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Vol. 18A, No. 12, DECEMBER 1959

CONTENTS

For Contents of Sections B & C, *see* page A4
For Index to Advertisers, *see* page A23

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CONTENTS

SECTION B

SECTION C

PLATINUM LABORATORY APPARATUS

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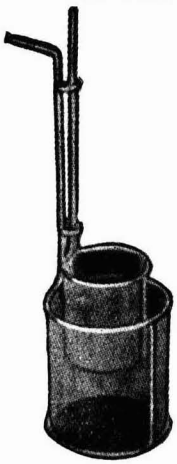

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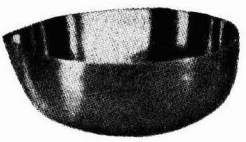

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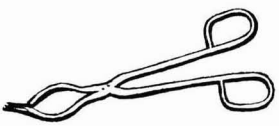

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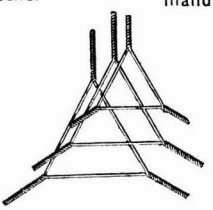
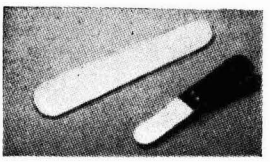


TRIANGLES



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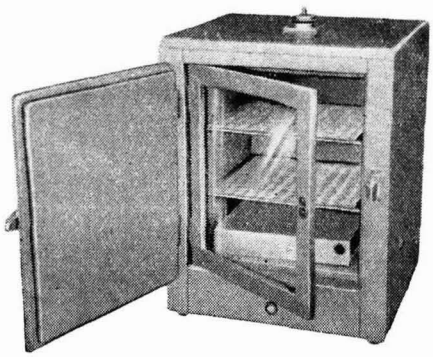

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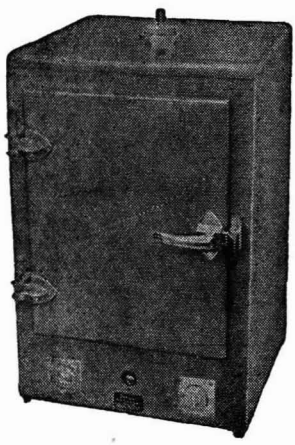

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INDEX TO ADVERTISERS

Current Topics

THE INDIAN STATISTICAL INSTITUTE

THE INDIAN STATISTICAL INSTITUTE BILL, 1959, passed by the Lok Sabha on 14 December 1959, accords recognition to the Indian Statistical Institute, Calcutta, as " an institution of national importance ". The statement of objects and reasons refers to the steady expansion in the activities of the Institute and points out that its activities now include: " (i) The work of designing of the annual rounds of the National Sample Survey (NSS) and the Sample Survey of Manufacturing Industries (SSMI), processing, tabulating and analysing the field data and writing and printing the various NSS and SSMI reports; (ii) the maintenance of an Operational Research Unit on Planning at Calcutta, Statistical Quality Control Units at Bangalore, Bombay, Delhi and Calcutta, and other Units for studies in regional planning, biometry and psychometry; (iii) advanced research in theoretical statistics and the application of statistical methods to problems in various fields, including demography, economics, planning, agriculture and industry; (iv) the training of statisticians deputed by the Central and State Governments; and (v) the running of an international Statistical Education Centre. In view of the importance of the functions of the Institute and the large sums of money received by it from the Government, it is considered necessary that the Institute should be declared to be an institution of national importance under Entry 64 in List I of the Seventh Schedule to the Constitution. The Bill makes such a declaration and provides for the requisite financial assistance to be given to the Institute and for suitable powers of control being exercised. The Institute is also being empowered to grant Degrees and Diplomas in statistics."

In his statement in the Lok Sabha, the Prime Minister pointed out that the Institute would retain its autonomy as before, and observed that science and matters connected with science cannot be, or should not be, dealt with by the normal routine methods. " You cannot have creative impulses dealt with by routine methods ", said the Prime Minister, " that is why wherever science has grown very considerably — let us say in the United States of America or in the Soviet Union — they give the widest latitude to their scientific apparatus to grow. Naturally they have checks to see that money is not wasted; but they give the latitude." The Bill protects the autonomy of the Institute in its scientific work and ensures that public funds are applied in the proper way for purposes laid down by the government, and serve as a model which may be extended generally to state-controlled enterprises.

ELECTRONICS CONVENTION

THE ELECTRONICS CONVENTION ORGANIZED BY THE Defence Science Organization at Bangalore, from 28 September to 1 October 1959, brought together specialists from 41 organizations in the country to discuss problems of research and development in the rapidly developing field of electronics. The subjects discussed in the technical sessions were: Environmental engineering in military electronic equipment; guidance and control systems; electronics instrumentation with particular reference to automation in defence equipment; trends towards miniaturization; reliability problems in defence electronic equipment; problems of air-borne electronic equipment; and education of electronic engineers. An exhibition of electronic instruments produced or in use in India was organized concurrently.

The Convention was concerned primarily with problems of interest to defence services and the stress was on the design and development of conventional instruments using materials available in the country. While it is necessary, and even urgent, that attention should be directed to the development of devices and equipment, fundamental research in semiconductors and solid state physics should also receive due attention. Electronics is a field in which research and development have reacted on each other with remarkable results and electronic devices become rapidly out of date unless research is actively pursued and the results put into use. The Convention helped to reveal several areas calling for research and efforts should be made to strengthen institutions devoted to

teaching and research in electronics. To this end, the Defence Science Organization, the National Physical Laboratory, the Central Electronics Research Institute, the recently established Central Scientific Instruments Organization and other research laboratories and institutes can make significant contributions.

RADIOISOTOPES & AGRICULTURAL RESEARCH

An International Training Course in the use of radioisotopes will be held at the Indian Agricultural Research Institute (IARI), New Delhi, from 20 January to 17 February 1960, under the joint sponsorship of the Ministry of Food & Agriculture (Government of India), the International Atomic Energy Agency (IAEA), the Food & Agriculture Organization (United Nations), and the Unesco. A committee comprising members representing the Unesco, IAEA and the Department of Atomic Energy has been constituted under the chairmanship of Dr B. P. Pal for organizing the course. Twenty-five candidates from Burma, Ceylon, India, Pakistan and Thailand are expected to attend the course. In addition to general training in nuclear and health physics and radiation dosimetry, candidates will have opportunities for specialization in one of the following subjects: (a) Radiation cytology and genetics; (b) Radioisotope techniques as applied to problems in soil fertility, fertilizer application and plant biochemistry; and (c) Use of radiations in the prevention of food spoilage and control of insect pests.

Radioisotopes find application in agriculture in three ways, namely tracers in physiological, nutritional and metabolic studies, mutagens and sterilizing agents. The Indian Agricultural Research Institute has been organizing annually, since 1956, a three-month training course on the use of radioisotopes in agricultural research.

Research on radioisotopes and radiations has been in progress at the IARI for the past five years and several economically useful mutants of wheat, potato, cotton and tomato have been produced. In order to intensify the mutation research programme in crop plants and to extend it to fruit trees, a large-scale field irradiation facility, known as Gamma Garden, has been set up in the Institute farm. This garden has at its centre 200 curies of Co-60 encased in a lead container with remote control mechanism for raising and lowering the Co-60 source. The plants grown in this field can be subjected to irradiation at any desired stage in their life-cycle.

Council of Scientific & Industrial Research — Meetings of the Board & Governing Body

THE Board of Scientific & Industrial Research and the Governing Body of the Council which met in New Delhi on 16 and 17 October 1959 respectively, approved the establishment of a Central Scientific Instruments Organization at Delhi and a Petroleum Research Institute at Dehra Dun. It was also decided to set up separate divisions for research on Essential Oils and Dyes & Organic Intermediates at the National Chemical Laboratory, Poona, and sections for research on Leather Economics and Leather Goods at the Central Leather Research Institute, Madras. The following new research projects were sanctioned: (1) Setting up of a pilot plant for semi-commercial production of pure active principles from some medicinal plants of the North-western Himalayan region at the Regional Research Laboratory, Jammu; (2) Establishment of small-scale units for the production of magnet alloy and ferro-alloys at the National Metallurgical Laboratory, Jamshedpur; and (3) An all-India survey for locating and testing the deposits of clays suitable for making puzzolanic *surkhi*, to be conducted by the Road Research Institute, Delhi.

New research schemes

The following 38 new research schemes were sanctioned:

1. *Investigation of soft woods (light woods) of Kerala State* — PROF. RUSSELL SOLOMON, N.S.S. College, Trivandrum

2. *Study of the cellular factors controlling sensitivity of plant chromosomes to X-rays and chemical agencies* — DR ARUN KUMAR SHARMA, Calcutta University, Calcutta

3. *Cytological and taxonomic studies on the Polypodiaceae of Eastern India* — DR G. PANIGRAHI, Botanical Survey of India, Shillong

4. *Economic design of large span roofs* — DR O. P. JAIN, University of Roorkee, Roorkee

5. *Study of certain non-stationary flow problems by electrical analogue techniques* — PROF. S. PANCHANATHAN, College of Engineering, Madras

6. *Study of contact pressure distributions under footings founded on soils that swell and shrink* — PROF. S. PANCHANATHAN, College of Engineering, Madras

7. *Secondary consolidation characteristics of black cotton soils* — PROF. S. PANCHANATHAN, College of Engineering, Madras

8. *Studies in proteins and certain B-vitamins interrelationships* — DR M. V. RADHAKRISHNA RAO, Haffkine Institute, Bombay

9. *Electrical conductance and viscosity of electrolyte solutions in a wide range of concentration* — DR C. V. SURYANARAYANA, Annamalai University, Annamalainagar

10. *Dielectric constant in relation to liquid-liquid miscibility* — DR C. V. SURYANARAYANA, Annamalai University, Annamalainagar

11. *Magneto-chemical studies on organo-inorganic complexes* — DR H. L. NIGAM, University of Allahabad, Allahabad

12. *Absorption of ions in micro and tracer concentrations* — DR H. J. ARNIKAR, Banaras Hindu University, Varanasi

13. *Studies in the electromigration of labelled ions* — DR H. J. ARNIKAR, Banaras Hindu University, Varanasi

14. *Inorganic microchemistry using Weiz ring oven technique* — DR ARUN K. DEY, University of Allahabad, Allahabad

15. *Studies in inorganic complexes*: (i) *chromatographic behaviour of anionic complexes*; (ii) *thermodynamics of complex-forming systems*; *and* (iii) *metal chelates involving polyphenolic compounds* — DR ARUN K. DEY, University of Allahabad, Allahabad

16. *Biochemical studies on the mode of action of different antibiotics* — DR JAGAT JIBAN GHOSH, University College of Science & Technology, Calcutta

17. *Role of riboflavin in the synthesis and regeneration of haemoglobin, plasma and liver proteins and enzymes* — DR SAILEN MOOKERJEE, Nagpur University, Nagpur

18. *Underground corrosion of metals and alloys under Indian conditions* — DR B. CHATTERJEE, Bengal Engineering College, Howrah

19. *Mechanism of coagulation of lyophobic colloids in non-aqueous media* — DR B. P. YADVA, University of Lucknow, Lucknow

20. *Transference measurements in polybasic acids* — DR RAM DULARY SRIVASTAVA, University of Lucknow, Lucknow

21. *Solvent effects in nucleophilic aliphatic substitution* — DR R. ANANTHARAMAN, University of Kerala, Trivandrum

22. *Physico-chemical studies on surface active substances at the dropping mercury electrode* — DR S. L. GUPTA, Birla College of Science, Pilani

23. *Designing of d.c. induction machines* — SHRI R. G. JANKIRAMAN, Coimbatore Institute of Technology, Coimbatore

24. *Designing of turbo chargers for diesel engines* — PROF. G. SHANMUGHAM & SHRI C. P. KOTHANDARAMAN, P.S.G. College of Technology, Coimbatore

25. *Development of an electro-mechanical machine tool cutter control mechanism for a central lathe for turning out machine parts in accordance with the contour of a template* — SHRI HIRONMOY BANERJEE, Birla Institute of Technology, Ranchi

26. *Development of a new torque meter using magneto-striction phenomena* — SHRI R. SUBBAYYAN, P.S.G. College of Technology, Coimbatore

27. *Development of investment precision casting techniques* — PROF. S. N. IYENGAR, Indian Institute of Technology, Kharagpur

28. *Refining of oleo-resin turpentine and effect of acidic refining agents* — DR K. C. GULATI, Indian Agricultural Research Institute, New Delhi

29. *Investigations on the aromatic resources of Kerala* — SHRI N. SUBRAMONIA WARIYAR, University College, Trivandrum

30. *Structure and genesis of the Singhbhum granite including the genesis of the associated mineral deposits* — SHRI AJIT KUMAR SAHA, Presidency College, Calcutta

31. *Regional gravity and magnetic investigations in parts of the Gondwana formations in the Godavari valley, Andhra Pradesh* — PROF. M. S. KRISHNAN & DR V. BHASKARA RAO, Andhra University, Waltair

32. *Systematic studies of the clays and clay minerals of Madhya Pradesh with special reference to their economic suitability and a fundamental study of clay minerals associated with ore bodies* — DR W. D. WEST, University of Sagar, Sagar

33. *Measurement of anisotropy of absorption and fluorescence spectra of organic aromatic single crystals* — DR S. C. GANGULY, Jadavpur University, Calcutta

34. *Spectra and potential energy curves of diatomic molecules* — SHRI YATENDRA PAL VARSHNI, Allahabad University, Allahabad

35. *Determination of spins and parities of the excited levels of the radioactive nuclei by* (a) *angular correlation method and* (b) *by measuring the half-lives of the levels using scintillation technique and millimicrosecond circuitry* — PROF. P. S. GILL, Muslim University, Aligarh

36. *Polarization of the echoes from the E and F regions* — DR R. SATYANARAYANA, Shri Venkateswara University, Tirupati

37. *Systematic study of ferro-resonant circuits with reference to their application as relaxation oscillators* — PROF. N. SARKAR, Shri Govind Ram Seksaria Technical Institute, Indore

38. *The phenomenon of electrical discharge through gases and vapours and its investigation by microwave probe and optical method* — DR SAMARENDRA NARAYAN SEN, Jadavpur University, Calcutta

New institutes and centres

One of the recommendations of the Committee appointed by the Planning Commission to formulate proposals for the development and manufacture of scientific instruments of different types in the country, was the establishment of a Central Scientific Instruments Organization; this recommendation has been accepted by the Council. The functions of the Organization will include: survey and assessment of the present and future needs of various types of scientific instruments required for teaching, research, industry and essential services; (2) preparation of a phased programme for the development of the scientific instruments industry during the next ten years; (3) establishment of design and development units and centres of instrument production; (4) preparation of specifications and blue-prints for instruments and the development of testing techniques and equipment for testing instruments; production of prototypes; and (5) organization of advanced training of technicians and specialized personnel required for the manufacture, repair and maintenance of scientific instruments.

Regional extension centres of the Leather Research Institute to be established at Calcutta, Bombay and Kanpur (or Agra) will maintain close contact with the tanners, especially the cottage industry level tanners.

Symposia and seminars

The holding of the following during 1959-60 was approved:

Symposia: (1) *Pilot plants in metallurgical research and development*, National Metallurgical Laboratory, Jamshedpur (February 1960); (2) *High polymers*, Chemical Research Committee (in Bombay, during January 1960 at the time of the Indian Science Congress Session); and (3) *Laboratory animals*, Indian Institute of Biochemistry & Experimental Medicine, Calcutta (February 1960).

Seminars: (1) *Electrochemistry*, Central Electrochemical Research Institute, Karaikudi (February 1960); (2) *Castor oil*, Regional Research Laboratory, Hyderabad (December 1959); and (3) *Problems of high speed flight and allied topics*, Indian Institute of Science, Bangalore, in collaboration with the Aeronautical Research Committee (December 1959).

Beneficiation of Minerals — A Symposium

As part of the scientific activities of the Indian Institute of Science, Bangalore, commemorating the Golden Jubilee Year, a symposium on 'Beneficiation of Minerals' was organized by the Department of Inorganic and Physical Chemistry from 28 to 30 September 1959. Delegates from a number of research institutions participated in the symposium. In addition to reading of 28 papers and discussions, there was an interesting lecture by Dr C. C. Patel on recent developments in the beneficiation of minerals by gravity, magnetic, electrostatic and flotation methods.

In his welcome address, Prof. M. R. A. Rao stressed the importance of beneficiation methods in concentrating and upgrading various mineral ores in view of the limited resources of high grade ores available in the country. Shri B. Rama Rao, former Director, Indian Bureau of Mines, in his inaugural address surveyed the development of mineral industry in the country. He observed that the value of mineral production, which was Rs 7-8 crores in the early part of this century, had risen to more than Rs 100 crores, and the number of minerals mined had increased from half a dozen to more than 35 now. His main address was on the 'Beneficiation and processing of minerals with special reference to the minerals of Mysore State'.

The subjects covered by the papers presented at the symposium were classified under the following heads: (i) theory of grinding; (ii) flotation theory and practice, with particular reference to sulphides, manganese ores, beach sands, gold tailings, uraniferous granite; (iii) heavy media and hydrocyclone methods in the beneficiation of pyrites and coals; (iv) phase separation methods for demineralization of coals and graphites; (v) chemical methods, including the theory and practice of chlorination; and (vi) miscellaneous, including methods for the production of ferromanganese from ferruginous manganese ores, contact angle measurements in welding, and microscopic petrography in beneficiation methods.

Flotation theory and practice

Microradiographic investigation of the distribution of xanthate over sulphide mineral surfaces has provided direct proof for the non-uniform and mosaic distribution of xanthate. This is attributed to the influence of the electrochemical heterogeneity of sulphide minerals. Besides, it has been found that the adsorbability of different particles of the same mineral varies considerably, elevated xanthate fixation being observed on sulphide mineral composites. Two causes for the formation of electrochemical heterogeneity have been indicated: (i) defective mineral lattice, and (ii) the difference in the quantity of the substance adsorbed molecularly at different areas of the mineral surface. The overall effect of these two causes determines the surface properties of sulphide minerals. The properties of xanthate collectors have been investigated under different conditions, and it has been observed that in the presence of oxygen, the xanthates undergo oxidation as well as hydrolytic decomposition. The extent of oxidation is found to decrease with increase in the hydrocarbon chain of the xanthates of primary alcohols. Among the xanthates examined, isopropyl xanthate (of secondary alcohol) has been found to undergo maximum oxidation. Oxidation is greater with a mixture of oxygen and carbon dioxide but the trend remains the same. The xanthates dissociate in the presence of carbon dioxide alone, and ferric salt reverses the trend of oxidation in the presence of oxygen and a mixture of oxygen and carbon dioxide. Ferric salt enhances the oxidation of higher xanthates, does not affect that of isopropyl xanthate and retards that of ethyl xanthate. Hydrolytic decomposition and dissociation of xanthates are not much influenced by the ferric salt. It has been observed that in the presence of oxygen and a mixture of oxygen and carbon dioxide, the contact angle due to xanthate film on iron pyrite surface gradually rises and attains the value of the corresponding dixanthogen. In the presence of carbon dioxide alone, the contact angle due to ethyl xanthate gradually vanishes while with other xanthates it attains the magnitude of the contact angle for the corresponding dixanthogens. It has been shown that the contact angle not only depends on the nature of collectors but also on the nature of the metal/mineral surface and also on the nature of the gas employed to determine the contact angle. The recovery in flotation processes has been shown to be dependent on the nature of the gas employed for flotation. Investigations on the collecting strength of fatty acid soaps on beach sand minerals have shown that unsaturated fatty acids have better collecting power than saturated fatty acids, and the collecting strength is maximum when the collector has two double bonds. Studies on the use of soaps from indigenous oils as collectors for quartz have shown that *Bombax malabarica* oil, due to its higher unsaturated fatty acid content, is a better collector than shark liver oil.

Although there is no appreciable angle of contact on chalcopyrite surface, conditioned by caproic acid, chalcopyrite can be selectively floated from gangue minerals containing iron pyrites. Sulphide minerals have been found difficult to float selectively and with good efficiency when they occur with micaceous gangue and graphite; such ores can, however, be effectively treated by the ammonia pressure leach method. Conditions have been standardized for floating Chitaldurg (Mysore State) chalcopyrite, and a concentrate containing 18 per cent copper with a recovery of 96 per cent has been obtained. A process has been worked out for the selective flotation of zircon in beach sands employing an alkaline medium (pH 11·4-11·5) instead of the usual corrosive acid medium as collector. The recovery of economic minerals from Kerala beach sands has been studied employing the usual beneficiation process after modification. It has been observed that monazite can be floated fairly free from ilmenite with an efficiency of 80 per cent employing Armac 12D. The tailings when subjected to high intensity magnetic separation give ilmenite containing less than 0·15 per cent monazite. Mixed amine acetate, prepared from coconut oil, has been found suitable for use in place of Armac 12D for the flotation of monazite together with sillimanite; the minerals can be easily separated subsequently by tumbling.

Since the working of the west reef ore lode of Kolar Gold Fields, the value of gold in the tailings has risen from 0·125 to 0·275 dwt per ton on account of the presence of sulphide minerals in the tailings. Flotation of tailings using ethyl xanthate as collector has resulted in a recovery of *c.* 74 per cent gold, intimately associated with the sulphide minerals. Employing a mixture of oleic acid, petroleum sulphonate and sodium oleate as the collector, it has been possible to upgrade, by flotation at pH 7·5, uraniferous granite from Salem district, Madras, containing 0·067 per cent U_3O_8, occurring as uraninite and fergusonite. The ore is likely to be a good source of uranium.

The Mysore manganese ores are classified as ferruginous and siliceous. It has been found possible to remove the ferruginous gangue in the ore by first subjecting iron oxides to reduction roasting at 500° to 550°C. to obtain magnetite and then to magnetic separation. The siliceous ores can be concentrated by flotation. Rajasthan manganese ores, which are high in silica, iron and phosphorus, are reported to be difficult and uneconomical to beneficiate.

Beneficiation of pyrites and coal

The recovery of pyrite with 43 per cent sulphur has been effected by heavy media separation and other gravity methods from Nowrozabad coal washery rejects. The effectiveness of cyclone type washers in upgrading small size and difficult-to-clean coals has been established. A 6 in. cyclone at an inclination of 20° has been reported to achieve as good a separation with low feed pressure as with high feed pressure. An inclined arrangement of the cyclone is claimed to have minimum reduction of the size degradation of washed coal and to provide greater flexibility in operational control of the plant. The phase separation process, based on the selective wetting and agglomeration of coal by petroleum fractions, has been standardized for the cleaning of high ash Indian coals; it has been found possible to reduce the ash content of East Bokaro coal from 40 to 18 per cent with a coal recovery of over 80 per cent, employing 15 per cent oil.

Phase separation methods

The rate of enrichment of graphite by the phase exchange method has been observed to increase with increase in oil content in the graphite-oil-mineral system, until a limiting value is reached. By this method, it has been possible to reduce the ash content of a graphite from 27 to 68 per cent to about 3 per cent in the enriched product with very little carbon loss in gangue minerals.

Chlorination of ores

Chlorination of leucoxene has been reported to be most efficient when 10 parts of −200 mesh mineral are mixed with 5 parts of carbon and 0·1 part of ceric oxide, and chlorination is carried out at 600°C. with chlorine containing some oxygen. Calculations of the standard free-energy and enthalpy changes of various chlorination reactions of ilmenite, rutile and leucoxene, employing carbon and chlorine as reducing and chlorinating agents respectively, have shown that the titania content of ilmenite can be increased by preferential chlorination of iron to ferric chloride at 450-550°C., when the ferric salt sublimes over.

Nuclear Optical Model*

RECENT theoretical and experimental work on nuclear phenomena like rotational spectra and inelastic scattering has afforded increasing support to the nuclear optical model concept. The optical model may be defined as the positive-energy version of the independent particle (i.p.) model; the negative-energy or bound-state version of the same is the shell model. The i.p. model, which has helped in understanding and correlating a vast amount of experimental data, envisages that nucleons within the nucleus move approximately independently in a common average field of force to absorb as well as deflect particles. The same idea, applied to electrons, is essential to the understanding of atomic and molecular structure. It has been employed, for example, in explaining, qualitatively and quantitatively, the density of nuclear energy levels and the properties of the low-lying levels of the very light nuclei. The i.p. model, which has been a working hypothesis till recently, has now a sound theoretical and experimental basis. The regularities in nuclear ground-state properties like spin, magnetic moment and binding energy could be understood only in terms of an i.p. model or the shell model. In fact, the experimental data have put the theory one step behind even. Data on neutron scattering obtained by H. H. Barschall (University of Wisconsin), together with data on the absorption and scattering of thermal neutrons, have indicated the inadequacy of the older ' strong-interaction ' models and pointed to the need for an approximate i.p. model in the positive-energy domain of scattering and reaction processes.

The nuclear optical model has increased our knowledge of the effective nucleon-nucleus interaction, and has made possible close fits of the theoretical values to the experimental ones in regard to energy, angle dependence and polarization in nucleon-nucleus scattering. Over the range of the incident nucleon energies 0-400 MeV., the nuclear radius and surface thickness, the depths of the real and imaginary parts of a central potential, and the strength of a complex spin-orbit potential can now be specified fairly accurately. Recent measurements of polarization of 10 MeV. protons by L. Rosen (Los Alamos Scientific Laboratory) have helped much to determine the spin-orbit interaction at low energy.

For the consideration of the direct interaction mechanism of inelastic scattering, the difference between the optical potentials required for the description of elastic and inelastic scattering needs to be emphasized. In the prediction of thermal neutron capture, it has been shown that for the heavy elements, a non-spherical complex potential well must be chosen for the neutron-nucleus interaction in order to account for the observed data. The calculations of A. E. S. Green and P. Wyatt (Florida State University) are of special interest in emphasizing the connection between the optical model and the shell model. Using a velocity-dependent potential well, they have been able to arrive at a correct sequence of bound states to account for the nuclear shell model and simultaneously to predict, fairly correctly, low-energy neutron scattering.

Theories of the optical model may be roughly divided into those which particularize a general theory and those which generalize a special theory. The general theory is the nuclear reaction formalism, within which special assumptions may be made in an effort to derive the optical model. The original work of Feshback, Porter and Weisskopf (Massachusetts Institute of Technology) fits into this category. A particular merit of this approach is that it relates features of the optical model to the details of the nuclear excited states. A new theoretical approach to the optical model presented by Feshback works also from a very general, but different, formalism.

