Journal of Scientific & Industrial Research

A — General

N THIS ISSUE

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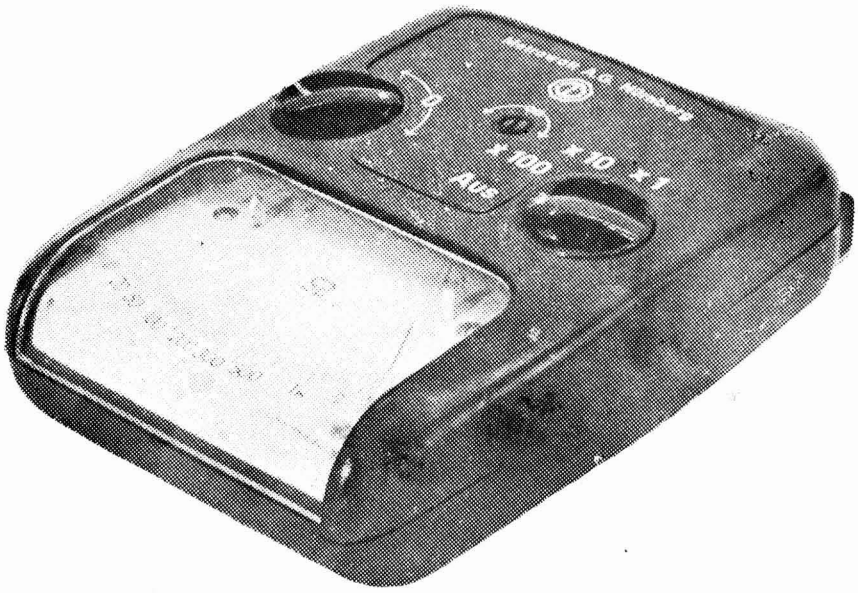

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Journal of
Scientific & Industrial Research

Vol. 15A, No. 11, NOVEMBER 1956

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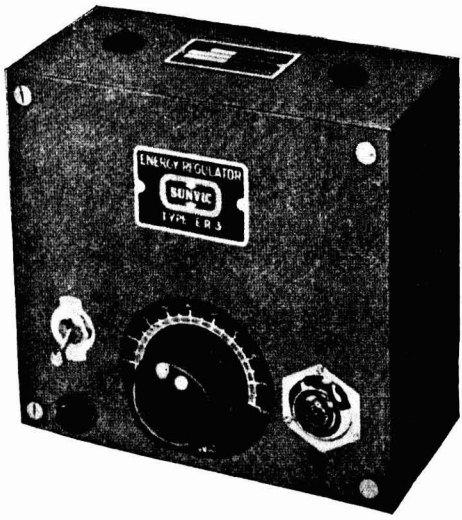

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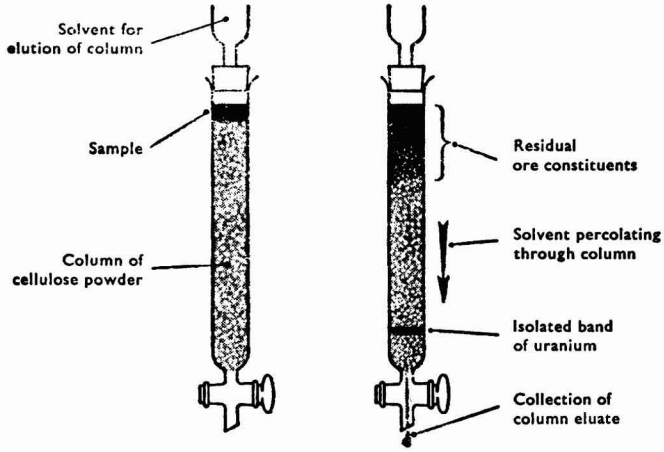

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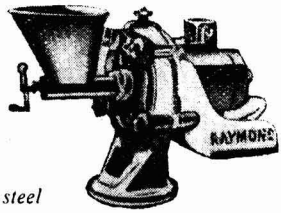

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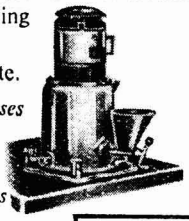

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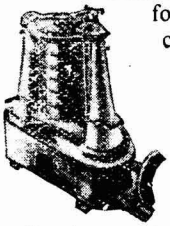

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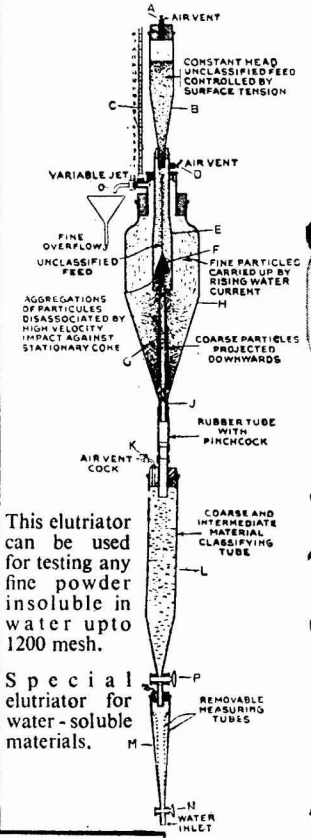

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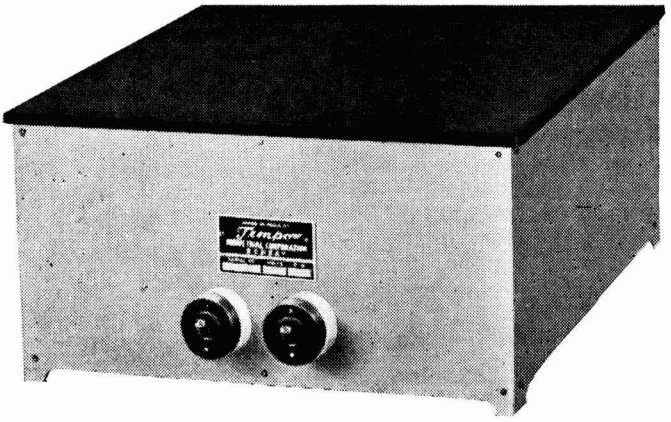

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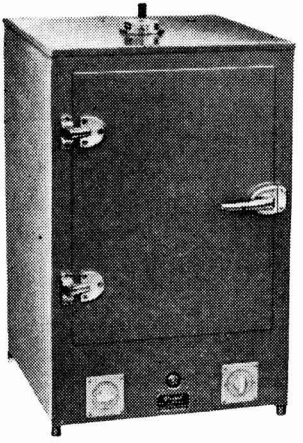

