M.S. pressure filter, 4 ft. 3 in. diam. by 5 ft. 3 in. overall height.

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

DOULTON 25-gal. **COPPERS** with lids. **NEW** and unused.

WELDED VESSELS of all types, in mild steel or stainless Fabricated to customer's specifications.

HORIZONTAL TRIPLE ROLL MILLS with chilled iron rolls, in excellent condition. Various sizes.

C. BARBER LTD.
SILVERDALE GARDENS
HAYES MIDDLESEX
Telephone—Hayes 2735/6

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

MALEIC ACID. Quantity available 20 tons per month. **BERNARD, 18, RUE DE LA CHAUSSEE D'ANTIN-PARIS** (9°).

ONE TORRANCE MICRO TWIN-ROLLER MILL. Cast rolls, 14 in. by 8 in. Water cooled. Fast and loose pulley-drive.

TWO DE LAVAL SEPARATORS, VEE-BELT DRIVE. Good condition.

THOMPSON & SON (MILLWALL), LIMITED,
CUBA STREET, LONDON E.14. TEL. EAST 1844.

MORTON, SON AND WARD, LIMITED
offer
STAINLESS STEEL

TUBING—second-hand, in excellent condition—¾ in., 1 in., 1¼ in., 1½ in. and 2 in. lengths, cut to requirements, with or without flanges.

Stainless Steel Jacketed Pans made to requirements in all sizes up to 300g., with or without agitators.

"MORWARD" "U"-shaped TROUGH MIXERS—in stainless steel with stainless steel agitators up to 2 tons—jacketed or unjacketed. Also in mild steel. Scroll or paddle type.

Stainless Steel Troughs, Tanks, Cylinders, etc., made to your requirements.

JACKETED PANS

100g., 150g. and 200g. **NEW** in **MILD STEEL** for 100 lb. p.s.i. w.p. with or without mixing gear.

ONE 600g. **JACKETED AUTOCLAVE** with detachable cover, in stock—150 lb. p.s.i. in jacket.

HYDRO EXTRACTORS

A selection in stock—**BROADBENT** and **WATSON LAIDLAW**—72 in., 60 in., 48 in., 42 in. and 36 in.

PUMPS

A selection of **MONO** and other Pumps in stock—2 in. to 5 in.—new and second-hand.

INQUIRIES INVITED.
MORTON, SON AND WARD, LIMITED,
WALK MILL,
DOBCROSS, NR. OLDHAM,
LANCS.
Phone: Saddleworth 437.

FOR SALE

600

TEN NEW ESCHER-WYSS SYSTEM TWIN ROLL SPRAY DRIERS drier rolls of chilled cast iron 40 in. long by 32 in. diam. for max. 74 lbs./sq. in. w.p. fitted air cooled doctor blades, rotary disc distribution trough, air spray jets and worm discharge conveyors. Ancillary equipment comprises stainless steel Feed Pump, jacketed Feed Tank, aluminium encased Powder Dresser, valves, gauges, and all electrical gear for driving.

SIX NEW VACUUM DRYING OVENS M.S. constr., approx. 7 ft. by 3 ft. 6 in by 3 ft. 6 in. deep, fitted 9 steam heated shelves to carry 36 acid resisting metal trays 36 in. long by 16 in. wide by 1¾ in. deep. Davit swung door at each end, with hand wheel closing mechanism. With Motor driven Horiz. Wet Vacuum Pump, metal trays, and all pressure and vacuum gauges, and connecting pipe.

STEAM HEATED TWO-COMPARTMENT DRYING OVEN by Mitchell, 6 ft. by 3 ft. by 6 ft. high inside to accommodate two four-wheel trolleys 3 ft. by 2 ft. 8 in. containing 15 steel shelves at 4 in. spacing. Counter-balanced doors back and front of oven. Motorized Air Circulating Fan, Exhaust System with trunking. Complete with Steam Fittings. Temperature 20-120 deg. C.

VERT. CAKE MIXER by Peerless, 100 qrt. capacity, four-speed machine with bowl, beater, whisk, and hook. Direct driven by 5 h.p. motor.