The second type of theory endeavours to generalize from the two-body problem to the many-body problem, to relate features of the optical model to two-body scattering data. Ingenious use of semi-classical approximations has been made to derive optical model features at very high energies. McManus and co-workers have shown how the nucleon-nucleus interaction at energies of several hundred MeV. may be derived from the known two-body scattering data. This work has, in particular, given a simple explanation of the fact that the depth of the real part of the optical potential becomes zero at about 300 MeV. Lengthy and difficult calculations have been carried out at Los Alamos to derive the properties of the ground state of Ca^{40} (and later other nuclei) using a formalism which works from the two-body interactions within the nucleus. The calculated results are so far only in qualitative accord with the experimental data, but represent a significant step towards a fundamental understanding of nuclear matter.

In recent experiments relating to the nuclear optical model, R. Eisberg and T. Gooding (Univeristy of

*Summary of conference report on the International Conference on the Nuclear Optical Model, *Phys. Today*, **12** (9) (1959), 22.

Minnesota) have succeeded in measuring total reaction cross-sections for protons more accurately than hitherto possible. The high-resolution experiments with 180-MeV. protons at Uppsala, reported by T. Maris (Florida State University), are of considerable interest, since angular distributions and polarizations were obtained both for elastic scattering and for inelastic scattering, leaving the nucleus in a definite single final state. The theory of the scattering of pions by nuclei takes advantage of the strong p-wave pion-nucleon interaction to derive a pion-nucleus optical model which is capable of giving good fits to the experimental data.

Some questions connected with the nuclear optical model, however, remain unanswered. These are: (1) What is the spatial distribution of the absorption strength within the nucleus? Some evidence, both theoretical and experimental, favours the idea that incident nucleons are absorbed most strongly near the nuclear surface. (2) What is the dependence of the absorption strength on mass number at low energy? (3) To what extent are reactions and inelastic scattering at low energies describable as direct (i.e. as one-stage processes) and to what extent as compound (i.e. as complicated many-stage processes)? (4) Do some nuclei possess a static octopole deformation as well as a quadrupole deformation? Absorption cross-sections for thermal neutrons (more exactly, the ratio of widths to spacings of nuclear resonance levels) can provide evidence on this point. The optical model is thus closely tied up with the shape of nuclei. (5) Why are the central properties of nuclei — depth of real part of optical potential and density of matter — so nearly constant from the lightest to the heaviest nuclei? The calculations of Brueckner (Pennsylvania State University), Lockett and Rotenberg (Los Alamos Scientific Laboratory) predict properties at the centre of the calcium nucleus to be substantially different from properties in an infinite sea of 'nuclear matter', in contrast to the experimental results. The 'experimental' results for infinite 'nuclear matter' consist of volume terms in the semi-empirical mass formula and extrapolations from the properties of the heavy nuclei.

Nobel Prize Awards, 1959

THE NOBEL PRIZE AWARDS FOR THE YEAR 1959 HAVE been announced by the Swedish Academy of Sciences.

Physics — Prof. Emelio Segré and Prof. Owen Chamberlain, of the University of California at Berkeley, share the Nobel Prize in Physics for their researches into the nature of the atom, leading to the discovery of the anti-proton. A team of workers headed by these two physicists confirmed, in 1955, the existence of anti-protons in a beam of subatomic debris created by the 6·2 BeV. bevatron at the University of California.

Chemistry — Academician Jaroslao Heyrovsky, Director of the Polarographic Institute at the Czechoslovak Academy of Sciences, Prague, has been awarded the Nobel Prize in Chemistry. The prize has been given for his life-long work in the development of the technique of polarography. Academician Heyrovsky developed a device, now known as the polarograph, for the first time in 1924. Later, the method of oscillographic polarography based on the use of alternating current was developed.

Medicine — Dr Arthur Kornberg of the Stanford University, California and Dr Severo Ochoa of the New York University College of Science, share the Nobel Prize in Medicine for their discoveries relating to the biological synthesis of ribonucleic acid and deoxyribonucleic acid. Dr Kornberg discovered an enzyme that makes it possible to produce deoxyribonucleic acid from smaller organic molecules. An enzyme capable of performing a similar function for the synthesis of ribonucleic acid was discovered by Dr Ochoa. Since the nucleic acids are present both in the nuclei and the protoplasm of living cells, their successful biological synthesis is expected to throw further light on the basic chemistry of life.

A Study of Shevaroy Bauxites for the Development of High Alumina Refractories: Part I—Factors Affecting the Preparation of Grog

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The various factors which affect the preparation of dense grog from red and white varieties of bauxite from Shevaroy hills (Salem district, Madras) for use in the production of high alumina refractories within the range 60-80 per cent alumina have been investigated. The proportions in which raw bauxite and china clay (Travancore) have to be mixed to give the desired alumina content in the fired grog have been determined and the temperature to which the bauxite-clay mix has to be fired to reduce shrinkage and lower the porosity of the grog has also been determined. These studies have shown that red bauxite is not suitable for high alumina refractories (70-80 per cent alumina) due to the deleterious effect of high iron content in it. Firing −200 mesh white bauxite and china clay mixes with 80 per cent alumina at 1600°C. ensures the removal of all shrinkage from the grog and reduces its porosity to <20 per cent. In the case of 70 and 60 per cent alumina compositions with white bauxite, grinding the bauxite to −200 mesh and −80 mesh respectively and firing the bauxite-clay mixes at 1550°C. produce dense grog with low porosity.

HIGH alumina refractories meet wide service conditions in different types of metallurgical furnaces, cement kilns and boiler installations. While alumino-silicate minerals such as kyanite, andalusite and sillimanite, and fireclays are ideal raw materials for the production of high alumina refractories, having about 60 per cent Al_2O_3, where service conditions demand a higher alumina content these raw materials have to be partly or wholly replaced by those having higher alumina content like diaspore, bauxite, gibbsite, etc. Most bauxite deposits of India are high in titania, which makes them unsuitable for use in high alumina refractories. In this study, the suitability of bauxites from Shevaroy hills in Salem district, Madras, which are low in titania but high in iron oxide content, has been investigated for the production of high alumina refractories.

When using bauxite, it is more or less the general practice in this country to calcine the bauxite at a high temperature and to mix raw fireclay with the calcined bauxite grog in making high alumina refractories. The main drawback of such a practice is that whereas the bauxite grog has a high refractoriness, the matrix which consists mainly of fireclay has a lower refractoriness and the brick fails at a lower temperature corresponding to the refractoriness of the matrix. To overcome this defect, an attempt has been made in this study to mix the raw bauxite and raw clay in requisite proportions to give the desired alumina content in the fired state, and to calcine the mixture at sufficiently high temperature to remove all contraction and lower the porosity of the product. The grog thus obtained is graded to different grain sizes and used for the final brick mix, with or without the addition of raw mix of the same composition, thus ensuring that the coarser aggregates as well as the matrix will have the same composition and refractoriness. This paper is confined to the study of the factors involved in the preparation of dense grog. The optimum grain size to which bauxite has to be crushed to ensure complete reaction with the clay, and the optimum temperature to which the bauxite clay mix has to be fired to remove all shrinkage and lower the porosity of the grog to reasonable limits have been studied.

Materials and methods

White and red bauxites from Shevaroy and washed china clay from Travancore have been used in this study.

The bauxites were crushed in jaw crusher, rolls, disc pulverizer and pot mill and graded to grain size frac-

tions of −80+100, −100+150, −150+200 and −200 mesh Tyler Standard Sieves. The china clay which was received in ground condition was used as such.

Mixes having 80, 70 and 60 per cent Al_2O_3 were compounded by mixing sufficient Travancore china clay with Shevaroy white or red bauxite to give the requisite Al_2O_3 content in the fired stage.

For each composition, four mixes were prepared using the four grain size fractions of bauxite. The batches were thoroughly mixed in the dry state first and again after the addition of 6 per cent water and pressed into $1\frac{1}{8}$ in. diam. × 1 in. specimen at 6000 lb./sq. in. pressure. Five specimens for each composition and grain size were dried and fired in a coke-oven gas fired furnace with 3 hr soaking at maximum temperatures of 1200°, 1300°, 1350°, 1400°, 1450°, 1500° and 1550°C.

Shrinkage and porosity of the specimens fired at each of the temperatures as well as specific gravity of specimens fired at 1300°, 1450° and 1550°C. were determined. The P.C.E. values of each of the compositions were determined and petrographic study of powder mounts of the specimen was carried out to get an idea of the conversion to mullite.

Results and discussion

Chemical analyses of the raw materials used in this study are given in Table 1 and the compositions of different mixes together with the grain sizes employed are given in Table 2. Porosity and shrinkage of specimens fired at different temperatures are given in Figs. 1 and 2. The P.C.E. and specific gravity of the specimens are given in Table 3. An approximate idea of the mineral phases present at different temperatures can be obtained in Table 4, where the mineral composition has been calculated from the phase equilibrium diagram according to well established methods, on the assumption that no solid solutions are formed.

The addition of china clay not only adjusts the Al_2O_3 content to the desired limit, but also helps in lowering the fluxes, especially of Fe_2O_3, and in increasing SiO_2 content of the mix so that the alumina could react with SiO_2 to form mullite, provided the reaction takes place. The addition of china clay further helps in imparting plasticity to the mass. Whereas in the case of the 80 per cent Al_2O_3 compositions only a small percentage of china clay is required (Table 2), for 60 per cent Al_2O_3 compositions it becomes the major constituent with bauxite added to provide the requisite Al_2O_3 content.

Effect of grain size of bauxite on shrinkage and porosity of the grog fired at different temperatures — In order to remove all shrinkage from bauxite and promote reaction between Al_2O_3 and SiO_2 to form mullite,

TABLE 1 — CHEMICAL ANALYSES OF RAW MATERIALS

	Shevaroy bauxite				Travancore china clay	
	White		High grade red			
	Raw	Fired (calc.)	Raw	Fired (calc.)	Raw	Fired (calc.)
Loss on ignition, %	30·30	—	29·72	—	13·72	—
Al_2O_3, %	58·75	84·28	56·61	80·56	40·70	47·07
Fe_2O_3, %	2·59	3·72	9·31	13·24	0·17	0·20
TiO_2, %	0·37	0·53	1·06	1·51	0·33	0·78
SiO_2, %	8·01	11·49	3·30	4·70	44·42	51·40
CaO, %	Trace	—	Trace	—	0·31	0·36
MgO, %	do	—	do	—	Trace	—
Alkalies, %	do	—	do	—	0·50	0·58

TABLE 2 — GRAIN SIZE AND COMPOSITION OF BAUXITE AND CHINA CLAY MIXES

Composition Code No.	Grain size of bauxite used *Tyler mesh*	Raw bauxite %	Raw Travancore china clay %	Al_2O_3 in fired body %
W	−200	100	—	84
WT_1	−180+100	92	8	80
W_AT_1	−100+150	92	8	80
W_BT_1	−150+200	92	8	80
W_CT_1	−200	92	8	80
WT_2	−80+100	65	35	70
W_AT_2	−100+150	65	35	70
W_BT_2	−150+200	65	35	70
W_CT_2	−200	65	35	70
WT_3	−80+100	38	62	60
W_AT_3	−100+150	38	62	60
W_BT_3	−150+200	38	62	60
W_CT_3	−200	38	62	60
R	−200	100	—	80
RT_1	−80+100	96	4	80
R_AT_1	−100+150	96	4	80
R_BT_1	−150+200	96	4	80
R_CT_1	−200	96	4	80
RT_2	−80+100	70	30	70
R_AT_2	−100+150	70	30	70
R_BT_2	−150+200	70	30	70
R_CT_2	−200	70	30	70
RT_3	−80+100	45	55	60
R_AT_3	−100+150	45	55	60
R_BT_3	−150+200	45	55	60
R_CT_3	−200	45	55	60

W = Shevaroy white bauxite; R = Shevaroy red bauxite; T = Travancore china clay.

TABLE 3 — P.C.E. OF COMPOSITIONS AND THEIR SP. GR. AFTER FIRING AT DIFFERENT TEMPERATURES

Composition Code No.	P.C.E. *Orton cone*	Sp. gr.			
		Raw	1300°C.	1450°C.	1550°C.
W	38	2·470	—	—	—
T	35-36	—	—	—	—
W_CT_1	38	—	3·683	3·613	3·599
W_CT_2	38	—	3·278	3·063	3·176
W_CT_3	36	—	3·073	3·063	3·017
R	36-37	2·566	—	—	—
R_CT_1	36-37	—	3·955	3·706	3·694
R_CT_2	36	—	3·408	3·327	3·270
R_CT_3	35-36	—	3·152	3·052	3·054

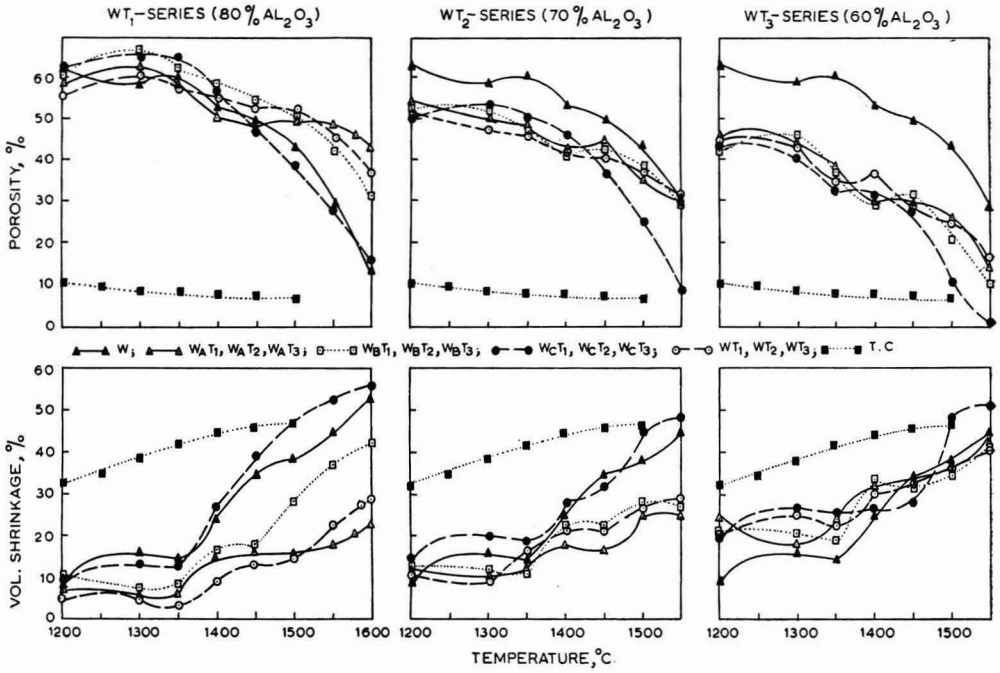

FIG. 1 — POROSITY AND VOLUME SHRINKAGE IN WHITE BAUXITE AND CHINA CLAY MIXES FIRED AT DIFFERENT TEMPERATURES

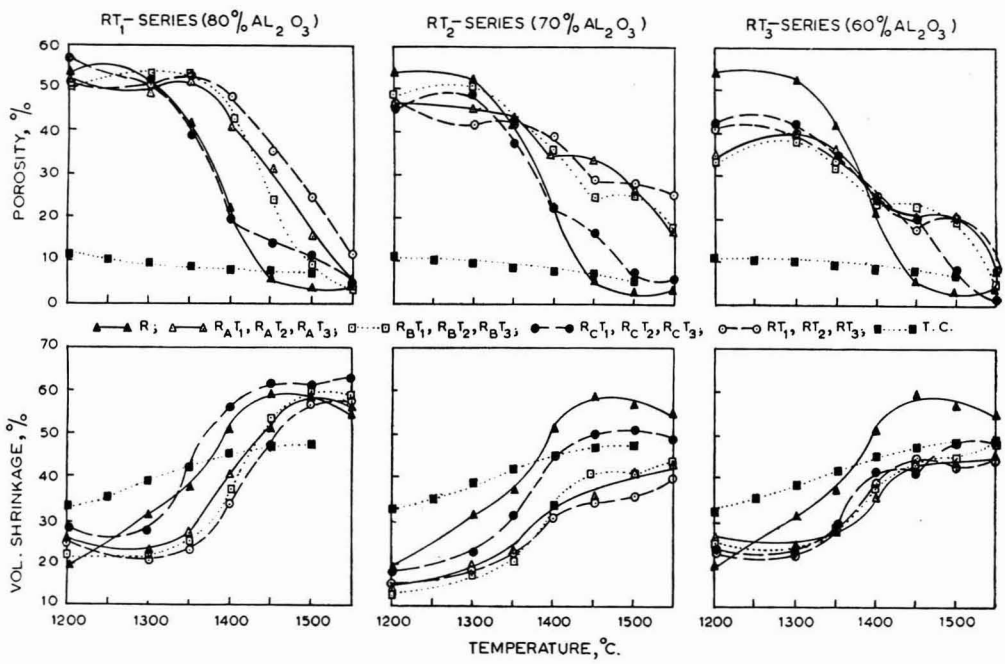

FIG. 2 — POROSITY AND VOLUME SHRINKAGE IN RED BAUXITE AND CHINA CLAY MIXES FIRED AT DIFFERENT TEMPERATURES

it is desirable that the bauxite and the china clay should be mixed as thoroughly as possible and such mixing will be more effective if the raw materials are ground very fine. But fine grinding being a costly operation, it was decided to find out optimum grain size to which bauxite should be ground so that all shrinkage could be removed without having to fire the mix at very high temperatures and that at the same time sufficient conversion to mullite could take place.

From a study of the curves in Figs. 1 and 2, it may be observed that the specimens containing the coarser fractions of bauxite have a higher porosity and lower contraction than those containing −200 mesh bauxite. Porosity and contraction curves for compositions containing three coarser fractions −80+100, −100+150 and −150+200 lie close to each other indicating that there is not much difference in their porosity and contraction when fired to the same temperature, whereas the composition with −200 mesh fractions show much lower porosity and higher contraction.

Removal of combined water from the bauxite and china clay leaves large pore space and on further heating the particles come closer till they touch one another. The coarser particles cannot come as close as the smaller particles and hence the contraction will be less and voids left in between particles being larger, the porosity will be higher. This lower shrinkage and higher porosity of the grog containing coarser fractions of bauxite is seen in all the three series of 80, 70 and 60 per cent Al_2O_3 compositions but as we pass from 80 to 60 per cent Al_2O_3, as the amount of bauxite added decreases, effect of grain size of the bauxite becomes less apparent.

Another general observation that can be made from the shrinkage and porosity curves of 80 to 60 per cent Al_2O_3 grogs, and bauxite and china clay, is that the position of the curves for the grogs, as their composition varies from 80 per cent Al_2O_3 to 60 per cent Al_2O_3, shifts from above the bauxite curves to a position in between the curves for bauxite and china clay. This is due to the increase in the percentage of china clay in 60 per cent Al_2O_3 grog as china clay has a much lower porosity than bauxite fired to the same temperature. In shrinkage curves also there is a similar trend but the shift is not as much as in the case of the porosity curves.

In the porosity curves for white bauxite, a hump is observed between 1300° and 1400°C. with a maximum at 1350°C. indicating an increase in porosity. There is a corresponding depression in the volume shrinkage curve indicating an expansion in this region. The possible explanation for this expansion and increase in porosity is probably the formation of mullite, as the raw white bauxite contains about 8 per cent SiO_2, which when fired would amount to 11·5 per cent (Table 1), and this would form approximately 40 per cent mullite with consequent expansion. In the case of red bauxite, no hump is observed in the porosity curve. This may be attributed to liquid formation at a lower temperature because of the higher iron oxide content and lesser mullite formation due to less SiO_2 in the bauxite.

Taking the compositions individually, it is seen from the porosity and shrinkage curves that for the 80 per cent Al_2O_3 grog with white bauxite (WT_1 series), bauxite should be ground to −200 mesh and bauxite-china clay mix fired to 1600°C. This would remove all the contraction and also bring down the porosity of the grog to below 15 per cent, so that when the final brick is made, using such a grog, there would not be any further contraction and the porosity also would be within reasonable limits of 25 to 30 per cent. If coarser grain bauxite is used, firing at 1600°C. will not remove all the shrinkage and porosity of the grog will also be high. If the mix containing −200 mesh bauxite is fired at a temperature lower than 1600°C., then also the porosity of the grog will not be sufficiently low and all the contraction will not be removed.

Reasoning on similar lines as above, it may be observed that for the 70 per cent Al_2O_3 composition with white bauxite (WT_2 series), bauxite should be ground to −200 mesh and the bauxite-china clay mix fired to 1550°C. to remove all contraction and to bring down the porosity of the grog below 15 per cent. In the case of 60 per cent Al_2O_3 composition with white bauxite (WT_3 series), it should be possible to remove all the contraction and bring down the porosity of the grog to about 15 per cent by using −80 mesh bauxite and firing to 1550°C.; with −200 mesh bauxite this could be achieved by firing at 1500°C. Firing at a higher temperature being a costly operation, finer grinding and firing at a lower temperature should prove more economical. Compared to the white bauxite compositions, those with red bauxite vitrify at a much lower temperature. Whereas white bauxite fired at 1600°C. shows about 15 per cent porosity, red bauxite attains this porosity between 1400° and 1450°C. This is evidently due to the much higher Fe_2O_3 content of the latter which forms glass and causes vitrification. Red bauxite when fired at above 1450°C. shows some bloating. Normally compositions having a larger amount of bauxite should show a higher porosity but with red bauxite compositions after firing beyond a certain temperature, when glass formation starts, it is observed that compositions having more china clay than bauxite show a higher porosity, e.g. at 1450°C., the porosity of R_CT_1 (13·4 per cent) is less than that of R_CT_2 (16·5 per cent)

which is less than that of R_CT_3 (20·0 per cent). This must be due to more glass formation in the compositions containing higher percentage of bauxite because of the higher Fe_2O_3 content of the bauxite as compared to china clay.

In all the three series of 80, 70 and 60 per cent Al_2O_3 compositions with red bauxite, maximum shrinkage occurs on firing to 1450°C. and corresponding porosities of the grog are very low due to vitrification. Therefore, though shrinkage can be removed at a lower temperature, as this is attained by a larger amount of glass formation, it is likely to affect other properties like refractoriness under load, spalling resistance, etc., of the brick made with this grog. This inference is substantiated by the calculated values for liquid formation at the firing temperatures (Table 3). Hence 80 and 70 per cent Al_2O_3 compositions (RT_1 and RT_2 series) which contain approximately 13 and 9 per cent Fe_2O_3 respectively and form more than 20 per cent liquid at 1500°C. may not be suitable as refractory bodies. Since the 60 per cent Al_2O_3 composition with red bauxite has 5·4 per cent Fe_2O_3 and 6·74 per cent total fluxes, it may be possible to reduce the total flux content below 5 per cent by blending red and white bauxites in requisite proportions and mixing enough Travancore china clay to give 60 per cent Al_2O_3 composition. By this means it should be possible to reduce the flux content and at the same time remove all the shrinkage by firing at 1500°C. The porosity of this grog would be below 15 per cent.

The P.C.E. of the raw materials as well as of the different mixes are given in Table 4. Among the compositions containing different grain size fractions of bauxite, the P.C.E. of those containing —200 mesh fractions have been determined as these are likely to have the lowest P.C.E. amongst the series, due to fine grinding and more intimate mixing which should lead to better reaction. In the case of white bauxite and mixes containing white bauxite, the P.C.E. seems to depend upon the alumina content, as the total amount of fluxes is less than 5 per cent. In the case of red bauxite and mixes containing red bauxite, the much higher amount of fluxes, especially Fe_2O_3, affects the P.C.E. values. The drop in P.C.E. value is only less than 2 cones between red bauxite (80 per cent Al_2O_3) and the composition R_CT_3 (60 per cent Al_2O_3 composition), though there is a difference of 20 per cent in their alumina content. This is due to the simultaneous reduction of fluxes from 13 per cent to about 5 per cent in the lower alumina compositions. The addition of china clay which is low in fluxes and which has a P.C.E. of Orton cone 35 actually improves the refractoriness of the red bauxite clay mixes by lowering the iron oxide and other flux contents.

TABLE 4 — MINERAL COMPOSITION CALCULATED FROM PHASE DIAGRAM

Composition Code No.	Temp. at which initial liquid forms °C.	Liquid		Mineral phases		
		At temp. °C.	Amount %	Corundum %	Mullite %	Cristobalite %
WT_1	1460	1460	7·23	43·37	49·70	—
		1550	10·60	44·80	44·70	—
		1600	13·40	46·75	39·85	—
WT_2	1380	1380	Trace	—	94·65	—
	1460	1460	5·35	—	93·40	—
		1550	6·60	—	92·70	—
		1600	7·30	—	—	—
WT_3	1380	1380	3·70	—	81·60	14·7
		1500	6·00	—	81·00	13·0
		1550	11·40	—	80·00	8·6
		1570	21·00	—	79·00	—
RT_1	1460	1460	25·80	69·00	5·20	—
		1500	30·20	69·80	—	—
		1550	31·60	68·40	—	—
RT_2	1460	1460	19·25	22·10	58·65	—
		1500	24·50	24·60	50·90	—
		1550	43·00	20·60	36·40	—
RT_3	1380	1380	17·20	—	79·60	3·2
		1480	22·20	—	77·80	—
		1500	23·80	—	76·20	—
		1580	26·10	—	73·90	—

Specific gravities of the compositions after firing at different temperatures given in Table 4 give an idea of the mineral composition, though calculating mineral composition from specific gravity values will be impracticable due to the complex nature of the fluxes present and the formation of solid solutions. In general, red bauxite compositions have a higher specific gravity compared to the corresponding white bauxite compositions which may be due to the higher iron oxide content. The specific gravity values of the 80 per cent Al_2O_3 compositions indicate that they are high in corundum. The specific gravity values of the 70 per cent Al_2O_3 compositions, which should have more than 90 per cent mullite, indicate the presence of mullite solid solution with Fe_2O_3 or incomplete reaction between corundum and silica to form mullite or a combination of both, as the specific gravity values are slightly more than that of pure mullite which should be 3·03.