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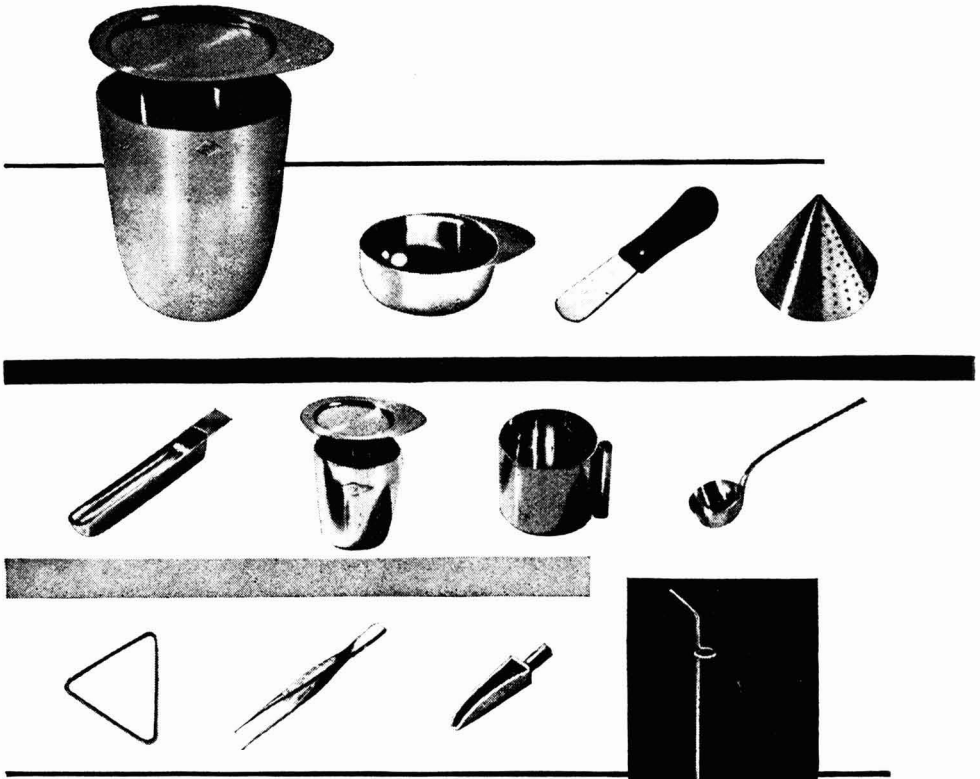

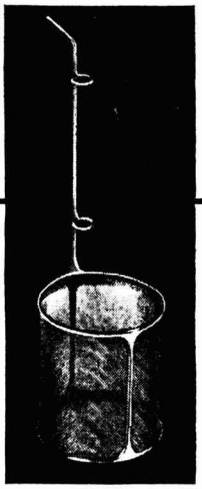

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Modern Large Reflecting Telescopes

W. M. VAIDYA

National Physical Laboratory of India, New Delhi

IN the post-war period there has been a marked growth of interest in observational astronomy resulting in the installation of large telescopes with reflecting mirrors of diameters 74 in. or more in different parts of the world. In India also, considerable interest is being evinced in this field and the Government of India have already set up a Standing Advisory Board for Astronomy to draw up plans for improving and expanding the facilities now obtaining in the existing observatories and for modernization of courses of astronomical studies in the universities. In view of this, a survey of the recent developments in observational astronomy with special reference to building of large telescopes in Europe should be helpful. The subject matter presented in this paper and the one following has been collected, during the past few months, as a result of discussions with several astronomers of Europe and of visits to optical workshops of Grubb Parsons at Newcastle-upon-Tyne and of Carl Zeiss at Jena, the two leading telescope manufacturers of the world.

Since the beginning of the century, America has been in the lead, possessing the largest telescopes of the world. Even as early as 1908, a 60 in. reflector was installed at Mt. Wilson. This was soon followed by a 100 in. telescope also at Mt. Wilson and later in 1948, the 200 in. telescope was completed at Mt. Palomar. The third largest telescope of the pre-war period — the 82 in. McDonald Telescope — is also in America.

Canada did not remain unaffected with such intense activity across the border. A 72 in. reflector was erected in 1918 for the Dominion Department of Mines and Resources, near Victoria, British Columbia. This was followed by a 74 in. telescope at Toronto in 1934.

Thus, till 1939, all the large telescopes were found in America and Canada. The famous Russian Pulkowa Observatory possessed a 40 in. reflector and several good refractors. In Germany, a Zeiss 39·4 in. reflector was installed at the Hamburg Observatory, while in 1927, a 49 in. reflector, also by Zeiss, was erected for the Berlin University. This is the biggest reflector in Europe. The Paris Observatory possesses a 47 in. reflector. In England, the programme of observational astronomy is considerably restricted on account of the exigencies of weather. This has resulted in the installation of moderate size telescopes in England, while bigger telescopes have been installed in different parts of the Dominion with better climates. The trustees of the Radcliffe Observatory, Oxford, decided to transfer the observatory to the clearer skies of South Africa and a 74 in. reflector was erected (1938-46). Even the Royal Greenwich Observatory possesses one 36 in. and a 30 in. reflector.

In the east, though there are astronomical observatories, the reflecting telescopes employed are not comparable in size with those mentioned above. The situation, however, has improved during the post-war period.

Since 1946, there has been an extensive programme of construction of large telescopes. Carl Zeiss (Jena) have already installed such telescopes at Budapest, Warsaw and Hamburg, while a 74 in. mirror for German Academy is undergoing polishing. In

England, Grubb Parsons (Newcastle-upon-Tyne) have been equally busy. A 74 in. telescope has already been supplied by them to the Australian Government and it has been erected at Mt. Stromlo, Canberra. Grubb Parsons have also under execution orders for two similar telescopes — one for the Paris Observatory and the other for the Tokyo University. Yet another telescope of 74 in. diam. has been completed by the same firm for the Egyptian Government. Fig. 1 shows this telescope ready for shipment for the Selwan Observatory, Egypt. Since this telescope is representative of the other three 74 in. telescopes made by Grubb Parsons, it is described in detail to give an idea of the design and construction of a modern 74 in. telescope.

Grubb Parsons 74 in. telescope

The main mirror is a parabolic mirror of 74 in. working aperture and 30 ft. (± 2 in.) focal length. The overall diameter is approximately 76 in. and the edge thickness is between 11 and 12 in. The central hole for the Cassegrain beam is 7 in. diam. Low expansion glass having a coefficient expansion not exceeding $3{\cdot}5 \times 10^{-6}$ per degree centigrade is used. The mounting is of the cross-axis type, suitable for erection in the latitude required, with the polar axis bearing housings resting upon reinforced concrete piers. The whole construction is arranged such that the telescope can be used with any of the following combinations: Newtonian, Cassegrain or Coudé. The polar axis is about 22 ft. in length and is made of cast steel. The pivots are of forged steel, shrunk into the axis and then machined as a unit, thus ensuring concentricity of the pivots.

The lower pivot is bored with a hole approximately 6 in. in diam. suitable for the beam from the Coudé mirrors. The declination axis is made of cast steel and mounted upon taper-roller bearings housed in the cube of the polar axis. It is bolted to the centre-piece of the tube and fitted with a door, operated by hand, which will seal off the second Coudé mirror.

The tube is made in three sections — (1) mirror cell, (2) centre-piece and (3) upper section. The mirror cell consists of an annealed steel casing which is bolted on to the centre-piece. The underside of the cell is provided with an arrangement of multiple supports which bear against the back face of the mirror. The cell is designed to ensure maximum rigidity and the supports suitably disposed so as to carry the mirror without significant flexure. An arrangement of counterpoised side levers is provided which will carry the radial load of the mirror in any position of the telescope. The interior of the cell is lined with an efficient insulating material.