DOUBLE TROUGH STEAM JACKETED MIXER by Baker Perkins, size 17, type 'X', fitted twin 'Z' blades, trough steam jacketed for 60 lbs./sq. in. w.p. and arranged for motorized screw tilt. Trough size 4 ft. 5 in. by 3 ft. 8 in. by 2 ft. 10 in. max. depth, fitted domed cover. Main driving motor and motor for screw tilt. 400/3/50 cycles.

NEW BATCH POWDER BLENDER by Sturtevant Engineering, size No. 20. capacity 20/24 cu. ft. approx. 1,000 batch. Mixing time 3-5 minutes, chain driven by 10 h.p. totally enclosed motor, 400/3/50 cycles.

TWO-POT BALL MILL by Pascall, with pots 4½ in. by 4½ in. long, driven through Opperman reduction gear from A.C. motor.

GEORGE COHEN SONS & CO., LTD.
WOOD LANE, LONDON, W.12.
Tel: Shepherds Bush 2070 and
STANNINGLEY, NR. LEEDS.
Tel: Pudsey 2241.

ONE BERTRAM TWIN ROLL FILM DRIER, with steam-heated rolls 60 by 28, complete with motor, starter, vapour hood, etc. In first-class condition.

One ½-ton **GARDNER RAPID MIXER,** with trough approx. 8 ft. long by 3 ft. by 3 ft.

Six Brand New **STERILISING VESSELS**—7 ft. long by 3 ft. diam.

One 4 ft. Positive-driven **EDGE RUNNER MILL,** with reduction gear, motor and starter.

One S.J. **WERNER MIXER** with pan approx. 2 ft. by 2 ft., of the tilting type.

Two Steam-jacketed **CAST-IRON FILTER PRESSES,** each with 38 s.j. plates and 39 frames, cake size 2 ft. 4 in. square.

Several Johnson **CAST-IRON FILTER PRESSES,** various sizes and types.

GARDNER Mixers, and Mixers and Sifters combined, sizes "E," "G," "H," "J" and experimental.

HYDRO EXTRACTORS—24 in., 30 in. and 36 in.

Two Gardner "H" size Steam-jacketed **MIXERS.**

Two 18 in. **KEK PLATE MILLS,** with feeders, delivery bins, motors and entablature.

RICHARD SIZER, LTD.,
ENGINEERS,
HULL.
Telephone: 31743.

FOR SALE

600

MILD STEEL SILEX LINED PEBBLE MILL by Boulton, 4 ft. 6 in. by 4 ft. 6 in., mounted on trunnion bearings, and driven through gearing and Wigglesworth clutch by Crompton Parkinson 10 h.p. Motor, 415/3/50. Complete with grinding media.

MILD STEEL SILEX LINED PEBBLE MILL by Boulton, 6 ft. by 6 ft. mounted on trunnion bearings, and driven through gearing and Wigglesworth clutch by 25 h.p. Crompton Parkinson motor, 415/3/50. Complete with grinding media.

PREMIER PASTE MILL by Premier Colliod Mills, size 2½ in. Stainless steel contact surfaces. Underdriven from vert. spindle A.C. motor, 10,500 r.p.m.

FOUR NEW WET AND DRY HORIZ. VACUUM PUMPS type PN. 6, single stage, double acting type. Capacity approx. 200 c.f.m. displacement at speed 125 r.p.m. Fitted outboard bearing with driving pulley, approx. 12 h.p. required to drive.

RECESSED PLATE FILTER PRESS by Edwards & Jones, aluminium plates 26 in. sq., 54 chambers 1¼ in. thick. Mounted on 3 cast iron stands and arranged screw operated closing gear. Provided with four final clamping bolts, 3 in. top centre feed, individual bottom discharge.

VERT. TOTALLY ENCLOSED GLASS LINED VESSEL by Pfaudler, 3 ft. 6 in. diam. by 4 ft. deep, capacity approx. 121 gallons. Domed top and bottom. Fitted hinged lid on top, arranged quick release bolt. Mounted on supporting legs and arranged bottom side run-off and bottom drain-cock.