Phase equilibrium considerations — In a detailed study of relationships at liquidus temperatures for the system iron oxide-Al_2O_3-SiO_2, Maun[1] has observed that the development of liquid in this system is affected significantly by the oxygen pressure of the atmosphere. At low oxygen pressures, a liquid phase may appear at temperatures as low as 1088°C., whereas at 0·21 atm. oxygen pressure, the lowest temperature of liquid formation is 1380°C. Fig. 3 represents the phase equilibrium diagram suggested by Maun illustrating phase relationships at liquidus tempera-

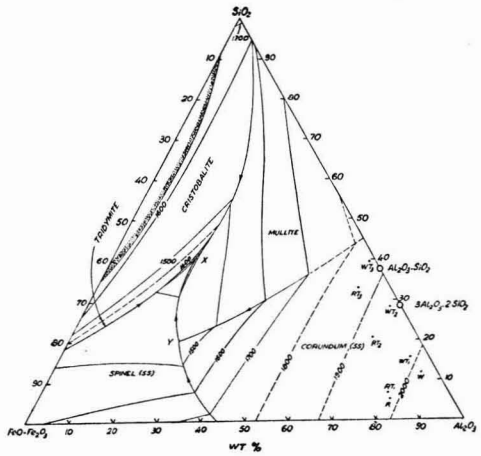

FIG. 3 — PHASE RELATIONSHIPS AT LIQUIDUS TEMPERATURES IN THE SYSTEM IRON OXIDE-Al_2O_3-SiO_2 IN AIR (AFTER MAUN[1])

tures in the system iron oxide-Al_2O_3-SiO_2 in air. This is a projection into the plane Fe_2O_3-Al_2O_3-SiO_2 of the phase equilibrium in the 0·21 atm. oxygen isobaric surface.

The location of the compositions studied are indicated in the triaxial phase diagram. Due to the formation of solid solutions and change in the Fe_2O_3/FeO ratio with change in the oxygen partial pressure, exact calculation of the mineral phases to be expected when fired to different temperatures and cooled subsequently is rather difficult and tedious. But, from the location of the composition points in the triangle, the final products of crystallization for these compositions may be summarized as follows:

WT_1, RT_1 and RT_2: Corundum (SS), mullite (SS)
WT_2 and RT_3: Mullite (SS)
WT_3: Mullite (SS) and cristobalite

where SS stands for solid solution.

Petrographic study — Both white and red bauxites consisted mostly of gibbsite with more quartz in the white bauxite and iron oxide in the red variety (Figs. 4 and 5). Black specks of magnetite, limonite and haematite were also observed in both the bauxites. In general, in mixes which contained finer mesh bauxite, on firing, the reaction appeared to be more complete, compared to specimens containing coarser mesh bauxites. But in the extent of mullitization, much difference could not be detected between those specimens containing finer mesh bauxites and the corresponding specimens with coarser mesh bauxites due to the very fine nature of the crystallites. Where reaction was complete, the grains were transparent and crystalline, whereas in other cases, grains appeared amorphous with a hazy cloud-like appearance. Specimens containing more china clay as well as those fired at lower temperatures showed more haziness. Corundum as well as mullite crystals appeared to have a range of refractive index indicating the existence of solid solution. Some of the specimens showed both corundum and cristobalite though according to phase equilibrium considerations these should not be present, thereby indicating that complete reaction had not taken place.

In the 80 per cent Al_2O_3 specimens containing bauxite fired at 1300°C. there was mostly corundum with a good amount of cristobalite and very little mullite. At higher firing temperatures the amount of mullite increased. At 1600°C. there was more corundum, less mullite and no cristobalite (Fig. 6). The corresponding red bauxite specimens were highly vitrified, and reddish brown to black in colour. Iron oxide was present partly as haematite and partly as magnetite in solid solution. Corundum content was more in the red bauxite specimens. This is due

FIG. 4 — PHOTOMICROGRAPH OF SHEVAROY WHITE BAUXITE × 30 [Bauxite grains are seen with specks of Fe_2O_3]

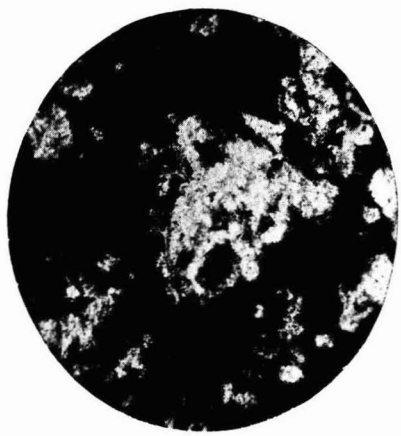

FIG. 5 — PHOTOMICROGRAPH OF SHEVAROY RED BAUXITE × 30 [Transparent, bauxite; black, Fe_2O_3]

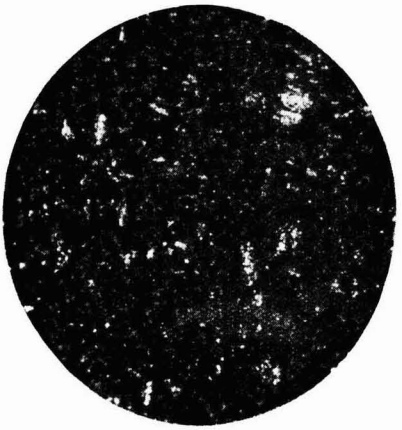

FIG. 6 — PHOTOMICROGRAPH OF 80 PER CENT Al_2O_3 COMPOSITION FIRED AT 1600°C. × 30 (CROSSED NICOLS) SHOWING CORUNDUM AND MULLITE

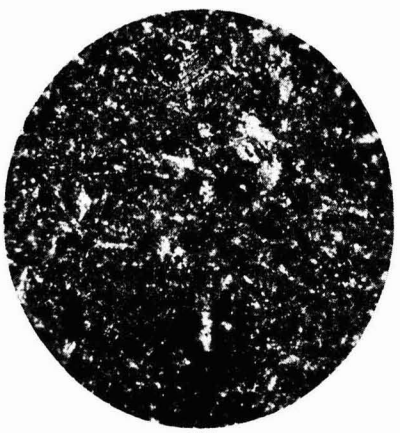

FIG. 7 — PHOTOMICROGRAPH OF 70 PER CENT Al_2O_3 COMPOSITION FIRED AT 1550°C. × 30 (CROSSED NICOLS) SHOWING MOSTLY MULLITE WITH SOME CORUNDUM

to the lesser amount of silica as compared to the corresponding white bauxite specimen.

In the 70 per cent Al_2O_3 compositions, the white bauxite specimens showed haziness and lack of crystallinity. At lower temperatures though mullitization had commenced, corundum and cristobalite were also present in appreciable quantities. At 1550°C. more than 90 per cent was mullite with a few grains of corundum and glass (Fig. 7). A few pleochroic bluish tinted well-developed crystals, probably of mullite, were also observed. The corresponding red bauxite specimens had more corundum surrounded by dark coloured glass. Iron oxide was present as haematite. No magnetite was observed. Reaction appeared to be complete at 1500°C. as there was no cristobalite or haziness of the grains.

In the 60 per cent Al_2O_3 compositions, which contained about 55 per cent china clay, the haziness of the grains persisted even at 1550°C. and along with mullite, corundum and cristobalite were present in the white bauxite specimens. In the corresponding red bauxite specimens, there was very little corundum and more mullite with haematite in solid solution, imparting pinkish red colour to the grains. A few grains of magnetite were also observed.

Summary and conclusions

1. Phase equilibria considerations as well as sintering shrinkage and porosity of the specimens fired at different temperatures indicate that red bauxite will not be suitable for high alumina refractories having 80 or 70 per cent alumina due to the deleterious effect of high iron oxide content.

2. For white bauxite mixes with 80 per cent alumina, grinding the bauxite to −200 mesh and firing the bauxite-china clay mix at 1600°C. would ensure removal of all shrinkage from the grog and reduce its porosity to below 20 per cent.

3. In the case of the composition with 70 per cent alumina, grinding the white bauxite to −200 mesh and firing the bauxite-china clay mix at 1550°C. produces a dense grog.

4. In the case of the 60 per cent alumina composition with white bauxite, the bauxite need be ground to −80 mesh and the bauxite-clay mix fired at 1550°C. to obtain a dense grog with low porosity. If the bauxite is ground finer, the firing temperature for the preparation of grog could be lowered.

5. It may be possible to use the red bauxite, which is of inferior quality, in the 60 per cent alumina composition, if it is blended with white bauxite so as to lower the Fe_2O_3 content to a maximum of 5 per cent in the fired state. This product should give fairly good service if not subjected to reducing condition in service.

Grog of 80, 70 and 60 per cent alumina prepared from Shevaroy bauxite as suggested above should be suitable for the manufacture of high alumina refractories of the respective classes having good refractory properties.

Acknowledgement

The author wishes to express his grateful thanks to Shri Gurbux Singh for help in the experimental work. Thanks are also due to Shri P. Prabhakaram and Shri Gurdial Singh for chemical analyses of the raw materials, to Shri M. R. K. Rao for his suggestions and help in the petrographic study and to Dr B. R. Nijhawan for his interest in the work.

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Examination of Cinders from a High Ash Coal & Its Possible Utilization

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Cinders from a high ash Indian coal have been found to consist of two distinct fractions on the basis of wettability and water dispersibility of the particles. The water-dispersible fraction (mostly argillaceous in nature) is not a desirable constituent of the cinder, when the latter is used as a building material, because the concretes prepared from the untreated cinders possess low mechanical strength and develop cracks on ageing. A simple method based on hydraulic elutriation has been found suitable for the resolution of the cinder into a water-stable and a water-dispersible fraction. The water-stable fraction may be utilized with advantage as a coarse aggregate in building mortars and road stabilizers, and the other fraction as a fine siliceous filler material.

CINDERS, which are the unburnt residue from a coal-fired furnace, are chiefly made up of inorganic aggregates mixed with some unburnt carbonaceous matter in the form of graphite particles. The relative proportion of the inorganic and carbonaceous matter in the cinder depends on the percentage of ash in the coal used, fusibility of the coal ash and its clinker-forming propensity as well as method of stoking the coal in the furnace, distribution of heat in the fuel bed, etc. The composition of the inorganic constituents in the cinder is highly variable and they are essentially of two types: (i) inert ignited oxides and silicates of aluminium, iron, calcium, etc., derived from the effect of heat on the argillaceous and pyritic constituents of the 'free ash'[1] in original coal and (ii) some silicates and aluminates of alkali and alkali earth metals formed by the incipient fusion and interaction of the fusible oxides, carbonates, sulphides and sulphates present as 'fixed ash' in coal with the argillaceous matter in coal. These silicates and aluminates can be hydrated and hydrolysed, and are capable of developing strength by reacting with lime. The relative amount of these varieties of inert ignited refractory oxides and silicates to that of the puzzolanic materials in a cinder depends obviously on the chemical composition and fusibility of the coal mineral matter and particularly on the ratio of 'free ash' to 'fixed ash' in coal.

The commercial utilization of a cinder as light aggregate in mortar, abrasive powders, reinforcing fillers in rubber, textile industries and sometimes as puzzolanic additives in road stabilizers, building materials, etc., depends primarily upon the relative proportions of inert silicates, aluminates, oxide materials and the materials of puzzolanic activity as well as on the amount of carbon and its graphitic nature in the cinder. But the essential factors other than the chemical composition of the cinder are the physical texture, size distribution and other physical properties such as wettability, water-dispersibility and hardness of the particles. It is sometimes necessary to resolve a cinder aggregate into a number of fractions on the basis of some physical property of the particles to get the desirable function from each fraction.

The present paper reports the results of an investigation into the chemical composition and physical properties of a sample of cinder from a high ash Indian coal and points to a possible way of utilizing it.

Experimental procedure

The cinder sample was examined qualitatively for its acidic and basic radicals, and its moisture content, chemical composition and unburnt coke content were determined in the usual manner.

The cinder was tested for its suitability as a light aggregate in cement mortar after pulverizing it to a fine powder in a ball mill and by testing the concrete blocks formed for tensile strength.

Results

The cinder, on qualitative examination, revealed the presence of the following radicals: basic — Al, Fe, Ca, Mg (trace), Na and K; and acidic — silicate, sulphide, sulphate and carbonate (trace).

The cinder, on analysis, was found to contain: moisture, 6·8; silica, 42·2; alumina, 12·2; ferric oxide, 2·9; calcium oxide, 5·9; magnesia, 0·8; alkalies, 1·8; S (SO_3), 2·9; and unburnt coke, 26·2 per cent.

The cinder can be divided into three portions on the basis of its solubility in water and mineral acid: (1) a water-soluble portion (nearly 3 per cent), faintly alkaline, and showing the presence of sulphides of sodium, potassium, calcium and traces of soluble sulphates; (2) a mineral acid-soluble fraction (40 per cent) comprising chiefly aluminium, iron, calcium and traces of alkali metals with silicates and sulphides as acidic radicals; and (3) a mineral acid-insoluble portion (50 per cent) consisting mainly of ignited fused particles in which aluminium, silicon, iron and calcium are detected. It is supposed that the particles consist of alumina, silica, ferric oxides, aluminium silicate, etc.

The tensile strength developed in standard cement concrete blocks made from compositions in which cinders are used in place of sand is given in Table 1.

The results given in Table 1, and the fact that the concrete blocks develop cracks on standing, show that the crude cinder is not a suitable aggregate in cement mortar.

The cinder particles exhibit some peculiarity in their behaviour with respect to the action of water on them. When the cinder is kept in contact with water, it swells up and the fine particles of the cinder get dispersed. The muddy dispersion carrying the fine particles can be easily separated from the coarse aggregate of the cinder. Fractionation of two types of aggregates may be hastened up by agitation and heating.

Water breaks up the cinders on prolonged contact and agitation into two fractions, A and B. Fraction A is an extremely fine fraction easily peptized out by water in the form of a muddy suspension. Being elutriated out from the cinder, this muddy suspension yields ultrafine particles, argillaceous in character. This mud is not plastic and presents a leafy structure like that of mica. Fraction B is a water-stable coarse aggregate consisting chiefly of ignited fused oxides and silicate materials mixed up with some coke particles.

TABLE 1 — TENSILE STRENGTH OF CEMENT CONCRETE USING CINDERS

Composition of concrete (*parts*)			Tensile strength after 7 days
Cinder	Cement	Sand	*lb./sq. in.*
nil	1	3·0	298
0·5	1	2·5	254
1·0	1	2·0	220
3·0	1	nil	198

Fraction B, on fine grinding, does not set and harden when it is reacted with lime in the presence of water. Thus, the water-stable fraction of the cinder has poor puzzolanic activity. Trial experiments with this fraction, for use as a light aggregate in cement mortar, showed some promise. The cracks that developed in the concretes made by using the crude unfractionated cinder were not observed in the concrete blocks prepared from this fraction. The tensile strength of the standard concrete block prepared by using the water-stable fraction of the cinder and cured for 7 days was found to be 245 lb./sq. in., which is higher than that obtained for concrete (198 lb./sq. in.) obtained by using crude untreated cinder in place of sand.

Discussion

The low crack resistance of the concretes prepared from untreated crude cinders may be primarily connected with the high sulphur content of the cinders[2]. But the presence of the non-puzzolanic water-peptizable mud fraction in the cinder seems to be partly responsible for lowering the mechanical strength of the setting gel formed by the hydration and hydrolysis of portland cement when the latter is used with the crude cinder in concrete. Removal of this water-dispersible fraction by hydraulic classification renders the water-stable residue quite suitable as a mortar constituent. The water-dispersible fraction of the cinder, being very finely divided, may be used as a filler material in textile, rubber and paper industries.

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Chemical Examination of the Grading of Flue-cured Tobacco

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The adequacy of procedures for grading flue-cured tobacco, on the basis of chemical composition of the leaves, has been examined, since the grading of flue-cured tobacco in India is done mostly on the basis of colour while in U.S.A. the stalk position is also taken into consideration. Chemical examination of different grades of flue-cured tobacco grown on non-manure, farm yard manure and nitrogen-phosphorus-potassium treated plots in a manurial experiment, has shown that on the basis of chemical composition, the grades of tobacco fall into two categories: grades 1-4 which are classified as good, and grade 5, light medium green and dark green, which are classified as poor. Grades 1-4 are characterized by high ash content, low total nitrogen, high soluble solids and total sugars, and high Kovalenko and Schmuck ratios, while the reverse is the case with the other grades.

THE flue-cured tobacco in India is graded according to the specifications prescribed in the Tobacco Grading and Marketing Rules[1]. The first four grades according to this schedule possess yellow to orange colour with sponginess extending from zero in the first grade to about 25 per cent of the area in the fourth grade. The fifth and sixth grades consist of light brownish yellow-coloured leaf with blemishes extending from 25 to 50 per cent of the area (L.B.Y.1 and L.B.Y.2). The seventh and eighth grades consist of brown and dark brown-coloured leaf with blemishes not exceeding 40 per cent of the area (B. and D.B.). In addition to these, there are the light green (L.G.) and light medium green (L.M.G.) grades with blemishes not exceeding 10 and 25 per cent of the area respectively. The dark green (D.G.) grade consists of leaf which does not fall in the light green or light medium green categories.

A simplified grading procedure is followed at the Tobacco Research Sub-station, Guntur, and Central Tobacco Research Institute, Rajahmundry. According to this, a mixture of grades 1 and 2 of Agmark is classified as grade 1 and that of 3 and 4 of Agmark as grade 2. L.B.Y.1 (grade 3) and L.B.Y.2 (grade 4) and D.G. are the same as the Agmark grades. Grade 5 is a mixture of B. and D.B. of Agmark and grade L.M.G. is a mixture of L.G. and L.M.G. of Agmark. Thus the grading of flue-cured tobacco in India is based mostly on the colour of the leaf, though body and texture are also taken into consideration; no reference, however, is made to the stem position. In the United States of America, on the other hand, the leaf is primarily divided into (1) scrap trash, (2) trash lugs, (3) sand lugs, (4) good lugs, (5) best leaf, (6) second leaf, (7) tips, and (8) trash tips which indicate positions on the stem of the plant from bottom to top in the above-mentioned order[2]. These are then divided into further grades on the basis of colour, body and texture. The present investigation is a preliminary study undertaken to ascertain how far the present grading procedure adopted in India is justified on the basis of the chemical composition of the different grades.

Materials and methods

The material used in these investigations is the cured leaf of the variety Harrison Special obtained from the No-manure, F.Y.M.- and N.P.K.-treated plots of a manurial experiment, Tobacco Research Sub-station, Guntur, in 1946. In the F.Y.M.-treated plots, farm yard manure was applied at the rate of 3 tons per acre about one month prior to transplanting, and in the N.P.K.-treated plots a mixture of 20 lb. nitrogen as ammonium sulphate, 20 lb. P_2O_5 as superphosphate and 50 lb. K_2O as potassium sulphate was applied about a week before transplanting. The cured leaf obtained from these plots was graded according to the grading procedures of the Tobacco Research Sub-station, Guntur. Leaves of each grade from all the replicates of these treatments were mixed

TABLE 1 — COMPOSITION OF THE LEAF GRADES OBTAINED

(Values expressed on oven-dry basis)

GRADE DESIGNATION	TOTAL N %	P_2O_5 %	POTASH %	TOTAL SUGARS %	REDUCING SUGARS %	SUCROSE %	IN-SOLUBLE N (PROTEIN N) %	AMMONIA N %	AMIDE N %	NICOTINE N %	SOLUBLE SOLIDS %	ASH %
No-manure grade												
1	1·33	0·36	2·97	20·83	12·84	7·99	0·70	0·015	0·02	0·14	54·93	17·56
2	1·54	0·31	2·71	20·95	12·35	8·60	0·74	0·010	0·03	0·17	56·53	17·01
3	1·54	0·24	2·67	19·23	14·84	4·39	0·68	0·019	0·04	0·21	54·45	17·36
4	1·49	0·27	2·07	22·72	18·32	4·40	0·55	0·012	0·02	0·21	57·27	15·90
5	1·69	0·36	1·72	17·92	11·19	6·73	0·75	0·015	0·04	0·17	54·14	14·81
L.M.G.	1·58	0·32	2·75	15·73	11·99	3·74	0·67	0·019	0·04	0·14	48·82	15·05
D.G.	1·76	0·33	3·19	16·05	10·35	5·70	0·86	0·019	0·05	0·13	49·51	15·45
Av.	1·56	0·31	2·58	19·06	13·13	5·94	0·71	0·016	0·037	0·17	53·81	16·16
F.Y.M. grade												
1	1·45	0·36	2·94	20·99	17·58	2·71	0·61	0·012	0·07	0·15	53·39	16·43
2	1·61	0·32	2·15	22·83	21·49	1·34	0·54	0·015	0·06	0·23	57·85	17·17
3	1·57	0·28	2·80	21·42	17·44	3·98	0·51	0·010	0·05	0·20	56·74	18·23
4	1·76	0·25	2·46	21·34	18·88	2·46	0·68	0·016	0·03	0·19	54·34	16·93
5	1·71	0·32	2·84	17·13	13·44	3·69	0·75	0·016	0·04	0·15	48·22	15·32
L.M.G.	1·74	0·31	2·74	12·64	9·55	3·09	0·92	0·009	0·05	0·15	47·42	14·87
D.G.	1·72	0·33	2·89	10·36	10·23	0·13	0·78	0·012	0·05	0·14	44·53	15·61
Av.	1·75	0·31	2·69	18·00	15·36	2·49	0·68	0·013	0·050	0·17	51·78	16·08
N.P.K. grade												
1	1·48	0·34	3·24	22·35	14·94	7·41	0·71	0·010	0·08	0·14	56·41	17·27
2	1·46	0·31	3·43	19·39	14·41	4·98	0·63	0·007	0·06	0·16	55·34	17·36
3	1·41	0·28	2·99	18·26	18·26	0·00	0·58	0·008	0·08	0·17	55·35	16·90
4	1·60	0·26	2·82	21·88	15·72	6·16	0·73	0·011	0·06	0·21	55·39	17·69
5	1·62	0·37	2·26	19·21	13·20	6·01	0·78	0·014	0·08	0·18	50·48	13·44
L.M.G.	1·62	0·33	2·69	12·71	12·32	0·39	0·77	0·013	0·05	0·14	49·97	15·11
D.G.	1·81	0·33	2·61	10·60	8·01	2·59	0·99	0·008	0·06	0·13	47·51	15·80
Av.	1·57	0·32	2·86	17·77	13·84	3·96	0·76	0·010	0·067	0·16	52·92	16·08

and composite samples of each grade were taken for chemical analysis. Material from these three treatments was chosen in order to take into account the effects of manuring also on the chemical composition of the different grades. The graded samples were dried at 60-65°C. in a current of air, powdered and analysed for important constituents. The methods of analysis followed have been described in a previous communication[3]. In addition, P_2O_5 and K_2O were determined by the A.O.A.C. methods (1945) for plant samples.

Results and discussion

The results presented in Table 1 show that F.Y.M. appears to increase the total nitrogen content of different grades, while N.P.K. treatment appears to increase the potash content slightly. The P_2O_5 content of the different grades is not affected by fertilization. On the basis of average values, fertilization with F.Y.M. or N.P.K. appears to decrease total sugars and increase amide N.

In the grades themselves the following trends are observed:

(1) In all the treatments, the ash content is higher in the higher grades, while there is a sharp fall in the brown and green grades.

(2) The phosphates are higher in the highest and lowest grades while they are intermediate in intermediate grades.

(3) The distribution of nicotine appears to be the reverse of P_2O_5 distribution.

(4) The soluble solids and sugars are high in the yellow grades and fall off in the brown and green grades. The reverse is true of total nitrogen.

In a study of this kind it is necessary to ascertain if quality, as determined by the present grading procedure, tallies with quality as determined by the various chemical constituents that are known to represent quality in flue-cured tobacco. According to Darkis *et al.*[2], total sugar is the only constituent which shows a direct relation with quality. Schmuck[4] thought that the ratio of carbohydrates to proteins would furnish a fair index of quality, while Kovalenko[5] and Blick[6] preferred the ratio of carbohydrates to nitrogen excluding nicotine nitrogen. These ratios are presented in Table 2.

The data presented in Table 2 show that none of the ratios described in literature is particularly correlated with quality as judged by the present grading system. On the basis of these ratios the leaf can be divided only into two broad categories: grades 1 to 4 which are high in sugars, and Kovalenko's and

TABLE 2 — QUALITY FACTORS IN DIFFERENT GRADES

GRADE DESIGNATION	TOTAL SUGARS %	KOVALENKO'S RATIO	SCHMUCK'S RATIO
No-manure grade			
1	20·83	17·80	29·76
2	20·95	15·30	28·31
3	19·23	14·45	28·28
4	22·72	17·75	41·31
5	17·92	11·80	23·90
L.M.G.	15·73	10·92	23·47
D.G.	16·05	9·85	18·66
F.Y.M. grade			
1	20·29	15·61	33·27
2	22·83	16·54	42·28
3	21·42	15·63	41·98
4	21·34	13·59	31·38
5	17·13	10·98	22·83
L.M.G.	12·64	7·95	15·42
D.G.	10·36	6·56	13·28
N.P.K. grade			
1	22·35	16·68	31·48
2	19·39	14·91	30·70
3	18·26	14·72	31·49
4	21·88	15·74	29·97
5	19·21	13·34	24·62
L.M.G.	12·71	8·59	16·50
D.G.	10·60	6·31	10·71

Schmuck's ratios; and grade 5, light medium green and dark green, which are low in these constituents. The good grades are further characterized by high ash content, low total nitrogen and high soluble solids, while the reverse is the case with brown and green grades.

It has been observed earlier that the American system of grading takes into account the position of the leaf on the stem of the plant. Whether the adoption of the American system of grading results in better correlation between the chemical composition and grade is a matter for further investigation.

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Corrosion of Steel: Part III—Protective Behaviour of Some Paints

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The corrosion of steel coated with paints prepared by mixing single pigments, viz. chromates, molybdates and tungstates of zinc and lead, with raw linseed oil, has been investigated by immersing the test specimens for different intervals in salt solution and measuring the change in the electrode potentials.

Zinc chromate and molybdate give satisfactory protection against corrosion of steel by salt solution. Protection by zinc chromate is due to the formation of an impervious paint coating on steel and in the case of zinc molybdate, protection is due to both chemical and mechanical effects. Zinc tungstate behaves similar to zinc molybdate, but its protective value is slightly less than that of zinc molybdate. Lead paints afford protection to steel during the initial stages of immersion in salt solution, but gradually break down when the coatings remain exposed to the action of salt solution for prolonged periods.

THE passivating action of sodium chromate, molybdate and tungstate solutions on iron in the presence of air was investigated by Robertson[1]. Pryor and Cohen[2] studied the corrosion inhibitive behaviour of these compounds and found that sodium molybdate and tungstate failed to inhibit the corrosion of iron in the absence of oxygen. Choudhury and Shome[3] investigated the

inhibitive properties of chromates, molybdates and tungstates of zinc and lead against the corrosion of steel and observed that when the paints were prepared by mixing single pigments with linseed oil, zinc molybdate in the paint retained its corrosion inhibitive property whereas zinc chromate afforded no inhibition.