The centre-piece is a fabricated steel cylinder about 7 ft. 6 in. diam. and bolted to the declination axis. In this is located remotely controlled, electrically operated sector-type cover for the main mirror. A steel strip support for the first Coudé mirror is also housed in the centre-piece.

The upper section is a skeleton construction of steel. The upper end is fitted with a central steel box supported by thin steel strips for carrying the Cassegrain and Newtonian mirror mountings. A gangway is fitted inside the tube to provide convenient access to the inside.

The telescope will be capable of two motions — one in right ascension (R.A.) and the other, declination. For giving motion in R.A. there is a sidereal worm-wheel, which is of cast iron fitted with a rim of special non-ferrous alloy about 8 ft. diam. and mounted on the polar axis with ball bearings. The motion of the worm-wheel is imparted to the polar axis, when required, by means of a R.A. clamp.

Besides the main mirror, described earlier, the other optical parts consist of: (1) first convex secondary mirror, (2) second convex secondary mirror, (3) Newtonian secondary mirror, (4) first Coudé mirror, (5) second Coudé mirror and correcting lens.

The first convex secondary mirror is a hyperbolic mirror to give, in combination with the primary, a Cassegrain focus, working at about F/18 (equivalent focal length 111 ft.). It is made of fused quartz. The second convex secondary mirror is also a hyperbolic mirror similar to the first except that it is to be used for a Coudé focus working at about F/29 (equivalent focal length 178 ft.). The Newtonian second mirror is a plane circular mirror of fused quartz, $20\frac{1}{4}$ in. working aperture and thickness not less than 3 in. The first Coudé mirror is a plane circular mirror of fused quartz of $13\frac{3}{4}$ in. working aperture, while the second Coudé mirror has a $9\frac{1}{2}$ in. working aperture. A Ross type

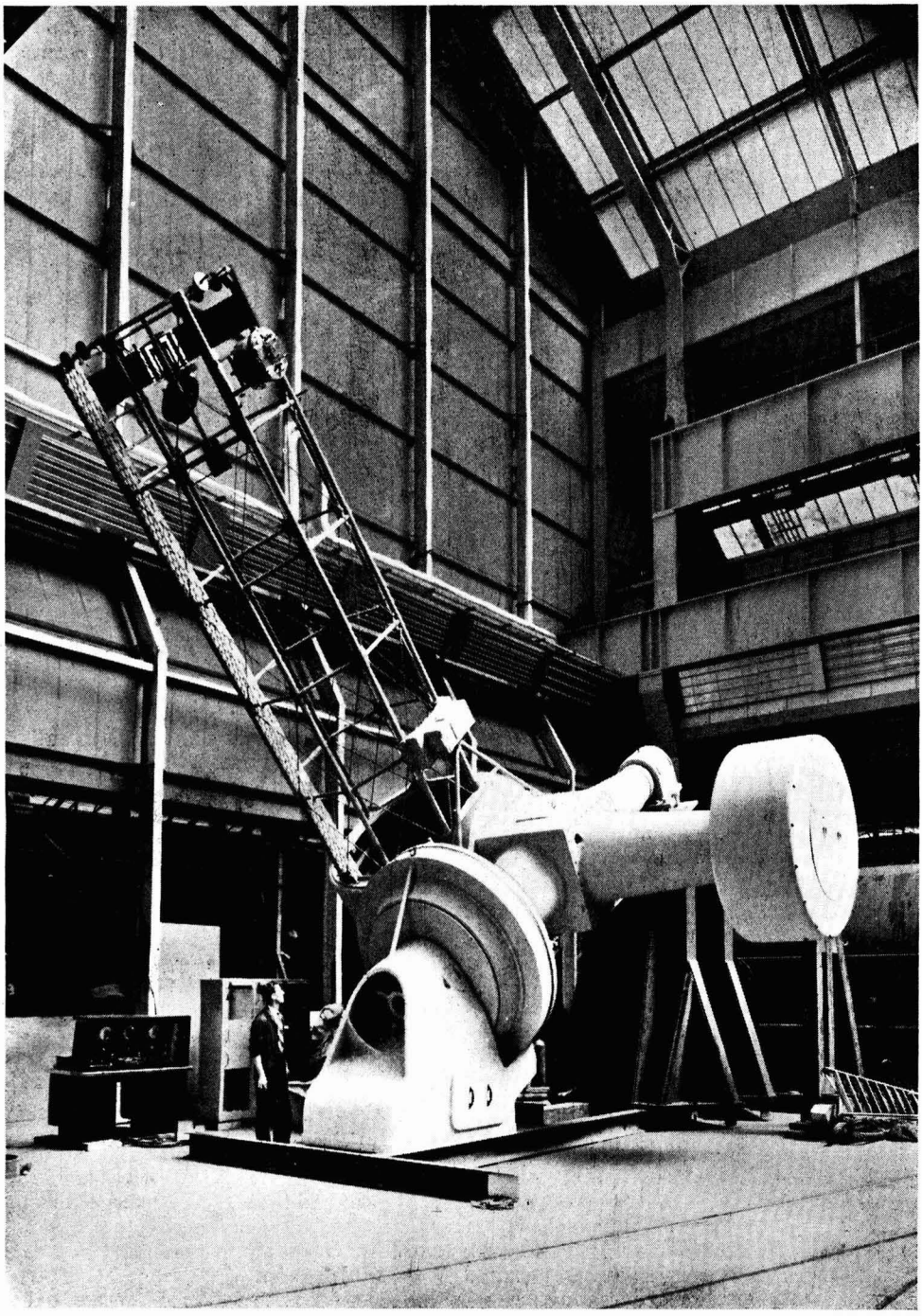

FIG. 1 — 74 IN. REFLECTOR TO BE SET UP AT THE SELWAN OBSERVATORY, EGYPT

correcting lens is supplied for use near the Newtonian focus to correct coma over a plate 16 × 16 cm. without vignetting.

Universal (Schmidt-Cassegrain) telescope

A more ambitious programme was contemplated at the Royal Greenwich Observatory which is being shifted to Herstmonceux. In February 1946, in his Presidential Address to the Royal Astronomical Society, Prof. Plaskett, made a strong plea for the revival of observational astronomy in England. A Committee with leading astronomers in England including the then Astronomer-Royal Sir Harold Spencer Jones was appointed. The first problem facing the Committee was to decide what should be the scope of work to be undertaken with the proposed telescope taking into consideration the exigencies of the English climate. On account of uncertain English weather, exposures are possible only on few days; on the other hand, high dispersion spectrography requires large condensing system. To meet these two distinct requirements, it was decided to investigate the possibilities of a 80 × 98 in. Schmidt type system. Such a combined telescope would perform the dual function as a Schmidt and a pure reflector. A drawing of such a universal telescope is shown in Fig. 2.