GEORGE COHEN SONS & CO., LTD.
WOOD LANE, LONDON, W.12.
Tel: Shepherds Bush 2070 and
STANNINGLEY, NR. LEEDS.
Tel: Pudsey 2241.

PHONE 98 STAINES

"PERKINS" JACKETED TWIN "Z"-BLADE TILTING MIXER. Steel pan 29 in. by 29 in. by 22 in. 400/3/50.

No. 2 **DE LAVAL "EMULSOR"**—15 in. by 15 in. Stainless steel jacketed container.

Two—**"CARTER" HEAVY SPIKED ROLL CRUSHERS**—18 in. by 12 in. diam.

No. 3 Electric-driven **KEK MILL.**

1,400 gal. **WELDED STEEL MIXING TANK**—7 ft. by 6 ft. deep.

JACKETED RECTANGULAR VACUUM OVEN—8 ft. by 3 ft. 6 in. by 4 ft.

1,000 and 1,500 gal. **ALUMINIUM ENCLOSED TANKS.**

PUMPS, PANS, FILTER PRESSES, BOILERS, HYDROS, CONDENSERS, STILLS, OVENS, DRYERS AND TANKS up to 44,000 gallons.

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

WANTED

CHEMICAL AGE. BACK ISSUES. Copies of March 1952 August 1952 also January 1953. Offers to **STECHERT-HAFNER INC. STAR YARD, CAREY STREET, LONDON, W.C.2.**

PEPPERMINT and other oils, etc., surplus and job. Parcels wanted. **BOX No. C.A. 3350, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

WANTED—DIRTY SOLVENTS. Distillation Plant and Tank Storage facilities available. Large and small quantities required. Own rail siding. **T.T.P., LTD., BEDDINGTON LANE, WEST CROYDON.** 'Phone: Thornton Heath 5561/3.

CONTRACT WORK OFFERED

MANUFACTURER OF ORGANIC PRODUCTS in London area wishes to contract out vacuum distillation of a non-corrosive intermediate.

Type of plant required for job is 40-50 ft. column with 3000-5000 gallons capacity boiler steam heated at 100 p.s.i.g. or more with heating surface of 1000 sq. ft. or more Vacuum equipment should be capable of 40 mms. Hg. at pump. Regular work guaranteed. Write Box **R372 C/O STREETS, 110 OLD BROAD ST., LONDON, E.C.2.**

SERVICING

CRUSHING, GRINDING, MIXING and DRYING for the trade.

THE CRACK PULVERISING MILLS LTD.
Plantation House,
Mincing Lane,
London E.C.2

GRINDING, CRUSHING AND GRADING
FINE GRINDING LTD.,
BLACKHOLE MINE, EYAM
TELEPHONE: EYAM 227

PULVERISING of every description of chemical and other materials for the trade with improved mills, wharfage, and storage facilities. **THOS. HILL-JONES, LTD., "INVICTA" WORKS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON," TELEPHONE 3285 EAST.**

AUCTIONEERS, VALUERS, Etc.

EDWARD RUSHTON, SON AND KENYON (Established 1855).

Auctioneers, Valuers and Fire Loss Assessors of CHEMICAL WORKS PLANT AND MACHINERY
York House, 12 York Street Manchester.

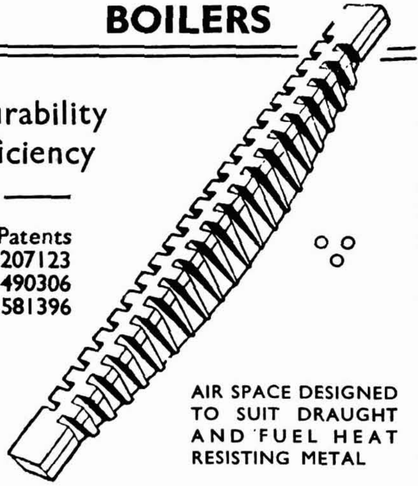
Telephone 1937 (2 lines) Central Manchester.