Burns and Haring[4], and Haring and Gibney[5] measured the electrode potentials of painted iron specimens immersed in salt water in assessing the protective value of paints against corrosion. A positive potential indicates passivity and a change of the potential in the negative direction suggests that the specimen has undergone corrosion. These workers followed the corrosion behaviour of painted specimens with the help of the potential/time curves. Among the pigments investigated by Burns and Haring, who undertook short-term experiments extending up to 20 hr, zinc chromate, and to a lesser extent red lead, showed remarkable protection. The electrode potential technique was later employed by other investigators for the evaluation of paint coatings. Wormwell and Brasher[6] showed that in assessing the ultimate protective value of the paints, conclusions drawn from the shape of the potential/time curves during the first few hours (or even days) may be misleading. Greenblatt[7] recently observed that shortly after immersion, the potential of a painted metal becomes more noble than the bare metal and as the paint deteriorates, the potentials approach those of the substrate metal. In the present study, the electrode potentials of painted steel specimens have been measured over a period of ten days in order to make a comparative study of the protective properties of single-pigment paints prepared from chromates, molybdates and tungstates of zinc and lead.

Experimental procedure

Painting of steel specimens — Specimens (6 × 2 cm.) were cut from cold-rolled mild steel strip and the surface prepared as described in an earlier paper[8]. Chromates, molybdates and tungstates of zinc and lead were prepared in the pure state[3] and employed as pigments (metallic zinc and red lead were taken for comparison). Zinc chromate pigment was prepared as the basic compound, i.e. zinc oxychromate. Each pigment was ground and passed through a 200-mesh sieve. The paints were prepared by mixing the pigments separately with raw linseed oil (commercial) to give a workable paste. The compositions of the paints are given in Table 1. The paints were applied uniformly with a brush to the steel specimens over an area of 4 × 2 cm., leaving an area of 2 × 2 cm. bare for electrical connections.

TABLE 1 — COMPOSITIONS OF PAINTS

Pigment	Pigment by wt %	Linseed oil by wt %
Zinc oxychromate	50·5	49·5
Zinc molybdate	50·0	50·0
Zinc tungstate	50·0	50·0
Zinc dust	73·0	27·0
Red lead	76·9	23·1
Lead chromate	72·3	27·7
Basic lead chromate	53·0	47·0
Lead molybdate	64·5	35·5
Lead tungstate	61·1	38·9

The first coat of the paints was allowed to dry for one day, then the second coat applied and the painted specimen allowed to dry for three months.

Corrosion test — Each painted specimen was coated with paraffin wax at the edges and partially immersed in 3 per cent salt solution in an inclined position in a 100 ml. beaker, so that the upper boundary of the paint remained above the liquid level. The progress of corrosion was followed by electrode potential measurements. The electrode potential was measured with reference to a saturated calomel electrode with the aid of a Cambridge valve potentiometer, the electrodes being connected through a saturated KCl-agar bridge. The tests were carried out in triplicates and the average values of potentials recorded. The experiments were continued over a period of ten days and the potential/time curves were drawn from values of the electrode potentials determined at intervals of 24 hr.

Results and discussion

The potential/time curves for the painted steel specimens are shown in Figs. 1 and 2. During the initial stages of immersion in salt solution, the dry paint films remained impervious to water and resisted the flow of electric current. The specimens coated with the zinc molybdate paint prevented the flow of current for *c.* 24 hr and those painted with the zinc chromate afforded complete insulation throughout the duration of the experiment. This makes the determination of potential/time curve for zinc chromate impossible. It thus appears that zinc chromate paint is anticorrosive because it gives mechanical protection to the underlying steel. Linseed oil, in the presence of zinc chromate, perhaps undergoes oxidation and polymerization producing an impervious coating which resists the attack of salt solution. This conclusion is supported by the previous finding that zinc chromate paint, based on raw linseed oil, has no corrosion inhibitive property[3]. Burns and Haring[4], however, obtained time/potential curves for zinc chromate paints employing similar electrode

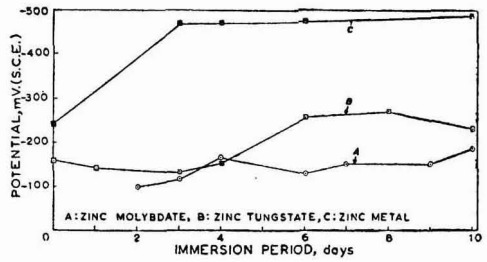

FIG. 1 — POTENTIAL/TIME CURVES FOR STEEL SPECIMENS COATED WITH ZINC PAINTS AND IMMERSED IN 3 PER CENT SALT SOLUTION

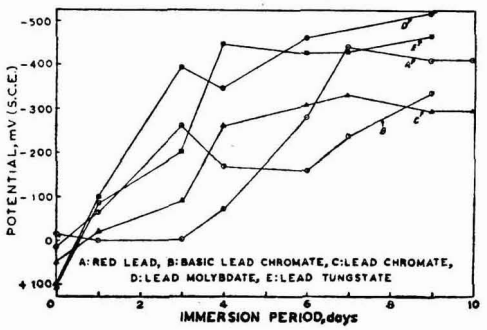

FIG. 2 — POTENTIAL/TIME CURVES FOR STEEL SPECIMENS COATED WITH LEAD PAINTS AND IMMERSED IN 3 PER CENT SALT SOLUTION

potential technique, but the paints were prepared in a different manner. They used varnish-reinforced linseed oil along with the driers and thinners as vehicle, whereas in the present study the vehicle was raw linseed oil only. Kittleberger[9] studied the diffusion of sodium chloride solution through various paint systems and found that the zinc chromate paints are permeable to the liquid. He employed bodied linseed oil as the vehicle and allowed the paints to dry for two weeks only. Zinc chromate pigments employed by Kittleberger were also different in composition from the basic zinc chromate used in the present study. The results of the present investigation are, however, in accord with the view advanced by Wagner[10] who reported that zinc chromate produces a relatively impervious paint film.

The potentials of steel specimens painted with zinc molybdate and zinc tungstate have small negative values and the potential/time curves run almost parallel to the time axis (Fig. 1), indicating that both the paints confer good protection to the steel specimens. Zinc tungstate paint is, however, somewhat less effective than zinc molybdate paint. The protection afforded by metallic zinc paint is comparatively small. Earlier it has been observed by us that zinc molybdate and zinc tungstate paints possess corrosion inhibitive properties[3]. The paint coatings may, therefore, prevent the corrosion of steel both by chemical and mechanical effects. The curves for all the lead paints originate at about zero potential value or on the positive side of the potential scale, suggesting thereby that the paints effectively protect the specimens against corrosion during the initial stages of the corrosion test (Fig. 2). The curves, however, rise gradually to the negative potential side owing to failure of the paint films. In the previous study[3] all the lead paints used in the present investigation were shown to possess feeble corrosion inhibitive properties. The early indication of positive potential in the case of steel specimens coated with the lead paints, therefore, suggests that the coatings afford only mechanical protection to the basis metal during the first few days of immersion in the corrosive liquid and afterwards the paint films suffer gradual breakdown.

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Studies in Packaging, Transportation & Storage of Some Edible Vegetable Oils

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The storage lives of 8 edible vegetable oils, viz. refined castor oil, crude coconut oil, crude mustard oil, crude olive oil, crude and refined peanut oils, crude sesame oil and vanaspati, packed in colourless and deep green bottles and stored at 71-93°F. and 138-42°F. have been determined; the two temperature ranges approximate to the temperatures encountered during normal storage and during transport in the tropics. The rates of increase in the acidity of the oils stored in both types of bottles are of the same order in both the temperature ranges, whereas the peroxide values of castor, coconut and crude peanut oils stored at 71-93°F. and of crude mustard and refined peanut oil stored at 138-42°F. were significantly lower when they were packed in coloured bottles. The differences in the storage lives of the oils packed in colourless and coloured bottles at 71-93°F. are significant only in the case of sesame, coconut, castor and crude peanut oils; at 138-42°F., this difference is significant only in the case of refined peanut and mustard oils. A positive correlation has been observed between red/yellow pigment ratios in the oils and their storage lives in both types of containers and at both the temperatures. A high red/yellow pigment ratio in the oils offsets the effects of degree of saturation of the oils and the colour of the container.

EDIBLE vegetable oils are generally transported and stored in metallic containers, thus leading to a great deal of deterioration. King *et al.*[1] have investigated the accelerating effect of Cu, Fe, Mn, V, Ni, Al, Pb, Zn, Sn and Cr stearates on the production of peroxides in lard at 208°F.; acceleration of development of rancidity was found to be highest in the case of Cu stearate and least in the case of tin stearate. The same workers repeated the experiment with strips of some of the metals immersed in lard and found that the relative effects of the various metals on the development of rancidity were different. Cu was found to be active in both the forms. Fe was inactive in solid state whereas Sn in solid form was active. Emery[2] and Emery and Henley[3] have shown that rancidity develops faster when oils and fats are stored in metallic containers or in contact with metals than when they are held in glass vessels. Coe[4] has established that development of rancidity is least when oils and fats are exposed to light in the green region (5400 A.) or in the region above 7400 A. According to Eckey[5] direct comparison between two natural fats would not show a correlation between unsaturation and susceptibility to oxidation as the effect of natural antioxidants is strong enough to obscure this relationship. The influence of (1) nature and type of oil, (2) colour of the glass container in which the oils are stored and (3) storage temperature (simulating the conditions obtaining during transportation) on the keeping quality of the oils has been investigated and the results are presented in this paper.

Materials and methods

Oils — Eight edible vegetable oils, viz. castor (refined), coconut(crude), mustard (crude), olive (crude), peanut (crude), peanut (refined), sesame (crude) and vanaspati (hydrogenated peanut oil with 5 per cent sesame oil), were employed.

Containers — Twenty-six oz. colourless and deep green glass bottles were used.

Storage temperature — The containers were kept at room temperature (71-93°F.) and at 138-42°F. The latter temperature range, as employed in the Schaal test[6], simulates the high-temperature conditions that are likely to be met with during transportation in the tropics under non-refrigerated conditions.

Analysis of oils — Acidity was determined by the method according to Jamieson[7], peroxide value by

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Wheeler's method[8] and iodine value by the Wijs method[9]. Pigment contents of the various oils were estimated in a Lovibond tintometer using a 1 cm. cell in terms of yellow and red colour units.

Storage of oils — The oils, packed in corked colourless and deep green glass bottles with a head space of 1·5 in., were stored at 71-93°F. and 138-42°F. Aliquots (15 g.) of oil for analysis were drawn from the same bottles at monthly intervals from the lot stored at 71-93°F. and daily from the one stored at 138-42°F. The oils kept at 71-93°F. were stored for 2 years and those at 138-42°F. for 35 days. Data at six-monthly intervals in the case of oil samples stored at 71-93°F. and for 7-day periods in the case of oils stored at 138-42°F. are presented in this paper. The lot stored at 71-93°F. was stacked on a laboratory bench exposed to light and the lot at higher temperature was stored in a hot-air oven and exposed to light for 5 min. daily at the time of drawing of aliquots for chemical analysis. This exposure of the higher temperature lot of bottles to light for 5 min. daily in a way simulates the conditions obtaining during transportation. Since the drawing of aliquots of the oils from the same bottles at intervals results in increased air space, necessary correction has been introduced in the values.

Results and discussion

In all the oils stored at 71-93°F., the rates of increase in acidity were the same in both the colourless as well as green glass bottles (Table 1). The rates of increase of peroxides were significantly lower in green bottles in the case of castor, coconut and crude peanut oils at 71-93°F. (Table 2).

In the oils stored at 138-42°F., the rates of increase in acidity were the same in both the types of bottles (Table 3). However, at 138-42°F., only mustard and refined peanut oils showed significantly lower rates of peroxide formation in green bottles as compared to the colourless ones (Table 4).

The data pertaining to the storage lives of various oils at the two temperature ranges are recorded in Table 5. At 71-93°F., the differences in the storage lives of the oils stored in green and colourless glass containers were significant only in the case of sesame, coconut, castor and crude peanut oils. However, in oils stored at 138-42°F., these differences were significant only in refined peanut and mustard oils.

The data recorded in Table 5 were further statistically analysed with reference to the differences in the storage lives of different oils. The analysis showed that the storage lives of oils stored in colourless and green-coloured bottles at 71-93°F. differ significantly from one another except in the case of refined castor oil and crude peanut oil stored in coloured bottles. Of the oils stored in colourless bottles at 138-42°F., those in the following groups did not differ significantly from one another in respect of their storage lives: (i) crude coconut oil, refined castor oil and crude sesame oil; (ii) crude sesame oil

TABLE 1 — CHANGES IN ACIDITY OF OILS STORED AT 71-93°F.

(*Acidity expressed as percentage oleic acid*)

Oil	Colour of bottle	Acidity of oil					Statistical analysis		
		At start	6 months	12 months	18 months	24 months	Rate of increase in acidity	Diff. in rate of increase in acidity (G−C) ± S.E.	Remarks
Castor (refined)	C	0·86	1·00	1·00	0·90	1·05	0·028	−0·003 ± 0·029	N.S.
	G	0·86	0·98	1·00	0·95	1·00	0·025		
Coconut (crude)	C	1·06	1·61	1·70	1·84	2·20	0·251	−0·023 ± 0·070	N.S.
	G	1·06	1·70	1·70	1·90	2·10	0·228		
Mustard (crude)	C	0·55	0·75	0·80	0·86	1·00	0·101	+0·003 ± 0·034	N.S.
	G	0·55	0·88	0·88	0·92	1·05	0·104		
Olive (crude)	C	0·17	0·33	0·25	0·20	0·28	0·009	+0·012 ± 0·028	N.S.
	G	0·17	0·30	0·21	0·25	0·30	0·021		
Peanut (crude)	C	2·05	2·41	2·40	2·58	2·86	0·179	−0·003 ± 0·033	N.S.
	G	2·05	2·30	2·40	2·60	2·78	0·176		
Peanut (refined)	C	0·15	0·28	0·29	0·20	0·28	0·018	0·000 ± 0·028	N.S.
	G	0·15	0·29	0·30	0·23	0·27	0·018		
Sesame (crude)	C	2·10	2·38	2·40	2·50	2·78	0·148	+0·009 ± 0·037	N.S.
	G	2·10	2·37	2·33	2·58	2·78	0·157		
Vanaspati	C	0·11	0·13	0·14	0·14	0·16	0·011	0·000 ± 0·003	N.S.
	G	0·11	0·11	0·12	0·14	0·15	0·011		

C, colourless; G, green; N.S., not significant.

TABLE 2 — CHANGES IN PEROXIDE VALUE OF OILS STORED AT 71-93°F.

(Peroxide value expressed as milliequivalents of peroxide oxygen per kg. of oil)

Oil	Colour of bottle	Peroxide value of oil					Statistical analysis		
		At start	6 months	12 months	18 months	24 months	Rate of increase in peroxide val.	Diff. in rate of increase in peroxide val. (G−C)±S.E.	Remarks
Castor (refined)	C	0·9	3·4	4·7	6·4	6·7	1·46	−0·91±0·303	Significant at 5% level
	G	0·9	3·0	2·6	3·5	3·4	0·55		
Coconut (crude)	C	0·6	1·9	2·4	3·0	3·3	0·65	−0·36±0·115	do
	G	0·6	0·8	1·1	1·7	1·6	0·29		
Mustard (crude)	C	4·7	23·5	38·3	47·7	48·4	11·16	−2·72±2·106	N.S.
	G	4·7	13·2	24·5	29·6	38·7	8·44		
Olive (crude)	C	58·0	74·6	87·5	83·2	88·0	6·86	−2·02±3·427	N.S.
	G	58·0	49·0	72·6	67·0	73·2	4·84		
Peanut (crude)	C	8·0	45·8	54·5	65·0	92·1	18·74	−14·20±2·978	Significant at 1% level
	G	8·0	16·0	23·4	24·2	26·6	4·54		
Peanut (refined)	C	18·0	33·7	40·2	47·0	49·2	7·57	+0·41±1·778	N.S.
	G	18·0	25·0	39·5	45·0	47·9	7·98		
Sesame (crude)	C	15·0	35·3	42·3	44·0	42·0	6·31	−1·88±3·056	N.S.
	G	15·0	25·9	36·0	33·0	33·6	4·43		
Vanaspati	C	4·6	9·8	11·8	12·9	14·0	2·19	−0·14±0·605	N.S.
	G	4·6	9·0	10·6	12·3	13·2	2·05		

C, colourless; G, green; N.S., not significant.

TABLE 3 — CHANGES IN ACIDITY OF OILS STORED AT 138-42°F.

(Acidity expressed as percentage oleic acid)

Oil	Colour of bottle	Acidity of oil						Statistical analysis		
		At start	7 days	14 days	21 days	28 days	35 days	Rate of increase in acidity	Diff. in rate of increase in acidity (G−C)±S.E.	Remarks
Castor (refined)	C	0·52	0·64	0·77	0·81	0·81	0·88	0·067	+0·002±0·017	N.S.
	G	0·52	0·61	0·77	0·81	0·83	0·86	0·069		
Coconut (crude)	C	2·50	2·61	2·64	2·74	2·85	2·88	0·078	−0·002±0·007	N.S.
	G	2·50	2·60	2·65	2·72	2·83	2·88	0·076		
Mustard (crude)	C	0·92	1·06	1·22	1·24	1·38	1·43	0·101	+0·012±0·014	N.S.
	G	0·92	1·06	1·21	1·23	1·44	1·48	0·113		
Olive (crude)	C	0·86	1·02	1·06	1·08	1·17	1·17	0·058	−0·003±0·016	N.S.
	G	0·86	1·02	1·08	1·08	1·16	1·16	0·055		
Peanut (crude)	C	1·33	1·39	1·41	1·45	1·48	1·49	0·032	+0·001±0·004	N.S.
	G	1·33	1·37	1·41	1·45	1·47	1·49	0·033		
Peanut (refined)	C	0·16	0·17	0·17	0·18	0·19	0·19	0·006	0·000±0·001	N.S.
	G	0·16	0·17	0·17	0·18	0·19	0·19	0·006		
Sesame (crude)	C	1·56	1·79	2·03	2·10	2·23	2·27	0·141	−0·016±0·026	N.S.
	G	1·56	1·76	1·94	2·10	2·13	2·18	0·125		
Vanaspati	C	0·09	0·20	0·20	0·17	0·18	0·18	0·010	+0·003±0·012	N.S.
	G	0·09	0·18	0·18	0·17	0·18	0·18	0·013		

C, colourless; G, green; N.S., not significant.

TABLE 4 — CHANGES IN PEROXIDE VALUE OF OILS STORED AT 138-42°F.

(Peroxide value expressed as milliequivalents of peroxide oxygen per kg. of oil)

Oil	Colour of bottle	Peroxide value of oil						Statistical analysis		
		At start	7 days	14 days	21 days	28 days	35 days	Rate of increase in peroxide val.	Diff. in rate of increase in P.V. (G−C) ± S.E.	Remarks
Castor (refined)	C	1·8	2·4	2·8	3·4	3·9	4·8	0·57	−0·063 ± 0·084	N.S.
	G	1·8	2·9	3·0	3·2	3·8	4·8	0·51		
Coconut (crude)	C	1·2	1·5	1·9	2·0	2·1	2·1	0·18	0·000 ± 0·052	N.S.
	G	1·2	1·5	1·9	2·0	2·1	2·1	0·18		
Mustard (crude)	C	2·3	2·2	3·8	5·4	7·4	11·7	1·83	−0·011 ± 0·350	Significant at 2% level
	G	2·3	1·7	2·7	3·8	5·1	5·8	0·82		
Olive (crude)	C	17·6	22·7	28·5	35·9	43·7	42·8	5·61	+0·038 ± 0·840	N.S.
	G	17·6	21·4	27·5	36·2	42·9	42·5	5·65		
Peanut (crude)	C	4·4	6·7	16·0	27·6	35·8	41·8	8·17	−1·598 ± 0·888	N.S.
	G	4·4	6·4	11·7	18·4	28·5	35·8	6·57		
Peanut (refined)	C	15·7	29·6	55·2	75·1	94·0	119·4	20·90	−14·370 ± 0·770	Significant at 0·1% level
	G	15·7	21·5	26·9	33·1	40·3	48·9	6·53		
Sesame (crude)	C	2·7	6·0	13·1	20·3	26·9	30·8	6·01	−0·174 ± 0·540	N.S.
	G	2·7	5·3	9·7	17·3	24·2	30·7	5·84		
Vanaspati	C	2·3	4·1	7·7	11·7	15·6	20·3	3·67	+0·080 ± 0·324	N.S.
	G	2·3	4·7	7·5	11·9	16·0	20·9	3·75		

C, colourless; G, green; N.S., not significant.

TABLE 5 — STORAGE LIVES OF OILS

(Storage lives determined on the basis of organoleptic tests)

Oil	Storage temp., 71-93°F.				Storage temp., 138-42°F.			
	Mean* storage life (*months*)		Diff. in storage life (G−C)	Remarks	Mean* storage life (*days*)		Diff. in storage life (G−C)	Remarks
	C	G			C	G		
Castor (refined)	8·0	10·0	2·0	Significant at 0·1% level	29·0	29·0	0·0	N.S.
Coconut (crude)	11·5	14·0	2·5	do	29·5	30·0	0·5	N.S.
Mustard (crude)	10·5	11·0	0·5	N.S.	18·5	24·5	6·0	Significant at 0·1% level
Olive (crude)	15·5	16·0	0·5	N.S.	27·5	28·5	1·0	N.S.
Peanut (crude)	7·0	9·5	2·5	Significant at 0·1% level	26·5	27·0	0·5	N.S.
Peanut (refined)	16·5	17·0	0·5	N.S.	19·0	25·5	6·5	Significant at 0·1% level
Sesame (crude)	14·0	15·0	1·0	Significant at 5% level	28·5	29·0	0·5	N.S.
Vanaspati	18·0	18·5	0·5	N.S.	33·0	33·5	0·5	N.S.

*Mean of two replications; C, colourless bottle; G, green bottle; N.S., not significant.

TABLE 6 — IOD. VAL., PROTECTIVE FACTOR AND PIGMENT CONTENT OF OIL

Oil	Storage temp., 71-93°F.					Storage temp., 138-42°F.				
	Initial iod. val.	Protective factor	Y	R	R/Y	Initial iod. val.	Protective factor	Y	R	R/Y
Castor (refined)	84·4	0·38	0·6	0·2	0·33	84·7	0·89	0·3	0·2	0·67
Coconut (crude)	8·4	0·45	0·5	0·2	0·40	8·2	1·00	0·3	0·2	0·67
Mustard (crude)	108·0	0·76	2·5	0·9	0·36	108·3	0·45	4·0	1·0	0·25
Olive (crude)	97·6	0·71	0·8	0·4	0·50	98·2	1·01	0·5	0·3	0·60
Peanut (crude)	100·2	0·24	0·8	0·2	0·25	100·5	0·80	0·6	0·2	0·33
Peanut (refined)	100·4	1·05	0·1	0·1	1·00	100·9	0·31	0·3	0·1	0·33
Sesame (crude)	109·1	0·70	1·0	0·5	0·50	109·0	0·97	0·6	0·4	0·67
Vanaspati	78·7	0·94	0·2	0·2	1·00	78·5	1·02	0·1	0·2	2·00

Y, yellow pigment; R, red pigment.

and crude olive oil; (iii) refined peanut oil and crude mustard oil; and (iv) crude olive oil and crude peanut oil. Similarly, in the case of oils stored in green bottles at 138-42°F., the storage lives of oils in the following groups did not differ significantly from one another: (i) crude coconut oil, refined castor oil and crude sesame oil; (ii) refined castor oil, crude sesame oil and crude olive oil; and (iii) refined peanut oil and crude mustard oil.

The data relating to initial iodine values, protective factor and initial pigment contents of the various oils are provided in Table 6. Greenbank and Holm[10] have defined the protective factor as follows:

$$\text{P.F.} = \frac{\text{Peroxide val. of untreated fat}}{\text{Peroxide val. of treated fat}}$$

In our studies we have defined the protective factor as follows:

$$\text{P.F.} = \frac{\text{Rate of increase in peroxide val. in green glass container}}{\text{Rate of increase in peroxide val. in colourless glass container}}$$

The results presented in Table 6 show that the yellow pigment in the oils is a weaker pro-oxidant, weight for weight, as compared to the antioxidant activity of red pigment. Our results on the pro-oxidant activity of yellow pigment are in agreement with those of Greenbank and Holm[10] who have shown that carotene is a pro-catalyst for fat oxidation.

The results given in Tables 5 and 6 show that there is a positive correlation between the red/yellow pigment ratios and the storage lives of the various oils in colourless as well as green glass containers for both the temperature ranges and that the effect of a high red/yellow pigment ratio is dominant enough to offset the effects of the degree of saturation of the oil and of the colour of the glass container. It is also observed that the deterioration of the various oils is much faster at 138-42°F. as compared to that at 71-93°F., and it may not be possible to control it even with adjusting the proportions of red and yellow pigments. Therefore, use of refrigerated transport appears to be essential in the tropics.

Acknowledgement

Our thanks are due to Dr V. Subrahmanyan, Director, for his keen interest in this investigation. Our thanks are also due to Shri A. N. Sankaran for the statistical analysis of the data.

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Letters to the Editor

SAMPLING OF LEATHER

In a paper that appeared recently in this *Journal*, Chakravarti[1] purports to show that the criterion developed by Mandel and Mann[2] for the selection of the best sampling position on a leather hide is "of no value", and "reduces to choosing the most uniform blocks, the criterion that they seemed to reject". Mr Chakravarti labours under a misapprehension since the development of our criterion is not based on the simple additive model used in his derivation. Using Mr Chakravarti's notation, the model underlying our criterion *is not*

$$x_{ij} = m + p_i + h_j + \epsilon_{ij} \quad \ldots\ldots\ldots \text{(A)}$$

but rather

$$x_{ij} = m + p_i + \beta_i h_j + \epsilon_{ij} \quad \ldots\ldots\ldots \text{(B)}$$

This model is apparent from the discussion in section IV of our paper. What Mr Chakravarti's argument amounts to is a mathematical proof that $\beta_i = 1$, on the assumption that $\beta_i = 1$.

The criterion developed in our paper is derived from equation (B) and is based on the assumption that the best sampling location is that for which the sample size is minimum. The calculation of the sample size involves, as usual, pre-assigned risks for the "errors of the first and the second type"[3] (p. 152). In our paper it is then shown that regardless of the

values assigned to these risks, the criterion for the best sampling location is the requirement that the quantity $\frac{\sigma_{\epsilon_i}}{\beta_i}$ be a minimum*. It is further shown that this requirement is mathematically equivalent to making the correlation coefficient between position value and hide average a maximum.