The Schmidt correcting plate would be of 80 in. aperture, with 98 in. main mirror, having a focal length of 288 in., taking a photographic plate 14 in. square. With the corrector in position, direct photography and nebular spectrography could be undertaken at the focus. For spectrography, the corrector plate would be dismounted and spectroscopic observations could be undertaken by using the main 98 in. mirror as a Cassegrain with concave Gregorian or as a Coudé telescope with a fixed Coudé focal point enabling a large automatically controlled spectrograph to be utilized.

This design, though attractive, raises some difficulties. For a Schmidt plate of this size it would be necessary to locate the photographic plate with an axial accuracy of approaching $\frac{1}{1000}$th in. and of lateral alignment of about 0·04 in. Moreover, the tube being some 60 ft. long would involve a large mounting to hold it rigidly and a dome of over 90 ft. diam. Removing and replacing the very large correcting plate would be a difficult task. The Gregorian must be very aspherical to correct the aberration of the large F3 spherical primary; the centring of the Gregorian with respect to the primary becomes a matter of critical importance and it was found that this mirror would have to be centred with an accuracy of 0·02 in. The most difficult task was to maintain correct optical alignment.

In view of all these difficulties, the project of a combined Schmidt and Cassegrain-Coudé has been abandoned. Instead, a simpler arrangement with a 98 in. parabolic mirror of focal length 288 in. has been preferred. It will be an offset fork mounting of an inverted and truncated cone. It has no polar axis in the conventional sense. The large disc is used in place of the conventional axis and the disc floats upon oil bearings. The design allows a good Coudé focus available at all positions in the sky. The telescope is being arranged to do astrometric work at the Cassegrain focus at F/15. It is hoped to install the telescope at the new site of the Royal Greenwich Observatory, Herstmonceux, by the summer of 1957.

The making and installation of a large size telescope is a co-operative effort and the co-operation of the astronomer, the optical designer and the engineer is called for. The making of the new 100 in. Greenwich telescope is the result of such a co-operative effort. The project was initiated by the retiring Astronomer-Royal Sir Harold Spencer Jones and finalized by the present Astronomer-Royal Dr. R. W. Wooley with the help of other leading astronomers in U.K. The technical points of the optical design were investigated by Dr. E. H. Linfoot of the Cambridge Observatory and the optical examination of the mirror was undertaken by Prof. R. O. Redman, Professor of Astronomy, Cambridge University. A Committee consisting mainly of engineers examined the mechanical engineering problems of the design.

Such projects are always beset with many problems, the most serious being that of obtaining a good quality mirror. Everything depends upon the quality of the mirror, which should be free from air bubbles and strain. In addition, the mechanical design of the telescope should be such that flexures are absent and easy movement of the telescope tube holding the mirror is facilitated. Telescopes are generally equatorially mounted, with the telescope axis pointing to the north pole of the sky and parallel to

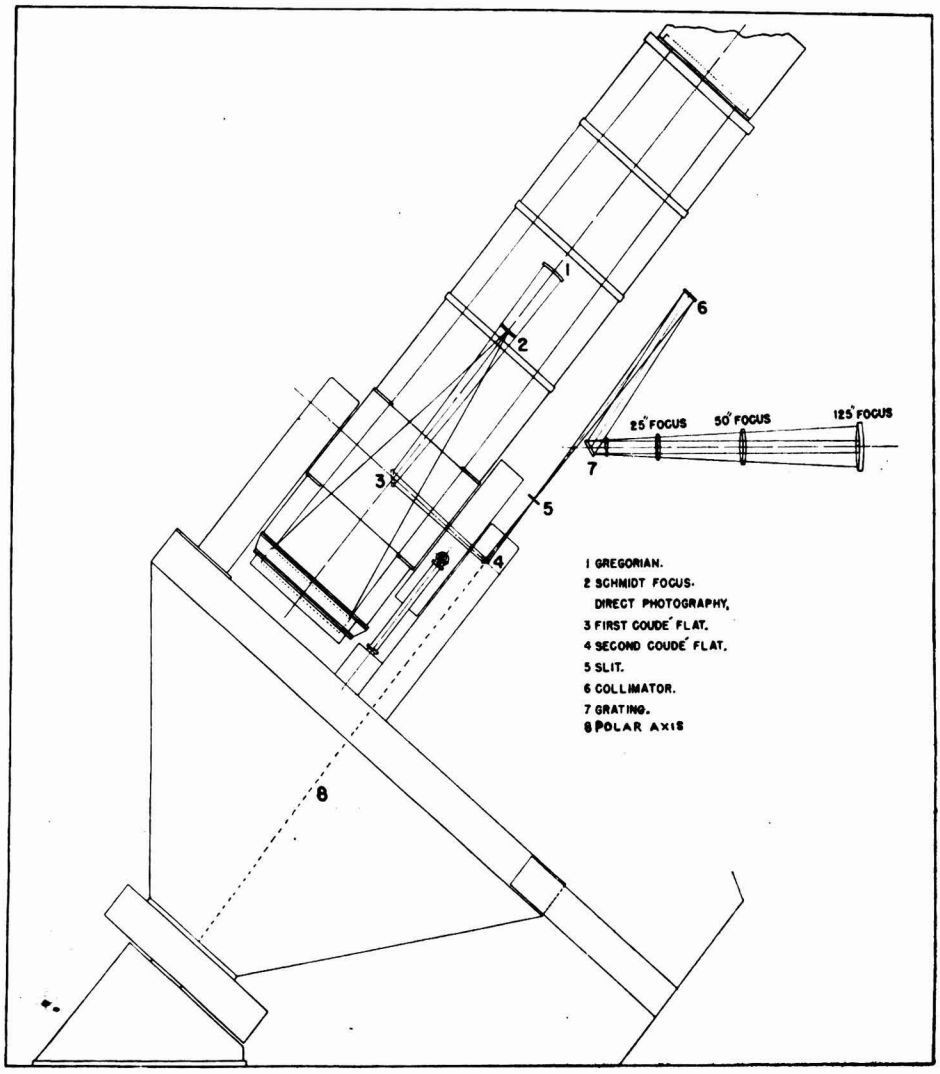

FIG. 2 — UNIVERSAL (SCHMIDT-CASSEGRAIN) TELESCOPE

the earth's axis of rotation. That part of the mounting which carries the tube rotates in hour-angle about the polar axis from east to west. The tube itself rotates from north to south in declination. The tube is the supporting structure for the principal optical elements in a fixed relationship in space, no matter where the telescope may be pointed. In the 200 in. telescope at Mt. Palomar, the mirror weighs 42 tons, the 55 ft. long tube holding the mirror is 125 tons. Such a heavy weight has to move with as little friction as possible. In this telescope the mechanical design is so perfect that only a $\frac{1}{12}$ h.p. motor is sufficient to turn the telescope on its bearings.

Acknowledgement

I am grateful to the Astronomer-Royal for giving me an opportunity to discuss with him the design of the new 100 in. telescope to be installed at Herstmonceux. I am also thankful to Dr. A. Hunter of the Royal Observatory and the Secretary of the Royal

Astronomical Society for data on the present position in astronomy in U.K. I have also benefited from discussions with Prof. C. W. Allen, Professor of Astronomy, London University.