Drying Trays

- IN HARD RESISTANT VITREOUS ENAMEL
- SPECIALLY PROCESSED TO GIVE MAXIMUM SERVICE
- ALL CORNERS AND EDGES ROUNDED
- SIZES TO SUIT CUSTOMERS REQUIREMENTS
- FINISHED IN GREEN OR OTHER SELECTED COLOUR

NATIONAL ENAMELS LTD.
53, NORMAN ROAD, GREENWICH
LONDON, S.E.10.
Telephone : Greenwich 2266-7 and 2429

FOR ALL TYPES OF BOILERS



Durability
Efficiency

Patents
207123
490306
581396

AIR SPACE DESIGNED TO SUIT DRAUGHT AND FUEL HEAT RESISTING METAL

COLLINS IMPROVED FIREBARS, LTD.
51, THE MALL, EALING, LONDON, W.5

MSE 'medium' centrifuge

1 Litre capacity

speeds up to 4,000 R.P.M.

A bench model, the "Medium," has a maximum capacity of 1,000 ml. when using slotted cups and 600 ml. with metal buckets ; it can take up to 64 small glass tubes in multiple carriers. It is a general-purpose centrifuge for both day-to-day and specialised work. A useful choice of interchangeable "Swing-out" and "Angle" heads, a Superspeed Unit and continuous action "Basket" Heads make the MSE "Medium" Centrifuge an extremely versatile machine.

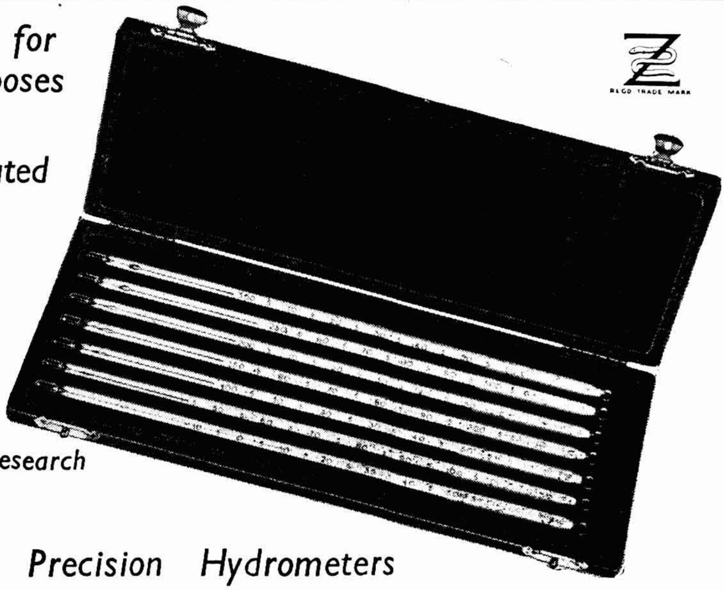
Full details in MSE Publication No. 127

MSE

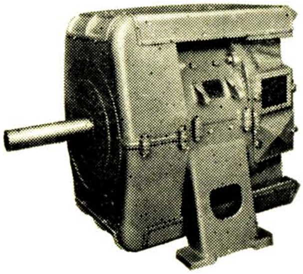
FOR YOUR FILE : MSE make the biggest range of centrifuges in the world in both refrigerated and non-refrigerated types. A brief review of all of them is given in Publication 888. Write for your copy

MEASURING & SCIENTIFIC EQUIPMENT LTD., SPENSER STREET, LONDON, S.W.1

INDEX to advertisers in this issue




TANTIRON
40 GALLON
MIXING VESSEL



Printed in Great Britain by THE PRESS AT COOMBELANDS LTD., Addlestone, and published by BENN BROTHERS LTD., at Bouverie House, 154, Fleet Street, E.C.4, 11 September, 1954. Registered at the General Post Office. Entered as Second Class Matter at the New York, U.S.A., Post Office.