The formulas derived by Chakravarti from his additive model are implicitly contained in the formulas given in our paper, by *making* $\beta_i = 1$. For example, his formula for the correlation coefficient ρ_i is immediately derived from our equation (4) by making the slope m equal to unity. His formula for the scatter about the regression line is inherent in our equation (B) above. Finally, assuming $\beta_i = 1$, the criterion that $\frac{\sigma_{\epsilon_i}}{\beta_i}$ be a minimum reduces, of course, to the requirement that σ_{ϵ_i} be a minimum!

Mr Chakravarti further criticizes our criterion by stating that " an average over an entire side does not represent any tangible quality characteristic ". But the validity of our criterion does not depend on this assumption. Footnote 3 on page 100 of our paper reads as follows: " Which value is relevant (e.g. average, largest, smallest) depends primarily on the use of the side in which one is interested. In view of the general nature of our problem the relevant value was taken to be the average of the test results of all 21 locations." A careful reading of our paper will show that the principle underlying our criterion remains entirely valid if the average of the test results of all 21 locations is replaced by any other pertinent measure characteristic of the side or of any portion of the side.

The table of standard deviations between sides for each block calculated from our data by Chakravarti neither proves nor disproves the validity of our criterion, since it fails to consider the value of the slope β_i which, contrary to Chakravarti's assertion, is not necessarily unity. For example, the upper graph in Fig. 2 of our paper illustrates a case in which the slope is distinctly different from unity. Incidentally, some of the significant values of χ^2 obtained by Chakravarti in the Bartlett test are due, in part at least, to the dependence of the standard deviation for each position upon the magnitude of the property in that position. As an example, consider stitch-tear strength of the split hides in the parallel direction. The data for this test are taken from the paper of Randall *et al.*[4] and are plotted in Fig. 1. One often finds a relation between standard deviation and magnitude of the measurement, both in physical and in chemical tests. This, in addition to other

*In our paper the symbol m is used for the slope (β_i).

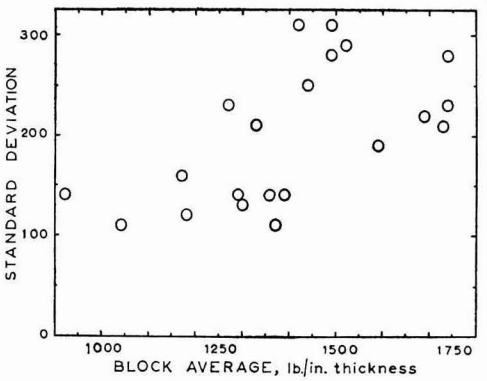

FIG. 1 — RELATION BETWEEN BLOCK VARIANCE AND STANDARD DEVIATION

considerations, makes the standard deviation an unreliable criterion for the comparison of test methods. This matter is discussed in detail in a paper by Mandel and Stiehler[5] in which a sound criterion is derived for the comparison of methods of test.

It is our belief that one must analyse each statistical problem in the physical sciences, such as the sampling problem under discussion, in terms of a statistical model appropriate to the problem, rather than in accordance with a standard formula which may not adequately reflect the physical situation.

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2 September 1959

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The problem considered by Mandel and Mann can be stated thus:

A consignment of similar hides is divided into two lots at random which are then given two different tannages. Of course, if a characteristic could be measured over the entire lots, the two tannages could be easily compared. This being generally impracticable, samples are drawn from the two lots and compared in respect of the characteristic. The problem is to find out how best to draw the samples.

It is known that leather is highly variable, i.e. the characteristic value and variance vary from location to location within a leather. Let us assume that the characteristic values at a particular location (block) over leathers are normally distributed. If samples were drawn from all locations of a leather at random, it would amount to drawing samples from a mixture of normal populations. Assuming that the mixture is also of the normal form, certainly the standard deviation would be larger, and hence a larger sample would have to be drawn than if samples were drawn only from locations that give consistent results.

For the better tannage to show up, the location that consistently discriminates between the tannages is the best. Common sense considerations lead to the choice of the most uniform location. The usual linear model confirms this. On this hypothesis, the leather variance should be less than the block variances in respect of any characteristic. The table of variances calculated by me does not contradict it.

My problem is broader. Suppose we are to find the best waterproofing treatment for leather. There are a few chemicals that might prove suitable, and the temperature, *p*H and concentration of the solutions at the time of treating the leather are important factors. An experimental design to study the above is required. This experiment, as will be appreciated, cannot be confined to one block only. The variability in a leather and the inequality of block variances make it difficult to decide upon an appropriate design. I have discussed how this problem could be attacked.

Mandel and Mann assert that β_i is not necessarily unity. If $\beta_i = 1$, sampling fluctuations will result in a few b_i's being very high and a few very low. If one such case is taken, a dependence of block values on side averages or a dependence of standard deviation on magnitude of the characteristic may be found, but that would prove nothing. To establish this assertion, it is necessary to show that the frequency distribution of observed b_i's differs significantly from the expected frequency distribution of b_i when $\beta_i=1$.

Moreover, the model referred to by Mandel and Mann in their communication is a consequence of their criterion of regression of block values on side averages and not a model by reference to which a criterion is developed. This model has also not been justified by appeal to physical concepts. In case the model used by me were inadequate, an interaction term would be required. This may be tested for by applying Tukey's[1] test for non-additivity.

My statement that " an average over an entire side does not represent any tangible quality characteristic " was in reference to sampling for acceptance inspection only. This problem has not been considered by Mandel and Mann.

It is my experience that in many cases a standard deviation becomes unreliable because of the crudeness of measurement in relation to requirement. It may be noted that in every case, observed quantitative data are in the nature of grouped data, the group interval being the precision of the measurement. Thus if heights of men are measured in feet and inches, the group interval is one inch. If it is found that the standard deviation is about one or two inches, it is unreliable because the entire population is divided into a few groups only. A safe practice would be to ensure that the group interval is not more than one-quarter of the standard deviation. Then if Sheppard's correction is used, the standard deviation generally becomes reliable criterion.

Lastly, I may add that the problem of finding an appropriate experimental design for use in the case of leather is yet unsolved. I have, in my paper, suggested a few possible designs, but their relative merits can only be assessed by analysing uniformity trial data.

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23 *September* 1959

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REVIEWS

NUCLEONICS FUNDAMENTALS by David B. Hosington (McGraw-Hill Book Co. Inc., New York), 1959. Pp. xii + 410. Price $ 9.50

This book is one of a series in nuclear engineering published by McGraw-Hill. It deals in general with elements of atomic physics, radioactivity and radiation protection, description of different particle accelerators and the basic principles of nuclear reactors, nuclear and thermonuclear power. This book is essentially for undergraduate students who have not had much of preliminary physics dealing with the nuclear atom. The author has taken considerable pains to explain the basic principles in a lucid and simple style.

The first three chapters deal with the atomic structure and spectrum of the hydrogen atom and the structure of nuclides. Nuclear stability and the relation between binding energy and the structure of the nuclei are described very briefly with instructive problems. The next two chapters deal with the phenomena of natural and induced radioactivity and the nature of the radioactive decay schemes. The sections on neutron cross-sections and neutron-induced reactions are useful additions for an understanding of the later chapter on nuclear fission. Chapter 6 contains the basic principles of particle accelerators and includes brief descriptions of high voltage, circular and linear accelerators. These are by no means complete and give only general ideas of the accelerators and the energies of the particles attained in each case.

Radiological safety and the instruments for surveying the radiation measurements and monitoring the operation of nuclear reactors are described in Chapters 7 and 8.

The subsequent two chapters deal with nuclear fission and the basic principles of nuclear reactors. The mechanism of a self-sustaining fission reaction is described. A number of useful numerical problems dealing with a chain reaction, power density in a reactor, fission product poisoning, etc., have been worked out in Chapter 9. Reactor materials, control and set-up of a reactor are described in Chapter 10 along with problems concerning shielding and the effects of radiation on nuclear materials.

Useful and instructive chapters on research reactors and on production of nuclear power follow. Illustrations, designs and working principles of the various reactors like the Oakridge X-10, Chalk River NRX, swimming pool type, ETR of Idaho, SUPO of Los Alamos, pressurized water reactor and the experimental boiling water reactor, Calder Hall natural uranium gas-cooled reactors, sodium reactor experiment assembly and the Brookhaven liquid metal fuel reactor are given in these chapters, though very briefly. It is instructive to go through the pages on the economics of nuclear power and the feasibility of nuclear propulsion for ships and nuclear-powered aircraft.

A few pages are devoted to thermonuclear power and fission reactions. There is already an increasing amount of work carried out in this field and necessarily, therefore, any attempt to present these phenomena in a book of this type can only be sketchy. The final chapter deals with the methods of production of nuclear fuels, more specifically those concerning the production of U^{235} and deuterium.

At the end of the book, a glossary of the terms in use in nuclear technology and atomic and nuclear data are given. The table containing the properties of nuclides would be useful for ready reference of isotopic abundances, half-lives of nuclides and neutron cross-sections.

On the whole, the presentation of the material has been smooth and easily understandable. The earlier chapters on the nuclear atom and atomic structure are, however, very elementary. As an introductory course on nucleonics, the book should be useful and should create further interest in nuclear engineering.

V. K. IYA

SOVIET PHARMACEUTICAL RESEARCH: Vol. III — MEDICINAL CHEMISTRY, Consultants Bureau Chemistry Collection No. 4 (Consultants Bureau Inc., New York). Pp. 556 + 6. Price $ 100.00

This volume is a fine collection of translations of 87 research papers of Soviet origin on various aspects of medicinal chemistry. It gives a fairly connected story of the endeavour of the Soviet chemists in the field of drug research over a period of ten years ending 1955. All these papers were published after the Second World War, but the subject matter of some of them would suggest that at least those published in the forties represent some of the work carried out during the war years.

The first ten papers relate to structure-activity relationships particularly with reference to the developments in the field of sulphanilamides and in the evolution of parasiticidal acridines and quinolines. Some of these papers such as those of Boldyrev and Postovsky, of Topchiev, Bekhli and Kirmalova or of Stavrosvskaya furnish a refreshing peep into the

trends in the thinking of Soviet chemists in the field of evolution of new chemotherapeutic agents. The rest of the papers are representative of the variety of problems in which the different medicinal chemistry and allied research centres in the Soviet Union are interested. There are contributions on the synthesis of a wide variety of possible chemotherapeutic agents such as the potential anti-tubercular isonicotinic hydrazide derivatives, homologues of para-aminosalicylic acid and thiozolidones, potential antimalarials among the quinolines and aminonaphthalenes, anthelmintics of the coumarin series, barbituric acids, chloromycetin analogues and the anaesthetics in the propanol ester and the substituted naphthalene series.

Ten papers deal with the comprehensive studies of Knunyants, Linkova and their colleagues at the N. D. Zelinsky Institute of Organic Chemistry of the U.S.S.R. Academy of Science on the reactions of mercapto amino acids. Synthesis of some interesting amino acid derivatives and a new method of synthesis of polypeptides, in which mixed anhydrides are replaced by N-acyl 3: 3'-dimethyl-B-thiolactones as the acylating agents, are described.

There are some interesting papers on the medicinally important natural products. One of these describes the synthesis of emetine by Evstigneeva, Livishits and Bainova and another on the synthesis of papaverine in good yield by Braz and Chizhov. Structure of gramicidin C is dealt with in three good papers by Gavrilov and his colleagues and by Reznichenko. One of the papers describes the synthesis of some colchicine derivatives by introducing substituents without disturbing the integrity of the basic skeleton of the molecule, another paper reports the synthesis of amino alcohols similar to ephedrine and there is a paper by Kanevskaya and Znaeva describing the synthesis of some homologues of aglucones of cardiac glycosides.

The volume also has a number of translational inaccuracies and printing errors. This volume, as also the first two volumes, are bound in stiff paper. For an expensive set such as this, a stiffer binding material should have been provided and would certainly improve the get-up.

In any case this volume, as also the first two, should find an important place in all the libraries of institutions connected with pharmaceutical and medicinal research. One cannot avoid to repeat that the price of $ 100.00 for the third volume is very high indeed; even $ 200.00 for the entire set of three volumes is high. It is to be hoped that the Consultants Bureau will endeavour to bring the price down so that more libraries may be able to acquire this valuable set.

M. L. DHAR

ENGINEERING MECHANICS — STATICS AND DYNAMICS by H. L. Langhaar & A. P. Boresi (McGraw-Hill Book Co. Inc., New York). Pp. xiv + 705. Price $ 9.00

Mechanics is a deductive science; hence it is essentially mathematical. The book, therefore, rightly aims at presenting the subject to the junior engineering students in such a way that the mathematical aspect is appreciated (rather than shunned) by the student. The stress is, therefore, on the methods of applying the principles of mechanics to solve physical problems and not on the derivation of formulae. To sustain the student's interest, every new concept is explained by a physical example and the mathematical theory is subsequently evolved. For example, the concept of simple harmonic motion is introduced with the familiar example of 'Scotch Yoke'. All this is in line with the present trend in classifying engineering disciplines under the heads: Energetics, Materials and Information.

The first seven chapters deal with statics and the remaining eight chapters deal with dynamics. Vectors are introduced in the very beginning. Vector product and differentiation of vectors are introduced in Chapters 6 and 15, which deal with three-dimensional statics and dynamics respectively. These two chapters illustrate the simplification achieved by the use of vector methods. The concepts of stress and pressure are explained clearly. A number of examples are given on trusses and joints. Distinction is drawn between dry friction and lubricated friction. Stress is rightly laid on free body diagrams.

Shearing forces and bending moments are not properly explained and the graphical method is not stressed. Virtual work is not properly dealt with. Hydrostatics is included in Chapter 4 on distributed forces. Some topics such as moments and coplanar forces are treated analytically. Use of gravity axis while dealing with centre of gravity is good. A whole chapter (Chapter 7) is devoted to energy principles in statics. Similarly, a separate chapter (Chapter 10) on momentum principles precedes the chapters on kinematics and dynamics of rigid bodies. This is in line with the current trend in teaching with emphasis on presentation of different topics as part of a single concept.

Relative velocity is explained clearly. The figures given on page 389 taken from 'elementary mechanics of fluids' and the example (p. 399) taken from fluid mechanics are quite interesting. The authors claim that the book "provides an adequate basis for later studies of fluid mechanics and mechanics of deformable bodies". The theory of free and forced vibrations is presented in a simple manner with due stress on engineering applications. Drawbacks in

Newtonian mechanics, when applied to electromagnetic theory, are mentioned. Passing reference is made to thermodynamics while dealing with energy. Such references serve to arouse interest and enthusiasm of the student to learn other subjects. References are also given to advanced works. One of the special features of the book is a number of review questions given at the end of each chapter. The book closes with an appendix containing some standard results on centre of gravity and moment of inertia which serve as ready reference for the students. The book, with its lucid treatment of the subject matter and with a number of solved and unsolved examples, and above all with due attention paid to the student's way of thinking, is easily one of the best text-books on the subject.

B. R. SETH

COLORIMETRIC METHODS OF ANALYSIS, INCLUDING PHOTOMETRIC METHODS: Vol. IIA, by F. D. Snell, C. T. Snell & C. A. Snell (D. Van Nostrand Co. Inc., London), 1959. Pp. x + 793. Price 112*s*. 6*d*.

A revision of the third edition of this useful book, especially of Vol. II, dealing with inorganic analysis, was being awaited for some time in view of the many important new methods developed since 1949. The present volume is thus a welcome supplementary, covering the recent literature from 1948 to the end of 1955, including earlier omissions. Similar supplementary numbers will appear for the other volumes comprising the third edition.

In the present volume, flame photometry has been regarded as essentially a colorimetric method; so, sensitive flame photometric methods have been included. As in the previous number, details of processing typical samples prior to determination of the particular constituent by a method of choice have been included, retaining the practical usefulness for which Snell's volumes are well known. A desirable degree of relaxation by the authors in the critical selection of published methods is noticeable in the present volume. The authors' team has also been enlarged from two to three by the inclusion of a younger Snell (C. A.).

One unavoidable disadvantage in a book of this kind is that the information provided in either of the two volumes (II and IIA) is incomplete without the other, and is altogether not easy reading to a general reader. It is to be understood, however, that Snell's volumes are not so much intended to be text-books as ready reference manuals to the senior analyst in his laboratory, providing him with a selected collection of the available colorimetric (and photometric) methods. This purpose is as faithfully served in the present volume as in its predecessors.

J. GUPTA

CHROMATOGRAPHIC REVIEWS — PROGRESS IN CHROMATOGRAPHY, ELECTROPHORESIS AND RELATED METHODS: Vol. 1, edited by Michael Lederer (Elsevier Publishing Co., London), 1959. Pp. ix + 276. Price 45*s*.

This publication, the first of a proposed series, gives in an attractive handy volume the reviews in English as originally appearing in the *Journal of Chromatography* in different languages. This is a welcome addition to the editor's comprehensive compendium ' Chromatography '.

Vol. 1 of this series contains: reviews on two techniques, Chromatostrip and Chromatoplate, and High Voltage Electrophoresis; besides, an original contribution on Paper Chromatographic Separation and Identification of Phenols', reviews on Methods for the Separation of South American Strychnos and Indian Curare Alkaloids, Chromatography of Sterols, Steroids, and Related Compounds, Paper Chromatography of Chloroplast Pigments, Chromatographic Identification of Anthocyanin Pigments; and two reviews covering inorganic compounds, namely Paper Chromatography of Inorganic Phosphorus Compounds and Separation of Isotopes by Chromatography and by Electrophoresis.

Though the reviews are written by different authors and are of varying length depending upon the subject, a certain uniformity and balance are seen in all, evidently following a pattern set by the editor. Each review, written by experienced senior workers in the field, brings out, after a general survey of the problem and work, specific methods with recommended procedures, the difficulties that will be met with, the precautions to be taken to avoid difficulties and pitfalls in the interpretation of the chromatograms. A special feature of the reviews on groups of compounds is the discussion on structure of compounds in relation to chromatographic behaviour, knowledge of which gives us good insight into the theory of chromatographic separation and provides a rationale in the selection of adsorbents, solvent combinations, etc., for better separation of mixtures of complex compounds.

There has been an increasing tendency, especially in India, to rely too much on R_f values as a means of identification. It has been clearly brought out in the different reviews that the R_f value is subject to large variation depending on a large number of factors and that it is preferable to compare the movement in relation to a known substance co-chromatographed. This is especially true in the case of complex organic compounds such as alkaloids and steroids where reciprocal influences are observed.

Being contributions from active workers in the field, these reviews will be extremely useful to the research workers and students alike and many reviews

also give much new unpublished data. The value of these reviews would be greater if the limits of detection of separated compounds in relation to detecting agents are also given. A minor point is that in the chapter on 'Separation of Alkaloids', a number of notations and certain ordinates in the figures have not been explained. The production is of a very high standard and the volume has a comprehensive index.

V. S. GOVINDARAJAN

QUANTITATIVE METHODS IN HUMAN PHARMACOLOGY AND THERAPEUTICS: Vol. 3 — Proceedings of a Symposium held in London on 24 and 25 March 1958, edited by D. R. Laurence (Pergamon Press Ltd, London), 1959. Pp. xvii + 253. Price 45*s*. net

Fourth in the series of symposia organized by the Biological Council's Co-ordinating Committee for Symposia on Drug Action, *Quantitative Methods in Human Pharmacology and Therapeutics*, edited by Dr D. R. Laurence, has been published by the Symposium Publications Division of Pergamon Press in 1959.

The title of the book represents a new trend that is developing in the field of pharmacology. The organic chemists keep on making closely related chemical compounds and their comparative assessment by animal experiments becomes difficult. So much so evaluation of therapeutic efficacy as well as safety and freedom from side effects of drugs have to be assessed in human beings more often than ever before. This is not to deprecate the importance of animal experiments or bypass laboratory tests but to emphasize the fact that comparison of drugs with related activities has to be critically carried out in human beings. Problems related to this subject have been dealt with in this symposium.

The symposium keeps the quantitative assessment in the forefront and dwells on the following aspects of the subject: (1) Methods and problems associated with evaluation of drugs in man; (2) Newer statistical methods applicable to human pharmacology and therapeutics; and (3) Introduction of drugs into clinical practice and clinical trials.

Part I deals with methods of objective measurements in man. Each chapter is followed by a discussion of the limitations and advantages of individual technical procedures, and a wide variety of techniques are dealt with. Besides this, the introductory chapter by Prof. J. H. Gaddum and the chapter on 'Experiences in Human Pharmacology' by Dr Harry Gold, who has been especially interested in carrying out trials with cardiac glycosides in human patients, deal with general problems associated with evaluation of drugs in man. The last chapter in this part by Dr H. K. Beecher deals with the problem of expressing symptoms in quantitative terms, and 'pain' forms the main theme of this chapter.

Part II deals with the newer statistical methods applicable to human pharmacology. It has been said that invasion by mathematics has robbed biology of its charm but the field of pharmacology is one branch of biology where mathematics has increased its application and thus added to its lustre. Some of the less obvious statistical methods have been discussed. Use of sequential analysis and randomized blocks as applied to certain trials have been dealt with.

Part III is on introduction of drugs into clinical practice and clinical trials. The first two chapters in this part deal with toxicity studies and small-scale trials. The last chapter deals with ethics of clinical trials, and the subject, naturally, has attracted much discussion. The various facets of the problem have been thoroughly discussed and this part makes interesting reading.

The book is an excellent addition to the literature on medicine and pharmacology, and should be a 'must' for all those interested in trying new drugs on human beings. In such a compilation, a little repetition is perhaps unavoidable: principles of randomization, double-blind study, use of dummies have been dealt with by more than one author. The general printing and get-up of the book are commendable.

M. SIRSI

PRINCIPLES OF MODERN PHYSICS by Robert B. Leighton (McGraw-Hill Book Co. Inc., New York), 1959. Pp. xii + 795. Price $12.50

As is indicated by the title, this is a book which covers practically the whole range of modern physics, building it up from physical principles. As the author states in his preface, "The general plan of treatment is to concentrate first on the broad fundamental principles which underlie most of modern physics as we know it, and then to see how these fundamental principles operate to yield the observed complex behaviour of matter". The book starts with a chapter on relativity, followed by a fairly long exposition of quantum mechanics extending over nearly 200 pages. A good account of the application of quantum mechanics to spectroscopy (both atomic and molecular spectra) then follows and after that a brief discussion of quantum statistics and the band theory of solids. There is a short chapter on X-rays dealing with the main facts of production of X-rays and their interaction with matter together with the essentials of the diffraction of X-rays by crystals. The rest of the book, about 250 pages,

deals with nuclear physics — with such topics as particle scattering, radioactivity, nuclear stability, nuclear reactions, forces and models, ending with fundamental particles and cosmic rays. There is a table of physical constants at the end, followed by a number of tables dealing mostly with nuclear physics.

The book is eminently readable and special care has been taken to set forth, in fairly good detail, the physical assumptions underlying the various theories. A large number of diagrams are included, in particular showing the variations of the different functions met with. The photographs dealing with particle tracks are particularly noteworthy. Every section contains a number of exercises, some of which fill up the gaps in the text and some of which require effort on the part of the student. The latter should help the student in gaining mastery over the subject.

The only defect, if at all, which the reviewer could notice in the treatment is a slight over-statement regarding the extent of our knowledge of Nature, e.g. dealing with quantum electrodynamics, the author states, " This theory is at present believed to be capable, in principle, of describing to any desired degree of precision, *all observable properties of matter, except those which depend upon gravitation or nuclear forces*" (italics as in the book). This is rather reminiscent of the types of statements made by physicists about fifty years ago.

The selection of topics is obviously based on the author's particular interests, e.g. the Raman effect and polarization of the photon do not find a place even in the index. However, the treatment of atomic spectra is better than in most books on quantum mechanics and on the whole the book does give a balanced account of the problems of modern physics.

The book can be confidently recommended to post-graduate students of physics who are not specializing in theoretical physics.

G. N. RAMACHANDRAN

INTRODUCTION TO THE PHYSICS OF MANY-BODY SYSTEMS by D. Ter Haar (Interscience Publishers Inc., New York), 1958. Pp. viii + 127. Price $ 3.85

This book by Ter Haar is the fifth volume in the series ' Interscience Tracts on Physics and Astronomy ', and is a welcome and timely addition to the rapidly growing literature on the theory of many-body systems.

The book has been divided into two parts: the first part deals with the effective field theories and the second with the various theories of collective behaviour and their applications. The discussion of the effective field theories starts with the Hartree-Fock approximation where one tries to reduce the many-body problem to a suitable one-body problem by replacing the effect of all other bodies by an effective field due to them. This method has been very successful in the case of the electronic structure of atoms, molecules and solids, and recently it has been lifted to a new level by Brueckner and his collaborators in dealing with the nuclear many-body problem. The theory due to Brueckner and his associates has one great advantage over the old Hartree-Fock theory in that it treats the interaction between two particles accurately and replaces the effect of the remaining A-2 particles by an effective field. Brueckner's theory is discussed in Chapter IV of the book and references are given for additional information.

The Thomas-Fermi statistical theory has been discussed in Chapter III and an up-to-date list of its various applications has been included by the author. Further, in Chapter V the concept of effective mass and quasi-particles which one comes across in solid state physics (exciton, polaron and excitaron) have been discussed.

Chapter VI in the second part of the book deals with the classical version of the collective theories: the Tomonaga method, Yevick-Percus method, Fourier components of density as collective co-ordinates method, and the redundant variable method. A brief introduction to the collective motion in quantum mechanics is given at the end of the chapter and references for further information are given. In Chapter VII the Tomonaga and Yevick-Percus methods are applied to sound waves in a gas and in one-dimensional crystal. The last three chapters (VIII, IX and X) are devoted to a discussion of the plasma oscillations in metals and their dispersion relation, the collective behaviour of nuclei and the collective approach to liquid helium.

In Chapter X, the author has only mentioned the problem of superconductivity along with the liquid helium problem, but there is no discussion of the work of Bardeen, Kuper, Schrieffer and Bogoliubov.

In conclusion, it should be mentioned that this is hardly a book for a newcomer to the subject, but it is an exceedingly useful ' repetitorium ', clear and brief.

D.S.K.