Thanks are also due to Mr. Manville and Mr. Sisson, Officers-in-Charge of the Optical Works of Grubb-Parsons, for facilities to examine the 74 in. telescope standing in their works ready to be shipped to Egypt.

World's First Large-scale Atom Power Station

A NEW ERA OF PEACEFUL APPLICATION OF atomic power was ushered in when Queen Elizabeth II switched on, on 17 October 1956, the atom power station at Calder Hall, Cumberland, in north-western England, to feed nuclear generated electricity into United Kingdom's National Grid.

Calder Hall is the first large-scale atomic power station to produce electricity in substantial quantities and feed it into a national consumer network. It will develop 15 times the power of the highest capacity of any nuclear power station operating at present. The station covers an area of 100 acres and has been built at a cost of £ 16,500,000. The fuel used in the reactor is natural uranium and the moderator is graphite. The reactor is cooled by air draught. The reactor building houses 4 charging motors controlling the £ 2,500,000 worth of uranium rods inserted in the graphite pile. A temperature of 400°C. is produced in the atomic furnace. On 17 October 1956, one reactor driving two turbines was in full use generating 35,000 kW. of power. With the other station, Calder Hall B, by the side of the present one, a total of 90,000 kW. of power will be generated. Part of the power is being used for lighting and heating some of the buildings at Calder Hall and for driving the machinery in the nearby Windscale industrial plant.

Calder Hall atom power station ranks as a remarkable civil engineering feat. The main civil engineering work was finished in 12 months and the whole of it in 33 months. Higher standards of accuracy than those obtained in normal civil engineering practice had to be attained, e.g. the tolerance for the walls of the biological shields against radioactivity is $\pm \frac{1}{10}$ in. and that of the alignment of the charging tubes along which the uranium is fed to the reactor core about $\frac{3}{16}$ in.

The genesis of the Calder Hall station dates back to the middle of 1953 when investigations on two experimental reactors — the GLEEP and the BEPO — built by the Production Division of the Atomic Energy Research Establishment, indicated that reactors could be cooled by a closed carbon dioxide current which would transfer the heat conducted away to a boiler. The type of the reactor built at Calder Hall is safe from explosion hazards and it is located at a remote place. Two more units besides the two at Calder Hall are to be built by the Authority to produce plutonium and power. Britain's ten-year programme for the building of atomic power reactors envisages 12 atomic power stations by 1965 besides the four U. K. Atomic Energy Authority's stations of the Calder Hall type. The 16 stations are expected to have an aggregate capacity of not less than 2 million kW. by 1965. It is expected that the electricity output per unit of capital cost would be greatly enhanced in the new stations by incorporating some modifications based on the experience in developing Calder Hall and from the recent researches on the possibility of using higher operating temperatures [*British Information Services*, 18 *October* 1956].

The First Indian Pharmacopoeia

B. MUKERJI
Central Drug Research Institute, Lucknow

THE publication of the First Indian Pharmacopoeia will be warmly welcomed. It provides the necessary basis for standardization of drugs and pharmaceuticals which is so essential both for internal consumption and for export. India now joins other 29 countries in possessing a national pharmacopoeia.

Projects of this magnitude take time and enormous and patient labour. It took nearly six years to complete the Indian Pharmacopoeia, and considering the meagre staff and resources placed at the disposal of the Indian Pharmacopoeia Committee, the achievement is praiseworthy.

The Drug Enquiry Committee appointed by the Government of India in 1930 under the chairmanship of Col. Sir Ramnath Chopra first brought to the notice of the Government, in 1931, the urgent need for an Indian Pharmacopoeia, but it was only in 1946 that any positive action was taken in the project. And, as a result of the work of an enthusiastic band of people, who were ably assisted by technical officers of the Ministry of Health, the nucleus of an Indian Pharmacopoeia, entitled " Indian Pharmacopoeial List 1946" was published. This had limited scope and contained only a small list of drugs for use in India, which, though not included in the British Pharmacopoeia, were of substantial medicinal value and justified their inclusion in an ' official pharmacopoeia '. As a result of the publication of this list, a number of Indian drugs were given recognition and their standards of strength, purity and potency, and analytical tests were defined for the first time. The Indian Pharmacopoeial List 1946 was well received by drug manufacturers in India and the Government was approached through the Drugs Technical Advisory Board to take steps to enlarge the scope of this publication and to bring out a comprehensive national pharmacopoeia for India. In 1948, the Indian Pharmacopoeia Committee was constituted by the Government in the Ministry of Health to undertake work on the Indian Pharmacopoeia. The work was completed in 1954 and the monographs completed by the Committee were compiled and printed as the First Indian Pharmacopoeia.

A pertinent question which may be asked is — what is the need for an ' Indian Pharmacopoeia' when there is the British Pharmacopoeia which is recognized as the ' official standard ' of reference in matters of drugs and pharmaceuticals in all Commonwealth countries for more than 60 years. There is also now an ' International Pharmacopoeia ' to cater to the needs of all parts of the world. The question is not easy to answer. While it is true that the majority of monographs in any pharmacopoeia are identical, a national pharmacopoeia is primarily meant to meet the needs of physicians in a country during a particular period. As these needs must vary in different parts of the world there must exist, and there exists, a great difference not only between the pharmacopoeias of various countries but also between various editions of the same pharmacopoeia. The Indian Pharmacopoeia, though it contains almost seven hundred important monographs which are mentioned in other pharmacopoeias of the world, also includes monographs of nearly one hundred thirty crude vegetable drugs and products which are peculiar to India and which are not likely to be described or recognized in any other national pharmacopoeia. In the interest of the development of the pharmaceutical industry in India and in the interest of the utilization of Indian medicinal plant products, it is essential that India should have a pharmacopoeia of her own where authentic Indian medicinal plant products find a place in a standardized form, of unvarying potency and quality which will not deteriorate on keeping. A modern pharmacopoeia is above all a book of ' standards '. Its fundamental object and scope is to " provide standards for the drugs and medicines of therapeutic usefulness or pharmaceutic necessity, sufficiently used in medical practice; to lay down tests for the identity, quality or purity; to ensure,

as far as possible, uniformity in physical properties and active constituents". It is refreshing to note that in the compilation of the Indian Pharmacopoeia, both this objective and scope have been fully kept in view. The result is a well-balanced selection of drugs of international usage which Indian doctors and pharmacists can employ as dependable medicaments, either singly or in combination. A Pharmacopoeia has to be a 'live' book and though it is realized that there would be many imperfections in the first edition, efforts would be continuously made to correct the mistakes that have crept in and to incorporate fresh material which would be available as the medical science progresses and the rational use of more Indian medicinal plants and other synthetic products is made in the treatment of diseases.