THE WEALTH OF INDIA, RAW MATERIALS, Vol. V: H-K (Publications Directorate, Council of Scientific & Industrial Research, New Delhi), 1959. Pp. xxv + 332 + xii. Price Rs 30.00

This volume, the fifth of the series, covers 380 entries (370 on plant species, 7 on animals and 3 on minerals)

beginning with Habenaria and concluding with *Kyllinga squamulata*. The general pattern of treatment is in conformity with the earlier volumes. It is not to be expected that each of the entries would be handled with equal thoroughness. But, every one of them is written by a competent authority. This, combined with the catholicity of the literature consulted, the scholarly precision in the presentation of data, clear printing easy to the eye for reading, and attractive get-up, all add up to ensure to this volume a worthy place in the distinguished family of its predecessors.

No reviewer can aspire to evaluate all this mass of information presented with such painstaking care; the data spill over many scientific disciplines. Naturally, there is room for difference of opinion on the space to be allotted to and the perspective in which any given item is to be handled. Even so, the coverage enjoyed by 'Insects and Insect Pests' running over 52 pages and forming nearly a sixth of the volume might be demurred to by the non-entomologist reader of *The Wealth of India*.

The exact connotation of the word 'Malnad' (p. 33), which, incidentally, is not in italics, may not be clear to the average reader. On page 84, 'Bhende' does duty for 'Bende', the Kannada name for *Hibiscus esculentus*. The bald statement that *Jacaranda acutifolia* is a host plant for lac (p. 278) could convey the erroneous impression that lac is actually being cultivated on this plant. The averment that "almost all superior perfumes contain at least a small amount of jasmine oil" (p. 289) is open to question.

These, however, are only minor blemishes and only serve to highlight the very high standard maintained throughout the volume. The colour plates are handsome, some strikingly so; the photographs are expressive, although Fig. 166, *Kochia indica*, provides poor company. The index is compiled with a thoroughness which is necessary.

In this volume, quantities are generally expressed in F.P.S. and only occasionally in C.G.S. units. A complete changeover to the metric units would bring the future volumes in line with the adoption of these international units by India.

Readers who consult an encyclopaedia are of two categories: the specialist who wants to know not merely what is known but the sources of such information; then, there is the 'average general reader' who likes to have his information dished out to him in a palatable form. Both these categories are well served by this volume which will prove to be amply rewarding to the specialist and fascinating to the layman.

M. N. RAMASWAMY

COLORIMETRIC CHEMICAL ANALYTICAL METHODS (The Tintometer Ltd, Salisbury, England), Fifth Edition, 1959. Seven Parts. Price 30s.

The fifth edition of this handbook is essentially a laboratory companion for those using chiefly the Lovibond comparators for colorimetric analysis. This book contains details of many tests which are in current use and which have been suitably modified for use with the Lovibond colorimeter. The text has been rewritten in this edition and 12 new monographs have been added.

In the introductory chapter the publishers claim that the Lovibond colour standards cover practically the whole range of colours that are usually required in laboratory colorimetric work and that the use of these avoids possible errors in the preparation of comparison standards of known composition. The colour standards are claimed to be permanent. These consist of three series of coloured glass slips, one of red (magenta), one of yellow and one of blue. Each series is a linear scale of the same colour rising from the palest perceptible shade to a fully saturated spectral colour. Any colour may be matched by superimposing suitably chosen colour glasses. It is claimed that there are in all nine million possible combinations of these glasses.

The handbook is divided into seven parts and in each part individual analyses are described lucidly. The different Lovibond colorimeters and the principles on which these operate are described in Part 1, and Part 2 deals with the colorimetric determination of *p*H, the use of indicators and the details of Lovibond colour standards ranging from *p*H 0·2 to 14 and procedural methods.

In Part 3, the colorimetric analysis of some 28 inorganic basic and acidic radicals is described. These colorimetric procedures include modifications, in certain cases to suit their use in the Lovibond apparatus. As is suggested in many places in this handbook, these methods are more useful in industrial practice such as in metallurgy, manufacture of cosmetics and electrolytic processes and also in agriculture, public health, etc. Part 4 deals with organic colorimetric analysis describing chiefly the analyses of industrially important organic chemicals like carbon tetrachloride, DDT, anionic synthetic detergents, furfuraldehyde, etc.

In Part 5 a number of chemical, pathological and analytical procedures are described in considerable detail, and the determination of noxious vapours, toxic gases, chlorinated hydrocarbons, nitrobenzene in the atmosphere of industrial locations and of hydrogen sulphide in fuel gas is described in Part 6. The last part deals with the use of the Lovibond comparators and discs in colour grading of refined cresylic

acids, benzole and allied products, lubricating oils and petroleum, shellac and varnish, oil lacquers and resins, the quality grading of active carbon, refined lower boiling products of coal-tar, milk and a few other items. Most of these follow the officially prescribed methods, with minor modifications wherever necessary.

This handbook describes in considerable detail the use of the comparatively less expensive colorimetric apparatuses manufactured by the Tintometer Ltd and it should be useful in most analytical laboratories. These techniques are simple and quick, and are, therefore, likely to be useful, particularly in industries and public health analytical laboratories. The publishers claim that the Lovibond comparators are extremely simple, strong and economic, and that even an unskilled worker can obtain reliable results without much training. The colour glasses are permanent and do not, therefore, require renewal as is the case with the tubes of standard coloured solutions. The use of a sufficient number of colour discs is claimed to cover practically the entire range of colours required in laboratory colorimetric analysis. Great care has been taken in the publication of this loose-leaf volume with three different indexes to make for easy reference. It is remarkably free from errors and each part is easily accessible through the appropriately captioned colour-coded sheets. The book is reasonably priced.

M. L. DHAR

HETEROCYCLIC CHEMISTRY — AN INTRODUCTION by A. Albert (University of London, London), 1959. Pp. viii + 424. Price 45*s*. net

This is an unusual book, very good from one point of view. It provides a sound framework, built from the common theoretical concepts of organic chemistry, within which the numerous types of heterocyclic compounds can be classified and studied in relation to their structure and properties. It suffers, however, from the defect of a tedious and laboured presentation of elementary electronic theory in its application to heterocyclic chemistry. The expressions π-deficient and π-excessive heteroaromatics are infelicitous and serve no special purpose. The author's treatment of heterocyclic compounds on the basis of the π-electron distribution in the ring systems is rational and useful, but by no means new. Noller's Chemistry of Organic Compounds, for instance, explains briefly and clearly the relative reactivity of benzene, thiophene, pyridine, etc., towards electrophilic and electron-donating reagents in terms of the unshared electrons of the hetero atom and the electron density on the carbon atoms.

There are 12 chapters: general introduction; heteroparaffinics; general discussion on heteroaromatics; π-deficient N-heteroaromatics; π-excessive N-heteroaromatics; π-excessive O- and S-heteroaromatics; heteroethylenics; spectra; ionization constants; oxidation-reduction potentials, dipole moments; interpretation of complex formulae in terms of physical and chemical properties; notes on some rational approaches to new synthesis. The chapters on physical properties provide useful data and constitute the best part of the book.

The book is weak in the treatment of the classical organic chemistry of important heterocyclic types and individual compounds, such as cyanuric chloride and symmetrical triazine derivatives, flavones and isoflavones, penicillin, and the alkaloids. The methods employed for determining the structures of heterocyclic compounds occurring in nature and synthetical reactions have received little attention. There are several statements which are ambiguous or erroneous. Examples are "the sulphur-dye, Hydron Blue, (made) by heating in turn with *p*-nitrosophenol and sodium sulphide"; "carbazole can also be prepared by diazotizing 2-aminodiphenylamine"; "the Kostanecki-Robinson reaction is best carried out in glycerol at 250°"; "the flavonols are 2-phenyl-3-hydroxyflavones"; "flavonols . . . occur in nature, but not to so great an extent as flavones"; "for the new light which infrared spectra shed on the constitution of indanthrone, see Wyman, 1956" (an uncritical reference to a paper of doubtful significance); "isoxazoles are made from 1:2-dicarbonyl compounds and hydroxylamine". Quercetin, rutin, cyanidin, khellin, Aniline Black, biotin, 8-hydroxyquinoline, vioform, strychnine and reserpine are not mentioned. Chloroquine is more valuable at the present time as an extra-intestinal amoebicide than it is as an antimalarial agent. The only reference to the biological properties of flavones is the discredited work of Moewus. The references have not been chosen judiciously and some are out of date. For no obvious reason reviews of the 1940's are sometimes preferred to those of the 1950's. Among several omissions of references to important publications, two are Wiley's excellent chapter on Heterocyclic Chemistry in Vol. IV of Gilman's *Organic Chemistry* and Acheson's *Acridines*.

The claim on the dust cover that the book is "a standard work of reference fully adequate to the purposes of research workers, including those working in biology and medicine", is unjustified. It can be recommended as an introduction to one aspect of heterocyclic chemistry.

K.V.

Recent Publications

Physics

PLASMA PHYSICS AND THE PROBLEM OF CONTROLLED THERMO-NUCLEAR REACTIONS (in four volumes), edited by M. A. Leontovich; translated from Russian by J. B. Sykes (Pergamon Press Ltd, London), 1959. Pp. *c.* 400 per volume. Price £ 8 or $ 24.00 (set of four volumes, £ 27 or $ 80.00)

GROUP THEORY IN QUANTUM MECHANICS — AN INTRODUCTION TO ITS PRESENT USAGE — International Series of Monographs on Pure & Applied Mathematics, Vol. 9 — by Volker Heine (Pergamon Press Ltd, London), 1959. Pp. *c.* 350. Price 70*s.* or $ 11.50

STATISTICAL METHODS IN RADIO WAVE PROPAGATION, edited by W. C. Hoffman (Pergamon Press Ltd, London), 1959. Pp. *c.* 360. Price 90*s.* or $ 14.00

QUANTITATIVE MOLECULAR SPECTROSCOPY AND GAS EMISSIVITIES by S. S. Penner (Pergamon Press Ltd, London), 1959. Pp. *c.* 570. Price £ 5 5*s.*

POWER REACTORS (NUCLEAR REACTOR PLANT DATA, Vol. 1) by the American Society of Mechanical Engineers, New York (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 128. Price $ 3.75 or 29*s.*

THE THEORY OF SPACE, TIME AND GRAVITATION by V. Fock; translated from the Russian by N. Kemmer (Pergamon Press Ltd, London), 1959. Pp. 500. Price £ 5 or $ 15.00

SPACE AGE DICTIONARY, edited by Charles McLaughlin (D. Van Nostrand Co. Ltd, London), 1959. Pp. viii + 128. Price 45*s.*

INTRODUCTION TO THE MECHANICS OF THE SOLAR SYSTEM by Rudolph Kurth (Pergamon Press Ltd, London), 1959. Pp. *c.* 120. Price £ 1 15*s.* or $ 6.00

THEORY OF ELASTICITY — Course of Theoretical Physics: Vol. 7 — by L. D. Landau & E. M. Lifshitz; translated from the Russian by J. B. Sykes & W. H. Reid (Pergamon Press Ltd, London), 1959. Pp. 130. Price 40*s.* or $ 6.50

THE STUDY OF ELEMENTARY PARTICLES BY THE PHOTOGRAPHIC METHOD by C. F. Powell, assisted by D. H. Perkins & P. H. Fowler (Pergamon Press Ltd, London), 1959. Pp. 640. Price £ 12 10*s.* or $ 40.00

PROPERTIES, PHYSICS & DESIGN OF SEMICONDUCTOR DEVICES — Bell Laboratories Series — by J. N. Shive (D. Van Nostrand Co. Ltd, London), 1959. Pp. xxi + 487. Price 73*s.*

Engineering

NON-NEWTONIAN FLUIDS by W. L. Wilkinson (Pergamon Press Ltd, London), 1959. Pp. 120. Price 40*s.* or $ 6.00

SELECTED TOPICS ON BALLISTICS — AGARDograph No. 32, edited by Wilbur C. Nelson (Pergamon Press Ltd, London), 1959. Pp. 280. Price 63*s.* or $ 10.00

CHEMICAL ENGINEERING CALCULATIONS by Ernest J. Henley & Herman Bieber (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 441. Price $ 9.00 or 70*s.*

KINEMATIC ANALYSIS OF MECHANISMS — McGraw-Hill Series in Mechanical Engineering — by Joseph E. Shigley (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 351. Price $ 7.75 or 60*s.*

DESIGN AND THE PRODUCTION OF HOUSES — ACTION Series in Housing & Community Development — by Burnham Kelly (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 428. Price $ 10.00 or 77*s.* 6*d.*

AERIAL PHOTOGRAPHIC INTERPRETATION by D. R. Lueder (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 500. Price $ 17.50 or £ 6 12*s.*

MAGNETISM AND MAGNETIC MATERIALS: Proceedings of the Fourth Conference, edited by J. A. Osborn *et al.* (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 323. Price $ 10.00 or 77*s.* 6*d.*

THEORY AND DESIGN OF SMALL INDUCTION MOTORS by Cyril G. Veinott (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 492. Price $ 13.50 or £ 5 4*s.* 6*d.*

CONTROL ENGINEERING — Van Nostrand Series in Electronics & Communications — by Gordon J. Murphy (D. Van Nostrand Co. Ltd, London), 1959. Pp. xii + 385. Price 56*s.*

AIRCRAFT ELECTRICAL ENGINEERING, edited by G. G. Wakefield (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 349. Price 50*s.*

ADVANCED AERO ENGINE TESTING — AGARDograph No. 37, edited by A. W. Morley & Jean Fabri (Pergamon Press Ltd, London), 1959. Pp. 300. Price 63*s.* or $ 9.00

EIGHT-LANGUAGE AERONAUTICAL DICTIONARY by Georges H. Frenot (Pergamon Press Ltd, London), 1959. Pp. 300. Price £ 7 or $ 20.00

ADVANCED PROPULSION SYSTEMS — International Series of Monographs on Aeronautical Sciences & Space Flight — by Morton Alperin & George P. Sutton (Pergamon Press Ltd, London), 1959. Pp. 278. Price 42*s.* or $ 6.00

RAREFIED GAS DYNAMICS — International Series on Aeronautical Sciences & Space Flight, Division IX: Symposia: Proceedings of the Symposium at Nice, 1958 — edited by F. M. Devienne (Pergamon Press Ltd, London), 1959. Pp. 420. Price £ 7 or $ 20.00

HANDBOOK OF AUTOMATION, COMPUTATION AND CONTROL: Vol. I (in three volumes), edited by Eugene M. Grabbe *et al.* (John Wiley & Sons Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 1020. Price $ 17.00

Metallurgy

AN ASIA TEXTBOOK — MATERIALS AND PROCESSES by James F. Young (*Distributors in India*: Asia Publishing House, Bombay), Second Edition, 1959. Pp. 1074. Price Rs 25.00

SELECTED METHODS OF ANALYSIS OF FOUNDRY MATERIALS: Part I — PIG IRON AND CAST IRON (The British Cast Iron Research Association, Birmingham), 1959. Pp. 97. Price 17*s*. 6*d*. or $ 2.50

FILLER METALS FOR JOINING by O. T. Barnett (Reinhold Publishing Corp., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 244. Price $ 7.00

INTERNAL STRESSES AND FATIGUE IN METALS, edited by G. M. Rassweiler & W. L. Grube (D. Van Nostrand Co. Ltd, London), 1959. Pp. 451. Price 72*s*.

PROGRESS IN METAL PHYSICS: Vol. VIII, edited by Bruce Chalmers (Pergamon Press Ltd, London), 1959. Pp. 350. Price £ 5 or $ 15.00

Chemistry

ADVANCES IN INORGANIC CHEMISTRY AND RADIOCHEMISTRY: Vol. I, edited by Jean Brachet & Alfred Mirsky (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 816. Price $ 22.00

CRYSTAL CHEMISTRY OF SIMPLE COMPOUNDS OF URANIUM, THORIUM, PLUTONIUM & NEPTUNIUM by E. S. Makarov (Consultants Bureau Inc., New York), 1959. Pp. 142. Price $ 5.25

HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE — McGraw-Hill Series in Advanced Chemistry — by J. A. Pople *et al.* (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 400. Price $ 12.00 or 93*s*.

BIBLIOGRAPHY OF THE STABLE ISOTOPES OF OXYGEN (O^{17} AND O^{18}), edited by David Samuel & Fritz Steckel (Pergamon Press Ltd, London), 1959. Pp. 230. Price 50*s*. or $ 7.50

SOAP FILMS — STUDIES OF THEIR THINNING by K. J. Mysels, K. Shinoda & S. Frankel (Pergamon Press Ltd, London), 1959. Pp. 150. Price 50*s*. or $ 8.50

TABLES OF PHYSICO-CHEMICAL SELECTED CONSTANTS AND NUMERICAL DATA — New Series — Nos. 8, 9, 10 & 11 (published for and on behalf of the International Union of Pure & Applied Chemistry) (Pergamon Press Ltd, London), 1959

- No. 8 — OXIDATION-REDUCTION POTENTIAL (£ 1 10*s*. or $ 5.00)
- No. 9 — OPTICAL ROTATORY POWER: II — TRITERPENOIDS (£ 7 or $ 21.00)
- No. 10 — OPTICAL ROTATORY POWER: III — AMINO ACIDS (£ 2 or $ 6.50)
- No. 11 — OPTICAL ROTATORY POWER: IV — ALKALOIDS (£ 8 or $ 24.00)

ELECTROPHORESIS: THEORY, METHODS AND APPLICATIONS, edited by Milan Bier (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 563. Price $ 15.00

Technology

INTRODUCTION TO RUBBER TECHNOLOGY, edited by Maurice Morton (Reinhold Publishing Corp., New York), 1959. Pp. *c*. 600. Price $ 10.00

THE RUBBER DICTIONARY, edited by the Rubber Stichting, Delft, Netherlands (D. Van Nostrand Co. Ltd, London), 1959. Pp. 1537. Price £ 15 15*s*.

URANIUM PRODUCTION TECHNOLOGY by C. D. Harrington & A. E. Ruehle (D. Van Nostrand Co. Ltd, London), 1959. Pp. 584. Price 131*s*. 6*d*.

Biology

THEORETICAL AND PRACTICAL PROBLEMS OF MEDICINE AND BIOLOGY IN EXPERIMENTS ON MONKEYS, edited by I. A. Utkin (Pergamon Press Ltd, London), 1959. Pp. *c*. 350. Price 50*s*. or $ 7.50

BIOLOGICAL ORGANIZATION — CELLULAR AND SUBCELLULAR, edited by C. H. Waddington (Pergamon Press Ltd, London), 1959. Pp. 344. Price 70*s*. or $ 12.50

ADVANCES IN BIOLOGICAL AND MEDICAL PHYSICS: Vol. VI, edited by C. A. Tobias & J. H. Lawrence (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 639. Price $ 16.50

RADIATION HYGIENE HANDBOOK — A Practical Reference Covering the Industrial, Medical & Research Uses of Radiation & Atomic Energy with Special Applications to the Field of Health Physics, Industrial Hygiene & Sanitary Engineering (McGraw-Hill Handbook Series), edited by Hanson Blatz (McGraw-Hill Book Co. Inc., New York), 1959. Pp. 650

Biochemistry

BIOCHEMISTRY OF VIRUSES — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna: Vol. VII, edited by E. Boda & W. Frisch-Niggemeyer (Pergamon Press Ltd, London), 1959. Pp. 224. Price 63*s*. or $ 9.50

THE PHARMACOLOGY OF PLANT PHENOLICS, edited by J. W. Fairbairn (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 151. Price 30*s*.

PROTEINS — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna: Vol. VIII, edited by H. Neurath & H. Tuppy (Pergamon Press Ltd, London), 1959. Pp. 272. Price 70*s*. or $ 11.00

THE ORIGIN OF LIFE ON THE EARTH — Proceedings of the First International Symposium — International Union of Biochemistry Symposium Series: Vol. I, edited for the Academy of Sciences of the U.S.S.R. by A. I. Oparin *et al.*, and edited for the I.U.B. by F. Clark & R. L. M. Synge (Pergamon Press Ltd, London), 1959. Pp. 750. Price £ 5 or $ 15.00

VITAMIN METABOLISM — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna: Vol. XI, edited by W. W. Umbreit & H. Molitor (Pergamon Press Ltd, London), 1959. Pp. 380. Price 73*s*. or $ 11.50

BIOCHEMISTRY OF MORPHOGENESIS — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna: Vol. VI, edited by W. J. Nickerson (Pergamon Press Ltd, London), 1959. Pp. 272. Price 70*s*. or $ 11.00

CHOLINESTERASES — A HISTOCHEMICAL CONTRIBUTION TO THE SOLUTION OF SOME FUNCTIONAL PROBLEMS — International Series of Monographs on Pure & Applied Biology: Modern Trends in Physiological Sciences Division, by M. A. Gerebtzoff (Pergamon Press Ltd, London), 1959. Pp. *c.* 150. Price 55*s.* or $ 8.50

THE BIOCHEMISTRY OF DEVELOPMENT — International Series of Monographs on Pure & Applied Biology: Modern Trends in Physiological Sciences Division, by Jean Brachet (Pergamon Press Ltd, London), 1959. Pp. 296. Price 65*s.* or $ 10.00

BIOCHEMISTRY OF INSECTS — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna, edited by L. Levenbook (Pergamon Press Ltd, London), 1959. Pp. 272. Price 70*s.* or $ 11.00

THE CELL: BIOCHEMISTRY, PHYSIOLOGY & MORPHOLOGY: Vol. I, edited by Jean Brachet & Alfred Mirsky (Academic Press Inc., New York; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. 244. Price $ 7.00

TRANSACTIONS OF THE PLENARY SESSIONS — The Edited Proceedings of the Fourth International Congress of Biochemistry, Vienna: Vol. XIV, edited by W. Auerswald & O. Hoffmann-Ostenhof (Pergamon Press Ltd, London), 1959. Pp. 312. Price 75*s.* or $ 12.00

BIOMETRICAL GENETICS, edited by Oscar Kempthorne (Pergamon Press Ltd, London). Pp. 150. Price 42*s.* or $ 8.50 (in preparation)

MECHANISMS OF COLOUR DISCRIMINATION — An ICSU-sponsored Symposium on the Fundamental Mechanisms of the Chromatic Discrimination in Animals and Man, edited by Yves Galifret (Pergamon Press Ltd, London), 1959. Pp. 300. Price 63*s.* or $ 9.50

Mathematics

THE THEORY OF LINEAR VISCOELASTICITY — International Series of Monographs on Pure & Applied Mathematics — by D. R. Bland (Pergamon Press Ltd, London), 1959. Pp. 100. Price 30*s.* or $ 5.00

ABELIAN GROUPS by L. Fuehs (Pergamon Press Ltd, London), 1959. Pp. 367. Price 63*s.* or $ 10.00

Miscellaneous

INVENTIONS, PATENTS AND THEIR MANAGEMENT by A. K. Berle & L. Sprague De Camp (D. Van Nostrand Co. Ltd, London), Fourth Edition, 1959. Pp. x + 602. Price 94*s.*

PUBLICATIONS RECEIVED

THE CHEMISTRY OF DRUGS by Norman Evers & Dennis Caldwell (Ernest Benn Ltd, London), Enlarged and Revised Third Edition, 1959. Pp. 415. Price 84*s.* net

1958 FIFTH NATIONAL SYMPOSIUM ON VACUUM TECHNOLOGY TRANSACTIONS, edited by Wilfrid G. Matheson (Pergamon Press Ltd, London), 1959. Pp. xi + 282. Price £ 5 net

PRINCIPLES OF ORGANIC CHEMISTRY by T. A. Geissman (W. H. Freeman & Co., San Francisco), 1959. Pp. viii + 635. Price $ 7.00

SIX-MEMBERED HETEROCYCLIC NITROGEN COMPOUNDS WITH THREE CONDENSED RINGS by C. F. H. Allen (Interscience Publishers Inc., New York), 1958. Pp. xxii + 624. Price $ 26.00

THE CHEMISTRY OF NATURAL PRODUCTS: Vol. II — MONO- AND SESQUITERPENOIDS, edited by P. deMayo (Interscience Publishers Inc., New York), 1959. Pp. vii + 320. Price $ 7.50

THE CHEMISTRY OF NATURAL PRODUCTS: Vol. III — THE HIGHER TERPENOIDS, edited by P. deMayo (Interscience Publishers Inc., New York), 1959. Pp. vii + 239. Price $ 6.00

MATHEMATICS FOR TELECOMMUNICATION ENGINEERS by S. J. Cotton (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), 1959. Pp. x + 245. Price 37*s.* 6*d.* net

CORROSION AND DEPOSIT IN COAL AND OIL-FIRED BOILERS AND GAS TURBINES by H. W. Nelson (Battle Memorial Institute) (Pergamon Press Ltd, London), 1959. Pp. vii + 198. Price 50*s.* net

INTRODUCTION TO PLASTICITY by William Prager (Addison-Wesley Publishing Co. Inc., London), 1959. Pp. viii + 148. Price $ 6.50 or 49*s.*

THE CALENDAR FOR THE MODERN AGE by Elisabeth Achelis (Thomas Nelson & Sons, New York), 1959. Pp. 220. Price $ 4.00

ELECTROLYTIC CONDUCTANCE by Raymond M. Fuoss & Filippo Accascina (Interscience Publishers Inc., New York), 1959. Pp. ix + 279. Price $ 8.00

CHEMISTRY OF CARBON COMPOUNDS — Vol. IVB— HETEROCYCLIC COMPOUNDS, edited by E. H. Rodd (Elsevier Publishing Co., New York; *Distributors*: D. Van Nostrand Co. Ltd, London), 1959. Pp. xviii + 1464. Price £ 5

SOME PROBLEMS OF CHEMICAL KINETICS AND REACTIVITY, Vol. II, by N. N. Semenov, translated from Russian by J. E. S. Bradley (Pergamon Press Ltd, London), 1959. Pp. x + 168. Price 35*s.* net

A DICTIONARY OF NAMED EFFECTS AND LAWS IN CHEMISTRY, PHYSICS AND MATHEMATICS by D. W. G. Ballentyne & L. E. Q. Walker (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), 1958. Pp. v + 205. Price 30*s.* net

CHEMIE DER AZOFARBSTOFFE by H. Zollinger (Birkhauser Verlag, Basel, Switzerland), 1958. Pp. 308. Price Fr. 37 or DM 37

THE ASHOKA GUIDE (Educational Trade Builders Association, Ambala Cantt, India), 1959. Pp. 360. Price Rs 18.50

NOTES & NEWS

Anti-lambda particle

EXPERIMENTAL EVIDENCE OF THE existence of the anti-lambda particle was presented at the Ninth International Conference on High Energy Physics held at Kiev. The anti-lambda particle is the newest of the 'strange' particles to be detected by the tracks left in a cloud chamber in its encounter with other particles. The photograph establishing its existence was taken in the 6 ft bubble chamber at the Lawrence Radiation Laboratory, University of California, and clearly showed the creation and decay of the anti-lambda particle. The photograph depicted an anti-proton entering from the bevatron at the bottom of the picture, then its track suddenly ended and, after a gap, two V-shaped tracks occurred. The V on the right was the result of the decay of an ordinary lambda particle. The V on the left was a consequence of the decay of an anti-lambda particle. Another particle was also seen on the left side of the V and was an anti-proton, which created, a little above, a four-pronged pi meson star [*Sci. News Lett., Wash.*, **76** (1959), 83].

Nature of gaseous carbon

GASEOUS CARBON AT HIGH TEMPERATURES, which has hitherto been considered as consisting exclusively of monatomic carbon, has now been shown to consist predominantly of polyatomic molecules, particularly triatomic molecules and molecules with five carbon atoms. This is unexpected because of the fact that the temperatures would be high enough to rupture the carbon-carbon bond.

The polyatomicity of carbon in the gaseous phase has been supported by a theoretical study using quantum mechanics. According to the calculations, if the gas phase is in contact with the solid phase in a closed system, the increasing pressure is sufficient to prevent dissociation at the polycarbon molecules at high temperature. There will be relatively little monatomic carbon at 2500°C. or higher temperature. Most of the molecules are in the form of chains, and those with odd number of atoms are more abundant. According to calculations, at 2500°K. the average chain length is 6·2 atoms [*Chem. Engng News*, **37** (33) (1959), 36].

Control of deuterium fusion reaction

THE OCCURRENCE OF A CONTROLLED fusion reaction for the duration of a small fraction of a second has been reported from the experiments involving thermonuclear reactions produced in the 'density magnetic mirror' machine at the Naval Research Laboratory, Washington. In this method deuterium, preheated by a shock wave, is compressed using an extremely high magnetic field. The energy released from an internal magnetic field and further magnetic compression bring the temperature up to its final value. A comparison between the magnetic pressure and the gas pressure has indicated that the temperature is of the order of 20,000,000°K., which is consistent with that necessary to produce the observed neutron yield by thermonuclear reactions.

These studies have led to three important new findings: (1) the plasma is contained for a long time relative to the time required for normal thermal distribution to occur; (2) the length of time during which neutrons are emitted is in agreement with theoretical calculations of plasma physics, and (3) the plasma is observed to be stable during approximately 10 μsec. in which neutrons are observed. Neutrons are emitted for a period of 2 μsec.

A larger device is being planned to verify these results. If the findings are confirmed, an important stage would be reached in the efforts for harnessing useful power from the deuterium nuclei [*Sci. News Lett., Wash.*, **76** (1959), 131.]

Verification of the quantum electrodynamic laws

A CRUCIAL EXPERIMENT DESIGNED to test whether the quantum electrodynamic laws, which hold good up to distances as small as 10^{-13}cm., are also valid for still smaller distances, has been proposed by a group of physicists at Princeton and Stanford Universities. The recent work of Hofstadter and his colleagues on the size of the neutron which has revealed that the magnetic moment of the neutron is not concentrated at a point but is spread over *c.* $0{\cdot}8 \times 10^{-13}$ cm., has stimulated this proposal for an experimental verification to find out whether the above unusual result is due to the invalidity of the usual quantum electrodynamic laws at such small distances, or due to other reasons.

The experiment will be carried out at the Stanford University's High Energy Physics Laboratory using the Mark III linear electron accelerator. In this machine, two high energy electron beams moving in opposite directions collide. Two beams are needed because a high energy beam colliding with stationary electrons would not give the desired effect. The relativistic mass of the high energy electrons would be so high compared with that of the unaccelerated ones that the latter would easily be knocked out of the way before there was a very close approach. The angular distribution of the scattered electrons will be measured with coincidence counters spaced around the collision area. If the laws are obeyed the distribution would be given, to a first approximation, by the formula

$$\frac{d\sigma}{d\Omega} = r_o^2 \left(\frac{m_o c^2}{E}\right)^2 \left(\frac{2}{\sin^2\theta} - \frac{1}{2}\right)^2$$

where $d\sigma/d\Omega$ is the number of electrons in a solid angle; r_o, the classical electron cross-section; $m_o c^2$, the energy of electron; E, the energy of electrons in the beam; and θ, the scattering angle. E will be varied from 100 MeV. (at which the theory is valid) to 500 MeV. (where its validity is doubtful) [*Chem. Engng News*, **37** (34) (1959), 36].

Ring current in space

EXPERIMENTAL EVIDENCE ABOUT the possible existence of a ring

current in space and encircling the earth at a considerable distance from it, a hypothesis put forward by Störmer many years ago, has been obtained from the results of experiments on space vehicles by the Russian scientists. This was reported at a recent meeting of the Cosmic-ray Subcommittee of the International Union of Pure and Applied Physics at Moscow.

The magnetometer measurements from the *Lunik* space probe, now in orbit round the sun, revealed an unexpected drop in the geomagnetic field strength at about four earth radii. The position broadly corresponds with the peak in intensity in the outer zone of Van Allen radiation. The curve of measured intensity against the theoretically calculated field strength at different distances from the earth indicated that the deviations are substantial. At a distance of between 20,000 and 21,000 km. it is assumed that the rocket passed through an electric current system; this is very much farther from the earth's surface than any previously detected layer of the ionosphere. The discovery seems to support the hypothesis of Störmer. Conditions were magnetically quiet on the day of the measurements and there had not been any major magnetic disturbance for a month preceding it [*Discovery*, **20** (1959), 400].

Study of upper atmosphere

THE NATIONAL BUREAU OF STANdards, U.S.A., has developed a promising method for studying the physics of the upper reaches of the ionosphere. The method uses very-high-frequency (v.h.f.) waves, most of which pass through the ionosphere, including those layers which reflect lower-frequency transmissions. In this passage, part of the energy of the v.h.f. waves excites electrons in the upper atmosphere — above heights of 50 miles. This causes re-radiation, or 'scatter', which returns low-power radio waves to earth. Until the development of this method, radar-type ionospheric soundings depended on observation at high frequencies (3 to 30 Mc/s.) of intense reflections from ionospheric layers dense enough to reflect the wave completely, and studies have largely been confined to determinations of the heights and characteristics of the 'maximum density' layers of the ionosphere.

Signals at a frequency of 41 Mc/s. generated by a transmitter capable of delivering 6 megawatts peak power are pulsed through a fixed antenna (beam width *c.* 4 deg.) into space. Pulses ranging from 50 to 150 μsec. in duration are repeated at a rate sufficient to maintain an average power of 40,000 watts. Four acres of land are covered by the antenna array which is composed of 1024 half-wave dipoles, 41·5 ft above a ground-reflecting screen.

The new technique should extend knowledge of the ionosphere by making possible temperature as well as electron-density measurements of the upper atmosphere. Such observations can serve to confirm rocket-derived measurements but are more suitable than rocket-mounted instruments for long-term studies of changes in the upper atmosphere up to a height of 400 miles, due to diurnal, seasonal and solar activity variations [*Tech. News Bull U.S. Bur. Stand.*, **43** (1959), 157].

Electron emission from silicon carbide

RESEARCH PHYSICISTS AT WESTinghouse's research laboratories have found that silicon carbide could be made to emit electrons continuously from its surface, thus acting as the cathode in a vacuum tube. This finding may make the vacuum tube popular again.

One of the chief disadvantages of vacuum tubes is that considerable power is needed to heat the cathode to emit electrons. But a silicon carbide semiconductor with a p-n junction needs very little power and yields electrons instantly and indefinitely when a small voltage is applied with reverse bias across the junction. Escape of electrons from silicon carbide is accompanied by emission of visible light — a form of electro-luminescence which occurs when enough voltage is applied to break down the junction's electrical resistance. This light is concentrated in small (*c.* 130 microns across) blue spots at the junction, but gives currents up to one microampere, with an electron density comparable to that from the cathode of a typical vacuum tube.

Many uses for this phenomenon have been foreseen: it could help in miniaturizing cathode-ray tubes, or vacuum tubes could be built with many components in them without being confronted with the problem of heat dissipation. Since the electrons come from almost a point source, the electron beam can be focussed readily. Other semiconductors also exhibit this property but none yields this high electron density.

Silicon itself and cesium on germanium give densities which correspond to about 1 μa. [*Chem. Engng News*, **37** (33) (1959), 36].

Stepping transistor

A p-n-p-n SEMICONDUCTOR ELEment that can serve as the basic building block of a silicon stepping transistor and which has potential applications in digital computers, push-button dialing and telephone switching is described. The four-terminal device acts as a pulse-controlled on-off switch. It may be used as a basic stage in building up certain logic circuits in digital computers, such as for counting and decoding. By using one element to drive two others, versatile decoders can be made. A more complex device, which is fabricated from a single piece of silicon, can also perform these logic functions. As a prototype arrangement, a stepping transistor with four stages or elements has been made.

The stepping transistor, as fabricated on a single piece of silicon, performs the function of a complex circuit. Hence it is referred to as a 'functional device'. The concept of a functional semiconductor device is a promising approach to microminiaturization. The stepping transistor utilizes a p-n-p-n transistor as the bistable element. The design of the structure results in a bistable voltage-current characteristic between a single common electrode and a set of multiple electrodes. Non-symmetrical geometry is employed to obtain a unidirectional transfer of voltage.

Close proximity between stages is not basically required in the stepping transistor. This is why stepping transistor elements comprising single four-terminal stages can be separately encapsulated and connected externally. The current level at which these devices are

operated can be designed to lie within the range of 1-100 ma. with supply voltages of 10-100 V. They have been operated at speeds up to one million pulses per second and improved designs may operate even faster [*News from Bell Telephone Laboratories, Release dated* 18 *August* 1959].

Sputtered microminiature resistors

AN IMPORTANT DEVELOPMENT IN microminiature electronics is the production of sputtered thin-film resistors, formed from refractory metals such as tantalum and titanium. Such resistors have been produced at the Bell Telephone Laboratories, New York, on glass or ceramic bases in lines as narrow as 1 mil spaced 1 mil apart, giving extremely high resistance in a small area. High component density in electronic circuits is thus possible.

To produce such a resistor, an overall thin film of copper is first deposited onto the ceramic or glass base by sputtering. Then, the desired pattern is etched into the copper surface by standard photo-etching techniques, leaving the bare substrate exposed. Tantalum, other refractory metals, or electrically useful alloys are then deposited into the etched copper pattern, and the whole unit placed in an etching bath. The copper with its overlay of tantalum is removed, leaving behind only the tantalum which is in direct contact with the bare surface. Since the masks are extremely thin, fine detail is possible. Also, since the sputtered materials adhere to the substrate itself, support considerations are not necessary and complex patterns can be produced.

An idea of the enormous miniaturization possible by such components can be had by the following example. In one experiment, a three-stage flip-flop circuit which occupied a standard printed circuit card $3{\cdot}5 \times 7$ in. was reduced to a ceramic substrate only 2×2 in.; but the board still contained 24 resistors in values up to 121,000 ohms, nine capacitors of 10,000 $\mu\mu$F. and plug-in arrangements for six transistors and nine diodes. In this arrangement, the density of passive components is about 275,000 per cu. ft, including the 50-mil thick substrate. Use of both sides of the board would approximately double this figure. Stacked modules would thus be a natural arrangement for extensive circuits.

One of the most important aspects of the new development is the production of high quality capacitors and resistors from a single metal, cutting down the number of required operations. Also interconnections can be made simultaneously with the components, thus eliminating faulty interconnections. Thus one of the greatest reliability hazards in miniaturized electrical circuitry can be eliminated [*News from Bell Telephone Laboratories, Release dated* 19 *August* 1959].

Printed circuits on ceramics

A NEW METHOD FOR PRODUCING printed circuits directly on ceramic basis without the use of adhesives has been developed at the Bell Telephone Laboratories. The basis of the new process, which uses standard silk screening techniques for forming the pattern, is a specially formulated copper-bearing paste. Following the printing of the desired pattern on the ceramic base, the piece is fired in a two-step process, resulting in a clean, durable pattern with good electrical characteristics. In the present methods of production, the bond of copper to the base is dependent on the strength of the adhesive and often, it fails during subsequent processing operations, such as soldering or assembly.

In the new process, a paste is prepared from a finely ground mixture of copper oxide and a special glass frit, blended with a standard silk screen printing vehicle. The paste is used to print the pattern on the ceramic, and the 'card' is heat-dried to remove solvents. After drying, the card with its pattern is fired in air at 750°C. for 20 min. to burn off the printing vehicle. This operation leaves a non-conducting copper oxide pattern, ready to be reduced to metallic copper.

The second firing operation is conducted at 850°C. for 30 min., in a controlled atmosphere containing hydrogen, nitrogen and oxygen. The hydrogen in the atmosphere reduces the copper oxides to metallic copper, while the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Without the presence of oxygen a poor bond results, the composition of the controlled atmosphere may be forming gas (85 per cent nitrogen and 15 per cent hydrogen) with the addition of 0·4 to 4·5 per cent oxygen. Such a gas mixture is non-inflammable.

Printed wiring cards prepared this way can be dip-soldered without bond failure and without the use of corrosive fluxes. In tests of bond strengths, 20-gauge headed wires were attached to the pattern with a contact area of about 0·01 sq. in. Bond failure did not occur up to a tensile stress of *c.* 2000 lb./sq. in., and even then generally involved breaking out the ceramic rather than bond failure.

The process is suitable for automatic production techniques, and should prove competitive with other printed wiring methods. With suitable modification of the vehicle, copper can be applied with a brush or spray gun. When fired, these coatings form a good base for making metal to ceramic bonds using lead-tin solders [*News from Bell Telephone Laboratories*].

Plasma jet spectroscopic source

A MODIFIED PLASMA JET OPERATING on conventional d.c. power supplies and capable of attaining temperatures up to 8000°C., designed and developed at the U.S. National Bureau of Standards, offers a new spectrometric method of analysing complex alloys. The plasma jet concept involves heating a gas stream to extremely high temperatures by constricting an electric arc passing between two electrodes. The hot ionized gas comprising the arc plasma emerges through an opening in the cathode as a flame-like jet. For spectrochemical analysis, a solution of the test specimen is drawn up a capillary tube and is sprayed into the arc plasma. The plasma jet vaporizes the solution and excites the elements to emit spectra that would not ordinarily be obtained at lower temperatures with chemical flames like the oxy-acetylene (attaining 3000°C.) and hydrogen-fluorine or cyanogen-oxygen (going up to 4500°C.) flames. The plasma jets developed for appli-

cations in high-temperature studies in physics and chemistry and as a source of high-temperature, high-velocity gas streams for wind tunnels have been several inches long and attained a maximum temperature as high as 40,000°C. and have been operated at currents ranging from 50 to many hundred amp. But to serve as a spectroscopic source, such large lengths and high temperatures are not required. With a d.c. current of 15-20 amp. the plasma jet attains a maximum temperature of 8000°C., sufficient to excite all elements in solution. For quantitative determinations the spectra of the test samples are compared with those of standard solutions. Using this method, iron, chromium and nickel, and the major constituents of stainless steel were determined within an error of 2 per cent [*Tech. News Bull. U.S. Bur. Stand.*, **43** (1959), 126].

Flexible plastic magnets

G. F. GOODRICH CO., AKRON, OHIO, have developed a flexible plastic which can be magnetized in any direction and can be cut into any size or shape without losing its magnetic properties. The plastic is being produced in strip rolls at the rate of 10 miles a week. The strips can be used on refrigerator doors to insulate and keep them shut by magnetic attraction.

The magnets are produced by melting a vinyl resin mixed with plasticizers and powder, then extruding the mixture in the desired shape and finally running the strips through a magnetic field. The poles, instead of being at the ends of the strips, extend the entire length, the north pole along one edge and the south along the other. The poles can also be reversed along a single strip at intervals, so that they can run north-south, south-north, north-south, etc., or, as in ordinary magnets, they can be induced at the ends of the strips. The keeping quality of these magnets is about double that of some small metal magnets now in use [*Sci. News Lett., Wash.*, **76** (1959), 88].

New ultraviolet absorbing material

THE AMERICAN CYANAMID CO., U.S.A., has developed a new ultraviolet absorber, UV314, in the Cyascop ultraviolet absorber series. The new product, 2,2′-dihydroxy-2-*n*-octoxy benzophenone, is a pale yellow powder, absorbing strongly in the 300-375 mμ region. Its long alkyl group (*n*-octyl) at the ether linkage makes it compatible with polyolefins.

Till now ultraviolet instability has limited polyethylene's use in outdoor applications, and currently available ultraviolet absorbers are not compatible with polyethylene. Though effective, carbon black limits the use of the resin to opaque black products. Extensive accelerated and outdoor exposure tests showed that 10-mil polyethylene sheets containing 0·171 per cent UV314 retained 85 per cent elongation after 2 months, while untreated ones retained only 9 per cent after the same period. The new absorber is expected to be available in commercial quantities next year.

UV314 will be used initially by the plastics industry in polyethylene fibres, films and sheeting in such applications as mulching greenhouse sheeting, high altitude balloons and moisture barriers for building construction. Marine ropes and fabrics for automotive upholstery and lawn furniture may be made with light-stabilized polyethylene fibres [*J. Franklin Inst.*, **268** (1959), 79].

Electrophoresis of plant virus preparations

ZONE ELECTROPHORESIS IN AGAR gel has been used for separating tobacco mosaic virus (TMV) and potato virus X (PVX) from crude plant extracts and reaction mixtures. The method also enables to follow the chemical changes that occur in biological systems.

The Reco electrophoresis chamber, model E-800-2, employed is modified for continuous buffer renewal by replacing the carbon electrodes with platinum wire contained within a $\frac{1}{4}$ in. dialysis tube. The electrode reaction products are removed by a slow passage of buffer through the dialysis tubing.

Stock Difco Bacto agar (2·5 per cent) is prepared by dissolving it in distilled water at 100°C., followed by cooling in a shallow tray, dicing, and finally dialysis against distilled water. The agar electrophoresis bed, 34 × 21 × 0·6 cm., is prepared by melting the stock agar with distilled water and tris (hydroxymethyl) aminomethane maleate (tris maleate), *p*H 7·0, buffer to give 0·7 per cent agar with a final buffer molarity of 0·02. The melted agar is then cooled to 50°C. and poured on to the water-cooled electrophoresis bed. Before the agar is poured, a celluloid sheet is placed on top of the bed to facilitate the removal of the agar after analysis. After the agar solidifies, narrow slots, 3 mm. wide, having approximately twice the capacity of the volume of the sample, are cut into the agar transverse to the electrical field and 6 cm. from the cathode end of the gel. A hot spatula is inserted into the empty slot and sufficient agar melted to seal the bottom to prevent the sample from running under the agar.

For large-scale preparative purposes a strip of Whatman No. 3 mm. paper is placed under the origin location of the sample before the agar is poured. This paper acts as a seal for the sample, permitting the omission of the heat-sealing step, a difficult procedure for large samples.

Tobacco plants, *Nicotiana tabacum* L. var. *haronova*, were inoculated with either TMV or PVX. Two weeks later the young top leaves were removed, immersed by their petioles in Hoagland's solution supplemented with Haas and Reed's trace element solution. Ten microcuries of P^{32} orthophosphate/ml. were added to the nutrient solution and the leaves permitted to photosynthesize under the mixed artificial and daylight illumination in the greenhouse. A sample of the leaf juice was expressed at 0°C. with a mortar and pestle and an aliquot of this juice was pipetted immediately into the slots for electrophoretic separation. The electric field strength was 4·4 volts per cm. (150 volts difference of potential at the electrodes with a current of 14 ma.). Upon completion of the electrophoretic separation the virus was located either by a variation of the serological gel diffusion precipitin test, by drying agar into a thin sheet suitable for autoradiography or for staining with Solway purple.

Serological precipitation was performed either on an extract from the gel or on the gel itself. In the

latter case a narrow strip of filter paper soaked in the appropriate rabbit antiserum was laid on the top of the gel. Incubation was necessary to permit diffusion of the antibody into the gel; usually 12 hr elapsed before a precipitin reaction was visible. Autoradiographic analyses were made using Kodak medical 'no screen' X-ray film.

Radioactive phosphate appears to be rapidly incorporated into a particle of large molecular weight which is probably TMV. The TMV band on the agar gel was found to be labelled within 2 hr of uptake of radioactive phosphate by young leaves, which suggests that the virus gets synthesized at a rapid rate [*Canad. J. Biochem. Physiol.*, **37** (1959), 119].

An antiviral drug

HELENINE, A COMPOUND PRODUCED by *Penicillium funiculosum* during conventional fermentation process, is the first chemotherapeutic agent which has been found to be an active antiviral agent. Helenine is found in the mycelium and is not exuded by the mold into the nutrient medium. It has been characterized as a ribonucleotide and is, therefore, structurally akin to the virus it combats. Being highly unstable, it has not been possible to characterize it further.

Helenine has been found to prevent the development of polio in monkey, if administered promptly before the appearance of symptoms. It also protects mice against a form of encephalomyelitis and against some other viruses [*Chem. Engng News*, **37** (34) (1959), 37].

New amino acid from *Citrullus vulgaris*

THE PRESENCE OF A NEW AMINO acid, α-amino-β-(pyrazolyl-N)-propionic acid, has been detected by two-dimensional paper chromatography in ethanol extract of ground seeds of *Citrullus vulgaris*. The amino acid is unique in that it is the first example of a natural product which contains a pyrazole ring. Furthermore, in contrast to other heterocyclic ring containing amino acids, the side chain is attached to the pyrazole ring through a carbon to nitrogen bond. The empirical formula corresponds to $C_6H_9N_3O_2$ and it contains an α-amino group. Hydriodic acid degradation gave alanine suggesting the presence of alanine in the structure of the amino acid and through a C—N linkage. The presence of a pyrazole ring was established as a result of the study of the nuclear magnetic resonance spectra performed on the isolate and various N-substituted imidazole and pyrazole derivatives. The fine structure of the spectrum of the isolate also indicated an unsubstituted α-amino group in alanine residue and the presence of a $-CH_2-$ group and an N—C linkage. The structure has been further confirmed by synthesis. The synthetic product was inseparable from the isolated material on paper chromatograms [*Nature, Lond.*, **184** (1959), *B.A.* 69].

Vitamin D and citrate metabolism

AN INTIMATE CONNECTION BETWEEN bone biochemistry, citrate metabolism and vitamin D is now well established, but the nature of this relationship is still largely unknown. It has been demonstrated by De Luca *et al.* [*J. biol. Chem.*, **228** (1957), 469] that vitamin D interferes with oxidative removal of citrate, added to kidney homogenates and mitochondria. While this observation may offer an explanation for the increase in tissue and urinary citrate induced by vitamin D, it does not preclude the possibility of an increased citrate synthesis due to this vitamin.

Meyer *et al.* [*Arch. Biochem. Biophys.*, **81** (1959), 340] have investigated this possibility by studying the synthesis of citrate from acetate and oxaloacetate in rachitic and normal rats. Kidney, liver, heart, gut and cartilage slices were used in this study. Except in the case of cartilage tissue, no difference was observed between rachitic and normal tissues. The data obtained suggested that vitamin D may interfere with the oxidative removal of citrate added as such, but not with that formed from its normal precursors. The same authors have also investigated the postulate that citrate *per se* may not be involved in the metabolic mechanism, but in an active form as the phospho or pyrophospho citrate. As calcium salts, these compounds form excellent vehicle for the absorption, transport and deposition of bone salts.

According to a recent report by De Luca *et al.* [*Fed. Proc.*, **18** (1959), 212] vitamin D does not have any direct effect on the enzymes involved in citrate metabolism, but it influences the structure and permeability of kidney mitochondria.

In contrast to other tissues, cartilage does show a distinct vitamin D effect, as evidenced by depressed metabolism and synthesis of citrate in rachitic cartilage. This was first observed by Dikshit *et al.* [*Indian J. med. Res.*, **44** (1956), 719] and later confirmed by Meyer *et al.*

Nutrients in agar

THE COMMON OBSERVATION THAT IN cultural experiments using large inocula, little or no growth occurs on agar without added nutrients, but with small inocula an appreciable multiplication takes place, has been made use of in the development of a method for assessing the freedom of agar from nutrients able to support the growth of microorganisms. The method involves exposing a small number of cells to a comparatively large volume of substratum in a manner that allows convenient determination of the amount of growth produced by each cell of the inoculum.

Millipore membrane filter of type TV, 20 μ thick with a pore size of 50 μμ, is cut into pieces 5×10 mm. which are sterilized by autoclaving in distilled water, and placed on the surface of sterilized filter paper in a petri dish. Each piece is seeded with a platinum loop of washed cell suspension. If the petri dish contains two 9-cm. Whatman No. 3 filter papers with one 7-cm. No. 1 filter paper on top, the whole being moistened with 5 ml. sterilized water or buffer, the suspension liquid is drawn through the membrane into the filter papers by surface tension within a few seconds, leaving the cells on the surface. This operation makes a filtration funnel unnecessary for membrane seeding, with resulting economy in area of membrane needed per experiment. The pieces of membrane may then be transferred conveniently with a small

stainless steel spatula to any desired environment. At the conclusion of the period allowed for growth, they are transferred to small drops of erythrosin-saturated lactophenol on a slide. The lactophenol partially cleans the membrane and the cells are made more easily visible by the dye. The mounts thus prepared are semipermanent.

In a typical experiment the method was used for comparing the growth of yeast in several environments of negligible nutrient content. It was found that agar washed with versene supported much less growth than commercial agar. Least growth occurred on porcelain. It has been concluded that when using commercial agar as a growth substratum in investigating the nutritive value of a substance, it is advisable to wash the agar thoroughly or else use large inocula. Other alternatives are to use instead blocks of unglazed porcelain or silica gel [*Canad. J. Microbiol.*, **5** (1959), 421].

Productivity

THE NATIONAL PRODUCTIVITY Council, India, has started publishing a new bimonthly entitled *Productivity* since November 1959 with the object of making the country productivity conscious and propagating the concept and techniques of productivity. The journal contains a number of informative and instructive articles on planning, standardization, quality control, occupational health, worker-management co-operation, management training, etc. The varied activities of the Council since its inception are set forth in detail in an article entitled 'NPC and the Productivity Movement'. The subscription for the journal is Rs 1.50 per issue and it can be obtained from the Council's office at 38 Golf Links, New Delhi or its regional offices.