In the compilation of the First Indian Pharmacopoeia, the Committee has followed the same principles which have been followed by national pharmacopoeias of nearly 29 countries of the world and by the International Pharmacopoeia. Latin nomenclature of the monograph titles have been retained in alphabetical order followed by abbreviated English names and synonyms. The Indian (Hindi) equivalent has been given wherever possible. The recent editions of the British Pharmacopoeia and the United States' Pharmacopoeia have changed the Latin titles to English titles. This would probably be a welcome departure but the Indian Pharmacopoeia authorities apparently felt that the traditional method is probably more useful and more easily acceptable to Indian doctors. The monographs have been arranged in more or less the same way as is customary in a pharmacopoeia, though the printing and format have been slightly altered. Including all the Appendices and the Index, the Indian Pharmacopoeia covers about one thousand pages and is as comprehensive in coverage on drugs as other national pharmacopoeias. The Appendices contain useful accounts of the various general reagents with their descriptions and standards and various test solutions required in carrying out the analytical tests recommended in the monographs. Determination of limit test, melting range, congealing temperature and boiling range and many other essential physical constants have been included. Methods for biological assays have also been included with variations necessary to suit Indian climatic and other conditions. For several items such as cobra and viper venoms useful assay methods have been given. The same applies to cholera vaccine for which standards and assay methods have been defined for the first time.

As one would expect in a collaborative venture of this type and where the Secretariat departments of the Government have to look after the printing of the publication from a distance of nearly a thousand miles from the press, there are a fair number of printers' devils, inconsistencies, omissions, etc., in the book. In the description of the dosages in the metric system and in the imperial system, some inconsistencies are noticeable. In some places, parallel dosages do not correspond with each other. In some assay methods, the results have not apparently been correctly checked by confirmatory standardization in different laboratories in India. A good feature of the publication is the inclusion of a list of items for which tests for 'limit of arsenic' is required to be carried out in respect of monographs included in the body of the book. Several items have been included in the monographs which are not commonly used in India. This has been largely taken from other parts of the world where those items have been in frequent use. Many new items which have already been accepted in recent editions of British and United States' Pharmacopoeias have not been incorporated in this Pharmacopoeia.

To keep the Indian Pharmacopoeia up to date, a permanent Indian Pharmacopoeia Committee has been established under the Ministry of Health. This step is of great significance in the context of control and standardization of pharmaceutical preparations in India and indirectly to the development of indigenous drug industry which has to cater to the needs of growing modern medical practice in this country. It is to be hoped that more Indian medicinal plants would gradually find a place in the Indian Pharmacopoeia as *Rauvolfia serpentina* has done. Then the real utility of the Indian Pharmacopoeia will be felt and it will serve not only the Indian nation but also other nations of the world. We look forward to the day when Indian talent in the field of drug research will rise to the occasion and discover such standardized drugs as would bring relief to suffering humanity.

Board of Scientific & Industrial Research, Thirty-seventh Meeting, New Delhi

THE thirty-seventh meeting of the Board of Scientific & Industrial Research was held in New Delhi on 19 September 1956. The Governing Body met on the following day. The Prime Minister, Shri Jawaharlal Nehru, presided.

The following new schemes have been sanctioned by the Governing Body on the recommendation of the Board:

1. *An arrangement for the self priming of hand pumps*: SHRI D. C. KHANNA, Public Health Engineer, Punjab Government, Simla

2. *Construction of all-weather soil stabilized patries in Usar area*: Chief Engineer, Uttar Pradesh P.W.D., Lucknow

3. *Selection of stone aggregate for use in road constructions under Indian conditions*: Chief Engineer, Uttar Pradesh P.W.D., Lucknow

4. *Design of concrete mixes*: SHRI K. T. SUNDARA RAJA IYENGAR, Indian Institute of Science, Bangalore

5. (i) *Investigation of the geotechnical properties of black cotton soils in India*; (ii) *The interaction between structural steel and concrete in steel-framed structures with encased beams*: PROF. S. MACKEY, Indian Institute of Technology, Kharagpur

6. *Studies on building stones in Rajasthan*: SHRI S. VENKATARAMAN, M.B.M. Engineering College, Jodhpur

7. *Continuity of pre-stressed concrete structures*: SHRI K. K. BANERJEE, Bengal Engineering College, Howrah

8. *Study of granitic rocks as building stones*: SHRI P. K. MUKHERJEE, Bengal Engineeging College, Howrah

9. *Effect of cladding walls in redistribution of stresses in the design of multi-storey rigid-framed buildings*: DR. S. K. MUKHERJEE, Bengal Engineering College, Howrah

10. *Characteristics of expansive clays and their effect on structures*: SHRI A. GHOSH DASTIDAR, Bengal Engineering College, Howrah

11. (i) *Development of pulse velocity method for testing concrete*; (ii) *Development of non-destructive testing of concrete, bricks and other clay products by the resonant frequency method*: DR. P. N. CHATTERJEE, Bengal Engineering College, Howrah

12. *Investigation on composite types of roof using locally available materials with special reference to Rayalaseema area*: SHRI B. RAMAKRISHNA RAO, D. JEBALA RAO & R. GIRI RAO, Engineering College, Anantapur

13. *Pilot plant for preparation of maleic anhydride from benzene*: SHRI R. T. THAMPY, Shri Ram Institute for Industrial Research, Delhi

14. *Establishment of a Pharmacological Research Unit at Baroda*: DR. G. K. KARANDIKAR, Medical College, Baroda

15. *The role of enzymes in toxic action of venoms*: DR. BEATRIZ M. BRAGANCA, Indian Cancer Research Centre, Bombay

16. *Absolute values of rate constants in polymerization*: DR. J. N. SEN, Indian Association for the Cultivation of Science, Calcutta

17. *Thermodynamic properties of high polymer solutions and binary liquid mixtures*: PROF. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta

18. *Study of physical properties of high polymers in relation to their molecular structure*: DR. S. BHAGAWANTAM, Osmania University, Hyderabad

19. *Mechano-chemical properties of polymers analogous to muscle proteins*: DR. S. BASU, University College of Science & Technology, Calcutta

20. *Investigation on the nature and kinetics of reactions and physico-chemical structure of various phenolics*: DR. SANTHAPPA, Madras University, Madras

21. *Utilization of lignin and lignocellulosic wastes*: DR. D. NARAYANAMURTHY, Forest Research Institute, Dehra Dun

22. *Study of various cellulosic materials as fillers in moulding powders*: DR. D. R. DHINGRA & DR. M. S. BHATNAGAR, Harcourt Butler Technological Institute, Kanpur

23. *Development of jute/resin (natural and synthetic) combinations*: DR. W. G. MACMILLAN, Indian Jute Mills Association Research Institute, Calcutta

24. *Modified urea formaldehyde resins for textile applications*: DR. V. B. CHIPALKATTI,

Shri Ram Institute for Industrial Research, Delhi

25. *Development of master frequency changer, etc.*: SHRI N. SUBBIAN & VEDAPURI, P.S.G. and Sons' Charities College of Technology, Peelamedu

26. *Study of magnetic saturation in induction motors*: PROF. P. K. CHARLU & SHRI N. SUBBIAN, P.S.G. and Sons' Charities College of Technology, Peelamedu

27. (i) *Development of methods for structural analysis of swept back wings*; (ii) *Study of fatigue problems associated with aircraft design and construction*: SHRI N. SRINIVASAN & DR. K. A. V. PANDALAI, Madras Institute of Technology, Chromepet