Building Research in India

THE CENTRAL BUILDING RESEARCH Institute, Roorkee, has compiled a list of research problems in various aspects of building research and related problems being undertaken at the several major Indian research organizations in the field. About 30 important research institutions are included in the list and under every institution the major research problems and their scope are briefly indicated as well as a list of the names of the workers engaged in the respective fields. It will be of value for those engaged in building research for keeping them informed of the activities of other research institutes and exchanging information of mutual interest.

Proceedings of Symposium on Contact Catalysis

THE PROCEEDINGS OF THE SYMPOsium on Contact Catalysis held in Calcutta during 4-5 May 1956 under the auspices of the National Institute of Sciences of India have been issued as a Bulletin of the Institute [*Nat. Inst. Sci. India, Bull.*, **12** (1959), pp. 302]. The contributions numbering 28 have been classified under the following heads: (1) Structure and surface of solid catalysts and their relation to catalysis; (2) Techniques of catalysis; (3) Catalytic reactions at high pressures; (4) Catalytic reactions at ordinary pressures; and (5) Miscellaneous. The Bulletin is priced Rs 13.75.

Proceedings of Symposium on Radioisotopes

THE PROCEEDINGS OF THE SYMPOsium on Radioisotopes held in Bombay during 3-4 May 1957 under the auspices of the National Institute of Sciences of India have been published. Besides the inaugural address of Dr V. R. Khanolkar on the role of radioactive isotopes in national development, 15 papers presented at the symposium are reproduced. The papers have been grouped under the following categories: Preparation of isotopes and measurement of radioactivity (4); Applications in chemistry (1); Applications in biochemistry (3); Applications in agriculture (1); Applications in industry and metallurgy (1); and Applications in medicine (5). The publication, running into 102 pages, is priced Rs 5.62.

Data on Corrosion Resistance of Aluminium

THE AMERICAN SOCIETY FOR TESTing Materials (ASTM) has published a special reprint of the 100-page booklet *Atmospheric Exposure of Wrought and Cast Aluminium Alloys* ($ 1.75), which contains the data covering the first three years of exposure of wrought aluminium and magnesium alloys as a part of the atmospheric exposure programme initiated in 1953 by the ASTM Committee B-7 on Light Metals and Alloys, Cast and Wrought. The data indicate that some of these alloys withstand the rigours of a wide variety of naturally corrosive atmospheres. These data will assist industry in the solution of various corrosion problems involving the use of aluminium and magnesium alloys in automotive, constructional and aircraft uses.

Under the exposure test programme, 27 aluminium and 8 magnesium commercial alloys are being exposed to atmospheres at five locations to determine change of tensile strength, elongation, and yield strength. Exposures are being made in industrial, rural and marine atmospheres, and will continue for a total of ten years.

The three-year data on aluminium and magnesium castings are reprinted from *ASTM Proceedings*, Vol. 58, 1958, and the data on wrought aluminium and magnesium alloys are reprinted from *ASTM Proceedings*, Vol. 59, 1959.

The reprints may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Index to Literature on Spectrochemical Analysis

THIS COMPILATION (STP 41D, pp. 318, price $ 6.50), the fourth part of a series of bibliographical surveys of the literature on emission spectrochemical analysis, covers, as in previous parts, the period 1951 to 1955 and contains 1879 new references besides 12 not previously listed from the periods covered earlier. The abstracts are largely quoted verbatim from *Chemical Abstracts*, but a few are abridged or directly quoted from other publications. Efforts have been made to ensure completeness; however, reference to papers containing only a few qualitative results have generally been omitted.

Copies of the book may be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa.

Russian scientific literature

THE PERGAMON INSTITUTE, Headington Hill Hall, Oxford, has undertaken a comprehensive programme of publishing translated versions of scientific, technical and medical journals, books and reports originating from Russia and the Slavonic countries. The projects which have already been started or are being planned include publication of translations of (1) a series of review volumes, with complete bibliographies, covering broad areas of Russian scientific, medical and technical progress, under arrangement with the U.S.S.R. Academy of Sciences' Institute of Scientific Information; (2) World Technical Digest, based on important articles selected from 48 weekly journals covering all the important industrial subjects; (3) Russian-English and Chinese-English scientific and technical dictionaries and glossaries; and (4) Important Russian books.

The Institute is already publishing translated versions of the following 18 Russian journals (in full or selected papers): *Atomnaya Energiya*; *Electric Technology, U.S.S.R.*; *Pavlov Journal of Higher Nervous Activity*; *Problems of Psychology*; *Problems of Cybernetics*; *U.S.S.R. Patents and Inventions*; *Problems of Virology*; *Problems of Hematology and Blood Transfusion*; *Journal of Microbiology, Epidemiology and Immunobiology*; *Biophysics*; *Problems of Oncology*; *Sechenov Physiological Journal of the U.S.S.R.*; *Physics of Metals and Metallography*; *Abstracts of U.S.S.R. Metallurgy*; *Radio Engineering*; *Radio Engineering and Electronics*; *Telecommunications*; *Applied Mathematics*; and *Mechanics*. In addition, the Institute provides listing and abstracting services, bibliographical services, reciprocal services, and services for critical evaluation of Russian publications and supply of books, journals and microfilms, translations of books, journals, articles and extracts and Soviet patents.

Announcements

▪ Dr J. W. Whitaker, formerly Director of the Fuel Research Institute, Jealgora, and later, Director of the Central Mining Research Station and the School of Mines & Applied Geology, both at Dhanbad, has now been appointed as an adviser on mining problems to the Government of India under the Technical Co-operation Scheme of the Colombo Plan. He will advise the Council of Scientific & Industrial Research on mining research and allied subjects and on the establishment of the Central Mining Research Station at Dhanbad. Dr Whitaker will also advise on the creation of facilities for research in, and development of, Indian petroleum resources. Dr Whitaker has served in India with the Council of Scientific & Industrial Research for the past 13 years. He has also served for some time as Deputy Director-General of Scientific & Industrial Research.

▪ Dr G. S. Puri has been appointed Director of the Central Botanical Laboratory, Allahabad. He succeeds Dr E. K. Janaki Ammal, who was the first Director of the Laboratory and has now retired.

Dr Puri's contributions to botany during the last 25 years have been varied. He has done outstanding work in palaeobotany and his work in phytogeography and ecology has brought him international recognition. He was the Forest Ecologist at the Forest Research Institute, Dehra Dun, for about 10 years and during the last three years he has served as Regional Botanist of the Western Circle of the Botanical Survey of India. He completed a reconnaissance survey of the vegetation of Western India. Dr Puri has published about 200 botanical papers; besides he is the author of two books, viz. *Indian Manual of Plant Ecology* and *Forest Ecology*.

▪ *Award of Doctorate Degrees* — Shri Kale Narayan Ramchandra has been awarded the Ph.D. degree of the Poona University for his thesis entitled "*Studies in some aspects of blood coagulation*".

The Agra University has awarded the Ph.D. degree to Shri Vishnu of the National Sugar Institute, Kanpur, for his thesis entitled "*Physico-chemical studies on polycomponent saccharine system*".

The following have been awarded the Ph.D. degree of the Delhi University for the theses given in parentheses against their respective names: Shri Rabindra Nath Konar (*Morphological and embryological studies on Pinus roxburghii Sar., and Pinus wallichiana Jack.*); Shri Surendra Parshad Bhatnagar (*Morphological and embryological studies in the Santalaceae*); and Shri Chandrakumar Kantilal Shah (*Morphological and embryological studies in the families Cyperaceae and Juncaceae together with a discussion on their systematic positions*).

INSTRUMENTS AND APPLIANCES

Infrared hygrometer

AN INSTRUMENT FOR MEASURING humidity by absorption spectrum analysis — the infrared hygrometer — has been developed which offers possibilities to the meteorologists in special problems where conventional methods prove inadequate and higher cost of instrumentation will be justified.

The instrument is a relatively simple one in which the energy attenuation in the 2·6 μ water band is related to the concentration of water vapour in the sensing path. The assembly consists of a source of infrared radiation, a means for isolating selected wavelengths of radiation, the sensing path or absorbing column containing the atmospheric sample, and a radiation detector. Some possible areas of applications for this technique are micro-meteorology, Arctic meteorology and upper air meteorology which present special difficulties in the use of conventional methods [*Bull. Amer. met. Soc.*, June 1959].

Ceramic magnets for microwave equipment

A PERMANENT CERAMIC MAGNETIC material, Indox VI, recently developed by the Indiana Steel Research Laboratories, has made possible substantial savings in both material and space in microwave equipment. It has an even higher coercive force than previously available Indox V, and it is designed for applications where greater resistance to demagnetizing fields is required, or where magnet length is limited as compared to its size. Another advantage is that it can be magnetized before assembly, with results almost equal to magnetizations after assembly. Indox VI has a greater resistance

to irreversible flux loss caused by exposure to low temperatures. A full line of 'C' type Alnico V permanent magnets for load isolators is available. They are lighter and shorter, thus permitting a more compact and efficient design. Further, there are special-purpose magnets for microwave equipment such as magnetrons and backward wave oscillators.

Full details are available from Ad. Auriema Inc., 85 Broad Street, New York 4, N.Y.

Non-magnetic alloy for instrument parts

A HIGH-PURITY COPPER-NICKEL alloy developed promises to be useful in the elimination of interfering small magnetic effects of material parts of measuring instruments which have to be used in the vicinity of magnetic fields. These items like balance arms, sample holders, Dewar walls to be used between the poles, torsion fibres, galvanometer suspensions, etc., are made of non-ferromagnetic materials like copper, brass, aluminium, quartz, etc., but occasionally the small effects due to intrinsic magnetic moment or impurities become a problem. The alloy with the composition 96·3 per cent copper and 3·7 per cent nickel by weight and fabricated from copper of 99·999 per cent purity and nickel of 99·997 per cent purity has been found to be completely non-magnetic. Tests have shown that the alloy has zero magnetic moment at room temperature and less than a tenth of the magnetic moment of pure copper at all temperatures down to 2°K. The susceptibility of the alloy is independent of the magnetic field from 0 to 24,000 oersteds [*Rev. sci. Instrum.*, **29** (1958), 1118].

Improved public address systems

A NEW ELECTRONIC METHOD developed at the Bell Telephone Laboratories, New York, minimizes the distracting howl of indoor public address systems caused by acoustic feedback of room reverberations. The method permits a two-fold increase in the loudness of a conventional public address system without incurring instability. The method is the consequence of an acoustics research investigation which led to the formulation, in 1954, of a theory of response fluctuations inside a room.

The basis of the present development is a constant-frequency shift device, called a frequency shift modulator. It is inserted in the circuit between the microphone and the loudspeaker. When the input signal frequency shift is made equal to the mean distance between the major peaks and adjacent valleys of the room's gain response characteristic, energy generated at the gain peaks is quickly absorbed in the valleys of the response characteristic after one trip of the sound energy around the acoustic feedback loop. A typical value of the actual frequency shift required is 5 c/s. [*News from Bell Telephone Laboratories*].

G-R secondary frequency standard

A COMPACT, CRYSTAL-CONTROLLED time/frequency calibrator, type 1213-D, with a short-time stability of 1 part in 10^7, which furnishes standard frequencies from 10 kc/s. to 1000 Mc/s. not only for the calibration of electronic equipment but also for the measurement of unknown frequencies, has been developed by the General Radio Co., West Concord, Mass. The instrument also provides timing markers at decade intervals from 0·1 to 100 μsec.

An internal crystal oscillator, using a 5-Mc/s. AT-cut hermetically sealed quartz plate, is electron coupled to 2: 1 multiplier, followed by a 10 Mc/s. buffer stage which drives a series of multivibrators with fundamentals of 1000, 100 and 10 kc/s. Generated harmonics can be mixed with an incoming signal in the internal crystal mixer or fed to other equipment through a coaxial 50-ohm line. Audio amplification is provided for the beat frequencies thus produced, and video amplification is available for the timing-marker signals.

Another feature is a narrow-range frequency adjustment for setting of the crystal oscillator to zero beat with standard-frequency transmissions or other external standards. A special feature is the provision of a touch-button deviator to introduce a small frequency decrease to establish *sense* in indications near zero-beat. When standardizing against radio transmissions, the calibrator affords all the functions of an accurate standard of frequency. The overall size including the power unit is 14·5 × 5·75 × 7 in.

ERRATA

This Journal, Letter to the Editor entitled "Detection of Low Concentrations of Ethane & Propane in Natural Gas Streams", **18B** (October 1959), page 442, R.H. col.: the caption for Fig. 1 should *read* as follows and not as printed:

FIG. 1 — INFRARED SPECTRA OF PURE METHANE AND OF BLENDS OF METHANE WITH ETHANE AND PROPANE [A: methane, 100 per cent; B: methane, 99·93; ethane, 0·04; propane, 0·03 per cent; C: methane, 99·85; ethane, 0·09; propane, 0·06 per cent; D: methane, 99·62; ethane, 0·22; propane, 0·16 per cent; E: methane, 98·97; ethane, 0·58; propane, 0·43 per cent; and F: methane, 89·74; ethane, 5·95; propane, 4·33 per cent].

Article entitled "Assimilation of Amino Acids by *Streptomyces olivaceus*", **18C** (September 1959), page 161, second paragraph of the 'Abstract', line 2, *for* "aerobic", *read* "anaerobic".

Progress Reports

INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE FORTY-NINTH ANNUAL REPORT OF THE INSTITUTE records the progress in research and instructional activities of the 15 departments and sections during 1957-58. The number of research papers emanating from the various departments and sections was 175. During the year, 42 research schemes sponsored by different organizations (including 21 C.S.I.R. schemes) were in operation. A special one-year course in metallurgy was instituted in the Department of Metallurgy since January 1958 for imparting specialized training to the personnel of the steel plants in the public sector. The total expenditure during the year was Rs 6,657,060.

General chemistry — Studies on the adsorption isotherms of association colloids have shown abrupt increase in the isotherm after the critical micellar concentration. The course of the adsorption isotherm has been accounted for by the new postulate that desorption of both single adsorbed ions and surface micelles occurs on collision between the adsorbing surface and micelles in solution, in addition to the previously established processes of adsorption and desorption of single molecules or ions and adsorption of whole micelles.

Investigations on the stabilizing action of different members of the homologous series of normal alcohols on lithium stearate suspension in heptane have revealed that the stability of the suspension is not only a function of the concentration of the additive, but also of its molecular weight. Work on the collector function of xanthates has indicated that traces of metal salts have profound influence on the rate of oxidation of the xanthate to dixanthogen. These results are supported by contact angle measurements at the solid-solution-air interface.

Work on the adsorption of carbon monoxide by metal powders has revealed that there is no formation of carbonyl in the case of cobalt, but in the case of iron, the metal appears to be converted into the oxide and carbide.

Organic chemistry — A stereospecific synthesis of the female sex hormone, estrone, has been achieved. Important among the other compounds synthesized were 2-methylazulene and Se-guaiazulene. Work is in progress on the synthesis of 8-isosteroid, 19-nortestosterone, 18,19-bisnorsteroids and analogues of cortisone and corticosterone.

Biochemistry — An enzyme catalysing the conversion of riboflavin to flavin mononucleotide was observed for the first time in plants. A 75-fold purification of the enzyme with a recovery of 38 per cent was achieved by fractionation with ammonium sulphate and chromatography on alumina. The optimum pH for flavokinase activity was found to be 8·6 and the optimum temperature 55°C. The occurrence of an enzyme catalysing the synthesis of riboflavinyl α-glucoside from riboflavin and maltose has been demonstrated in green gram. Another enzyme capable of building up glucofructosans from sucrose has been detected in the water extracts of the tubes of *Crinum longifolium* and *C. latifolium*.

A new species of Streptomyces, producing highly potent antibiotic against fungi and yeasts, has been isolated from Indian soils. The enzymes synthesizing flavin nucleotides have been shown to occur in cow and human milk. It was shown for the first time that the nucleus could be seen in living yeast cells under specified physiological conditions. From a study of several species and strains of yeasts, the living nucleus has been shown to have a structure similar to that of higher organisms.

The agar electrophoresis technique developed for the separation and quantitative estimation of proteins has been adopted as a preparative method for the isolation of large quantities of proteins. About 1-2 ml. of serum can be subjected to electrophoretic fractionation. Albumin, α-, β- and γ-globulins of serum have been separated in a homogeneous state without denaturation. The technique has been employed for the separation and isolation of mucoprotein and albumin. A paper chromatographic method for the separation of DNP amino acids has been developed and is being applied to the end group analysis of proteins. A new species of anaerobic bacterium, *Clostridium lactoacetophilum*, has been isolated from soil. The organism has been shown to be dependent on iron for its growth and metabolic activity and it is likely to be of use in the assay of iron in any of its combinations.

Physics — Several related topics in the field of solid state physics, such as Raman and infrared spectra of crystals, crystal structure analysis by X-rays, paramagnetic resonance in crystals and thermal and optical properties of crystals featured prominently among the research activities of the department. Structure analysis of potassium perchlorate, potassium permanganate and ammonium perchlorate crystals by X-ray crystallography has been completed and accurate data on the atomic positions have been computed for these crystals. The technique of depression of the scattering of an atom for wavelengths close to its absorption edge has been successfully exploited for the first time in the analysis of the structure of cartosymmetric crystals.

Metallurgy — The effect of unsaturation on the collecting power of unsaturated fatty acids was studied by contact angle measurements on calcite. The collecting power has been found to increase with unsaturation only up to two double bonds, further increase in the number of double bonds having no effect.

Two methods have been worked out for determining ultrasonic velocities through short lengths of solids using a two-crystal piezoelectric set-up. The first method depends on the observation that when the specimen is placed between a quartz driver and a quartz gauge crystal, two kinds of signals with dif-

ferent arrival times are present in the gauge circuit at any driving frequency — one due to the propagation of mechanical vibrations and the other due to the e.m.f. directly induced in the gauge circuit from the driver. By changing the driving frequency it is possible to find the frequency at which the difference between the times of arrival of the two signals corresponds to a self-integral multiple of the period of vibrations. This frequency is determined either by decrease or increase in the amplitude of vibration as obtained from the voltage output of the gauge crystals. From two such frequencies it is possible to calculate the velocity of sound through the specimen by means of a simple equation. The second method consists in determining the time delay of the signal travelling through the specimen as compared with the e.m.f. in the circuit of the driver crystal at direct frequency and comparing the time lag with the the lag of the signal in case of direct contact between the driver and the gauge crystals. The difference between these two time lags is the time of travelling of the signal through the specimen.

Chemical technology and chemical engineering — From fundamental studies on Fischer-Tropsch synthesis, the formation and existence of CO-complexes and CO-H_2-complexes on iron and cobalt crystals at low temperatures prior to the proper synthesis reaction have been ascertained.

A pilot plant for carrying out hot fluidization experiments up to 800°C. has been constructed.

A continuous electrolysis process has been worked out for the enrichment of heavy water in pre-enriched water from bitterns. A separation factor of 1·4, which is much higher than the separation factor for the distillation operation, has been achieved.

Aeronautical engineering — Studies on transition in the boundary layer of a flat plate have given a uniform picture of the mean transition flow. The main finding concerns with the explanation of the fundamental role played by the intermittency factor in the transition region. The observed statistical similarity of transition regions on a flat plate can be explained on the basis of an extension of Emmon's theory, knowing the location when the intermittency factor departs from zero. In the transition region the entire behaviour of the mean boundary layer flow can then be explained.

An exact solution has been found by using oblique co-ordinates for thermal stresses in simply supported parallelogram plates.

Internal combustion engineering — It has been established that considerable saving in fuel consumption can be effected in an air-cooled diesel engine by suitable matching of the cooling air-flow to the load conditions. Keeping the engine operating temperature at a high value at all loads confers the additional advantage of reduced wear of engine parts. From studies on phased injection of fuel in high speed diesel engines it has been observed that a decrease in the noise level, exhaust temperature, smoke density, ignition delay and specific fuel consumption can be obtained by suitable phasing of the fuel injection during the later part of the compression stroke.

Power engineering — Experiments conducted on induction heating at power supply frequency of 50 cycles and supply voltage of 220 V. have yielded results which hold promise of using this form of heating for both domestic and industrial purposes with advantage over resistance heating. A small induction heater using steel and ordinary D.C.C. coils has been designed and constructed and has given good results. With only about 300 W. of power input at the supply frequency it has been possible to obtain a temperature of the order of 300°C. on the steel plate, sufficient to boil a good quantity of water in a few minutes. Compared to this, resistance heaters required three times the power to do the same work in almost the same time.

Electrical communication engineering — A method has been developed which, without resorting to conformal transformation, utilizes the superposition technique to arrive at amplification factor formulae for high vacuum triode configurations with large screening fractions. By this method formulae have been derived for cylindrical triodes having a simple cylindrical cathode wire or a squirrel-cage type filamentary cathode.

From a statistical study of some of the Indian languages (Hindi, Malayalam, Marathi, Tamil and Telugu) a method based on phonetic analysis has been developed for collecting data on the relative frequencies of speech sounds and speech sound diagrams for the different languages. The data thus obtained have indicated the possibility of developing a telegraph code common to all Indian languages. Based on these data a common code has been worked out which does not fall short of the optimum codes for any of the individual languages by more than 7 per cent.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN): ANNUAL REPORT, 1958

THE STRENGTH OF SCIENTIFIC AND TECHNICAL PERsonnel of CERN, which moved into its permanent headquarters at Meyrin during the year, stood at 428. Fellows, associates and guest professors together numbered 60. The budget for the year was 56,453,400 Swiss francs.

The synchro-cyclotron was brought into full operation during the year and research work carried out with it has already yielded significant results; the first important result obtained relates to the direct decay of a π-meson into an electron and a neutrino. Further research programme envisaged relates to the design and construction of counters and small and large bubble chambers and new principles of acceleration.

The activities carried out directly under the authority of the Director-General included the study of high energy ($\sim$100 Bev.) nucleon-nucleon collisions in paraffin (the Jungfraujoch experiment). Out of thousands of photographs obtained, fifty which satisfy pre-established criteria for measurability were selected.

During the year the CERN brought out about 30 technical publications. The 1958 Annual International Conference on High Energy Physics was arranged at the CERN headquarters from 27 June to 5 July 1958, and was attended by over 300 scientists from 30 countries.

Some important activities of the different divisions are summarized below:

Theoretical Studies Division — A number of useful contributions have resulted from exchange of ideas between experienced guest professors, theoretical physicists and experimental workers in such branches of study as calculation of bremsstrahlung of polarized electrons; rearrangement energy in nuclear matter; evaluation of the high energy inelastic scattering of nucleons in complex nuclei; and the μ-capture problem.

One group of physicists has reformulated the static theory of pion-nucleon interactions. New information has been obtained on pion-nucleon scattering, photoproduction and radiative scattering. The corrections to the nucleon form factor due to nucleon recoil have been evaluated. Dispersion relations have been set up for the scattering of particles by potentials. It is expected that a comparison of these relations with the usual field theory dispersion relations will lead to information about the mesic potential between two nucleons.

A simple and general formulation of the cusps theory has been developed which can be applied to Λ production near the Σ threshold. Consequences of the global and restricted symmetry hypotheses for the production of hyperon-antihyperon pairs have been derived and experiments for the approximate verification of these hypotheses have been suggested. Attempts have been made at a formal unification of the weak interactions and the discovery of π (e ν) has considerably simplified the problem.

Proton-synchrotron Division — The work of this Division has been mainly concerned with the construction of the 25 GeV. proton-synchrotron, and research on new types of accelerators centred around the problems of establishing a very high intensity electron stream at relativistic velocities. Two methods, the ' plasma betatron ' and ' beam stacking ', have been pursued. The beam stacking method can be applied to a different problem, viz. designing an intersecting beam machine. The model being studied can support, in the same magnet, two electron streams going in opposite directions. When sufficient intensity is built up in both streams they can be allowed to intersect, producing interactions at twice the energy in the centre of mass system of each single beam.

Synchro-cyclotron Division — An outstanding result obtained during the course of the first experimental programme is the discovery of a new mode of decay of the π-meson which has contributed fundamentally to the knowledge on elementary particles and stimulated other fundamental problems in elementary particle physics. By using a range-telescope to discriminate between the electrons from pion decay and muon decay and by using a photographic system of recording, the existence of the theoretically predicted and till then experimentally undetected electron mode of decay has been conclusively established. From 73 instances of the pion-electron decay observed, it has been established that the branching ratio between this mode and the normal decay mode is about 10^{-4} as required by theory. The discovery has removed a major difficulty in the theory of elementary particles and their interactions.

An experiment designed to test the hypothesis of charge independence directly by measuring (with an accuracy of 5 per cent) the ratio of the cross-sections of the reactions

$$p + d \rightarrow He^3 + \pi^\circ$$
$$\text{and } p + d \rightarrow H^3 + \pi^+$$

has given encouraging results. If charge independence is valid the ratio should be 2. The high intensity of the extracted proton beam enables counting rates of 1/s with high angular resolution. In this experiment the external proton beam traverses a liquid deuterium target and the He^3 and H^3 particles produced at a definite angle have been identified by momentum selection, by time of flight and by pulse height analysis.

Studies have been undertaken on the reaction $p + d \rightarrow He^3 + \pi^\circ$ with a view to measuring the effective mass of the π° mesons produced in the process. The results should throw light on the existence or otherwise of the new type of π°-meson with zero isotopic spin, proposed by Baldin. Preliminary exposures made have confirmed that the cross-section is about what was expected.

From tritium measurements undertaken in the meteorite fall in 1958, the tritium content could be correlated with the cosmic radiation producing the tritium as spallation product in high energy nuclear events. The measured activity is equivalent to a cosmic ray intensity of 0·44 primary particles/sq. cm./sec./ster. This value is higher by a factor of 2 than the intensity measured by balloon flights and rockets. This is not improbable considering the results from the artificial satellites and Pioneer rockets.

Scientific and Technical Services Division — This Division has been engaged in providing auxiliary services in such subjects as instruments for evaluation of photographs, electronic computation and health physics. Besides, the design and construction of a few special instruments to meet the requirements of the different Divisions have been undertaken. They are: (1) a tissue equivalent dosimeter; (2) an integrator using a magnetic amplifier and low inertia motor for measuring very low doses; (3) a pulse height analyser using scintillation and proportional counters for analysing the stray radiation fields around the cyclotron and (4) a low background sectional steel shield for standardization counters used for environmental measurements.

Programming for the analysis of experimental data on pion-pion scattering on the 704 computer has been started. The printed output of the computer gives the description of the event as reconstructed in space after correction for the optical distortions, the angle between the tracks, the coplanarity and the data on kinematics of the collision, all with corresponding errors. It also prints out indications on the events to be rejected because of internal inconsistencies in measurements. The calculation time is *c.* 7 sec./event.

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