28. *Design and development of air speed indicators*: SHRI N. SRINIVASAN & DR. I. R. RAO, Madras Institute of Technology, Chromepet

29. (i) *Flow pattern of fluids past blades of pumps*; (ii) *Design and manufacture of water reaction turbines of small capacity*: SHRI G. R. DAMODARAN & R. K. K. R. GOVINDARAJAN, P.S.G. and Sons' Charities College of Technology, Peelamedu

30. *Design and manufacture of venturimeters and orificemeters*: SHRI R. K. K. R. GOVINDARAJAN & N. SUBBIAN, P.S.G. and Sons' Charities College of Technology, Peelamedu

31. *Elasto-plastic theory of metals*: DR. B. KARUNES, Calcutta University, Calcutta

32. *Molecular weight determination by X-rays*: DR. G. N. RAMACHANDRAN, Madras University, Madras

33. (i) *Setting up of secondary standards by microwave spectral lines and study of microwave spectra of different isotopic species of methyl alcohol and methyl amines*; (ii) *Molecular spectra of halogens in the vacuum ultraviolet region*: DR. P. VENKATESWARLU, Muslim University, Aligarh

34. *Optical studies on etched surfaces of metal alloy crystals*: DR. N. S. PANDYA, Baroda University, Baroda

35. *Study of weak lines in the L-spectra of elements from tantalum* (73) *to bismuth* (83) *using the technique of curved crystal focussing spectrograph*: DR. B. C. GOKHALE, Lucknow University, Lucknow

36. *Imperfections in crystals and study of the growth and etch phenomenon in crystals*: DR. AJIT RAM VERMA, Delhi University, Delhi

37. *Hydrography and plankton production*: PROF. P. N. GANAPATI, Andhra University, Waltair

38. *Studies on the 'Lampbrush' chromosomes in the oocytes of certain fishes, frogs, reptiles and birds*: DR. M. D. L. SRIVASTAVA, Allahabad University, Allahabad

39. *Algal research*: PROF. M. O. P. IYENGAR, Madras University, Madras

40. *A systematic chemical analysis and examination of the fat, protein and vitamin contents of the fresh water fish Labeo rohita*: DR. R. D. TIWARI, Allahabad University, Allahabad

41. *Transport of fruits and vegetables*: DR. A. N. BOSE, College of Engineering & Technology, Calcutta

42. *Biological role of metaphosphate in micro-organisms*: DR. P. S. KRISHNAN, Lucknow University, Lucknow

43. *Studies on the production of riboflavin by a mutant yeast and assessment of the commercial feasibility of the process*: DR. K. K. MITRA, College of Engineering & Technology, Calcutta

Regional Research Laboratories — The Governing Body discussed the need for establishing regional research laboratories and concluded that such laboratories were necessary for effectively tackling the problems peculiar to different regions of the country. It was decided that such centres should function under the Council of Scientific & Industrial Research to ensure closest possible coordination with the national laboratories.

Coal Survey Station at Hyderabad — The Governing Body approved of the establishment of the Regional Coal Survey Station at Hyderabad to conduct a comprehensive physical and chemical survey of the Godavari Valley coalfields, under the supervision of the Fuel Research Institute.

Pilot Plant Design — The Governing Body has decided that a well-equipped laboratory should be set up for the design and fabrication of pilot plant for various industries in India. This is considered important in view of the inadequate facilities in this direction due to dearth of qualified technical personnel essential for the translation of laboratory researches into industrial practice. A planning committee was recommended to be set up to work out the details of the proposed laboratory.

Utilization of Sambhar Bitterns — It has been decided that investigations on the

utilization of bitterns left over after the manufacture of common salt at Sambhar Lake should be taken on hand as quickly as possible. The bitterns which are thrown away as waste at present, contain valuable chemicals which could be used in a number of industries. A planning committee has been set up to submit concrete proposals for the project, including the setting up of a research station.

New Research Centres — Two planning committees have been set up for preparing specific schemes for the establishment of a Public Health Engineering Research Institute and an Aeronautical Research and Development Centre which would prepare comprehensive programmes of research in the engineering aspects of the respective subjects.

Research in Biophysics — The Governing Body generally agreed with the recommendations of the Biophysical Research Committee regarding the establishment of active schools of research in biophysics in some Indian universities. A capital grant of Rs. 2 lakhs and a recurring grant of Rs. 2·5 lakhs have been made for the Chittaranjan Cancer Hospital, Calcutta. The recommended programmes of work in biophysical research in the university departments of Madras, Calcutta and in the Indian Cancer Research Institute, Bombay, have been approved and the Ministry of Health and the University Grants Commission have been advised to provide the necessary funds. The Governing Body also approved the allocation made in the budget for providing facilities for biophysical research at the Central Drug Research Institute, Lucknow.

Biochemical Research — The Governing Body considered the proposals of the Biochemical Research Committee regarding the selection of 3 or 4 centres for developing active schools of biochemical research and came to the conclusion that only one centre should be selected for financial assistance by the Council of Scientific & Industrial Research, for one specific line of work, to avoid duplication in respect of the major lines of biochemical research. It has been suggested that the centres should be modelled on the school of research in dyestuff technology in Bombay which has won international recognition.

A sum of Rs. 10 lakhs had been provided in the Council's development programme during the Second Five-Year Plan for biochemical research.

Development of Indian Medicinal Plants — The Council agreed with the Pharmaceuticals and Drug Research Committee that a Central Organization for the Development of Indian Medicinal Plants was imperative and recommended to the Director-General of Scientific & Industrial Research to draw up a detailed specific scheme in consultation with the concerned Ministries and other organizations.

Scientific Instruments — The Council endorsed the recommendations of the Scientific Instruments Committee and further recommended that (1) Government should encourage the manufacture of scientific instruments for school and collegiate teaching; (2) The National Physical Laboratory, New Delhi, should render all possible technical assistance for the development of manufacture of advanced type of instruments for research and industry; and (3) a committee of experts be constituted to make a survey of the scientific instrument making techniques early.

Symposia — The Council approved the holding of the following symposia during 1956-57: (1) Cellulose Research; (2) Curing and Preservation of Raw Hides and Skins; (3) Mineral Beneficiation and Extractive Metallurigcal Techniques; and (4) Utilization of Indian Medicinal Plants.

The Probable Factors Governing Puzzolanic Action

N. R. SRINIVASAN
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OUR knowledge regarding puzzolanas is far from complete. Puzzolanas have been classified under different groups and their mode of reaction is supposed to differ from group to group. Wide variation in their activity has been reported[1]. Many of our present ideas regarding puzzolanas do not explain the reasons for these variations and some apparently contradictory results have been obtained. Research undertaken at the Central Road Research Institute indicates an entirely new approach to the problem of puzzolana and its mode of action, and a tentative theory has been proposed which, it is hoped, will lay down a few general principles applicable to all types of puzzolanas and explain many of the defects in the existing theories. Further work to confirm the theory is in progress.

Present-day theories and their defects

Puzzolanas are defined as " siliceous materials which though not cementitious in themselves, contain constituents which at ordinary temperature will combine with lime in the presence of water, to form compounds which have a low solubility and possess cementing properties "[2]. Quite a number of siliceous materials (quartz, etc.) which are composed of crystalline silica do not possess these characteristics. It is also said that ' amorphous silica ' is a necessary constituent of active puzzolana. Based on this, tests like the ' silica release test '[3] have been devised to measure puzzolanic activity. But while appreciable percentages of amorphous silica is soluble in a solution of sodium or potassium hydroxides, the amount of soluble silica in many puzzolanas of proved activity is surprisingly low. Some puzzolanas with appreciable percentage of soluble silica are not as reactive as some with far lower percentages. In Table 1 are given the soluble silica contents of some active puzzolanas. It appears highly improbable that such low percentages of soluble silica could account for such high reactivity and strength development with lime as has been noted.

TABLE 1 — SOLUBLE SILICA CONTENT OF ACTIVE PUZZOLANAS

MATERIAL	SOLUBLE SILICA %
Tungabhadra surki (calcined at 600°C.)[4]	0·20
Delhi kaolin* (calcined at 600°C.)	0·07
Fly ash (Illinois)[5]	0·50
Bonneville Dam, calcined[6]	1·70
Calcined Kansas shale[6]	0·30

*Chemical analysis by Mr. N. S. Bawa, Central Road Research Institute, Delhi.

Some bauxites have been found to yield good puzzolanas, though the often quoted definition of Dr. Lea for a puzzolana is restricted to siliceous materials only. Puzzolanic action has also been attributed to both silica and alumina by some.

Many specifications require a minimum silica content for an active puzzolana. For puzzolana used in Davis Dam, U.S.A., a minimum silica content of 60 per cent was specified and for that used in Bonneville Dam, was 50 per cent[6]. These specifications do not even take into account the manner in which the silica is present. Thus in some cases, granite powder and stone dust, which are highly siliceous, have actually been used mistaking them to be puzzolanic materials, and it was only later that such materials were proved to be non-puzzolanic[7]. In India, brick earths containing a large percentage of silica are even now used to make surki though the high percentage of quartz which form the bulk of the silica present makes the product of a poor quality. The lime reactivity of some of the surkis made from brick earths is given in Table 2.

It is now realized that chemical analysis gives no indication of the puzzolanic activity of a material. It also gives no idea of the manner in which the various oxides are pre-

TABLE 2 — LIME REACTIVITY STRENGTH OF SURKIS FROM DIFFERENT SOILS

Material	Lime reactivity strength (*lb./sq. in.*) of surkis prepared with soils calcined at		
	600°C.	800°C.	1000°C.
Okhla brick earth	162	200	171
Rewa brick earth	197	385	249
Manunagar brick earth	111	301	234
Delhi soil at Indian Medical Institute site	119	227	121
Delhi soil II	106	248	172

sent. Though the mineralogical composition is a much better index of the puzzolanic activity of a material, it still does not explain some of the anomalies, such as the different reactivities of materials similar in both chemical and mineralogical compositions.

The findings of Mielenz on calcined clays represent the first important advance in the field of puzzolanas in recent years. Some of his conclusions are:

(1) Each type of clay mineral has an optimum temperature at which it should be calcined for maximum reactivity.

(2) This optimum temperature is within the temperature range at which disintegration of the clay structure occurs.

(3) In minerals heated to the optimum temperature, the clay structure is either completely disintegrated or is in a highly disordered state owing to partial disintegration.

(4) Heating the mineral above the optimum temperature brings about a reduction in reactivity.

The first disintegration products of clay are the oxides of silicon, aluminium and iron. At the time of disintegration, the products are in a nascent and microcrystalline state with high surface area and reactivity. At higher temperature, there is growth in crystal size, resulting in reduced surface area and reactivity. This, however, does not explain the high reactivity in cases where there is only partial disintegration and the disordered structure of the clay is maintained. It does not also explain the puzzolanic activity of glasses.

Proposed theory

A new theory based upon the theory of solid reactivity has been suggested by the author as a result of investigations carried out in the Central Road Research Institute. This theory does not contradict what Mielenz has said; it supplements his views by bringing in a few more factors which were not considered till now.

The disintegrated products from clays, whether they be in the form of oxides after complete disintegration or in a highly disordered state after partial decomposition of clay structure, have a very imperfect and faulty structure. X-ray diffraction studies show that Tungabhadra surki prepared by calcining the clay at 600°C. has high structural disorder and poor crystallinity which is indicated by the diffuse band (Fig. 1a). The partial collapse of the clay structure has left the remnant clay and the microcrystalline oxides of silicon, aluminium and iron in a nascent and structurally imperfect state. Heating the clay to 1000°C., however, causes sharp lines of silica, alumina and iron oxides with an orderly structure due to the growth in the crystal size of these oxides during continued heating (Fig. 1b).

In the case of kaolin, heating to 600°C. causes the characteristic 7A line to disappear, indicating structural collapse. The only lines that remain, besides a diffused band showing the tiny and imperfect crystallinity of the decomposed products, are those of feldspar and quartz, which were present as impurities in the clay. Heating to 1000°C. brings forth the sharp lines of silica and alumina with good crystallinity, which are the products of decomposition of the clay.

In both the above cases, the surkis prepared at 600°C. had a highly imperfect structure with the consequent lattice strains and high reactivity. Surkis prepared at 1000°C. had a more orderly structure and exhibited reduced activity. These observations are in

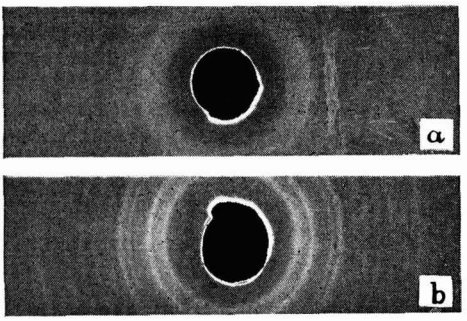

FIG. 1 — X-RAY DIFFRACTION PATTERNS OF TUNGABHADRA SURKI PREPARED FROM CLAY CALCINED AT (a) 600°C. AND (b) 1000°C.

agreement with the principles of reactivity of solids.

The results of lime-reactivity tests for a few clays carried out in the Road Research Institute are given in Table 3.

The high reactivity of structurally imperfect crystals forms an important phase of the science of solid reactions and is being increasingly recognized in many industrial processes. Bogue[8] has drawn attention to the importance of these principles in cement chemistry and cement manufacture. Often the effects of imperfections in structure may be so great as to outweigh the effects of surface area. Hedvall[9] observes that the effect of faulty structure in increasing reactivity is frequently so great that it surpasses the influence of size of surface. A coarse powder of crystals with faulty lattices may, therefore, react better than a fine powder of stable crystals.

The above discussion explains why only certain forms of silica, alumina and iron oxides contribute to high reactivity while others do not. The lime reactivity strength, which is an index of the reactivity of a puzzolana, for a few siliceous substances is given in Table 4.

In the case of quartz, for example, there is a highly orderly structure and no internal strains. No high reactivity could be expected from quartz even if it be finely powdered, unless the degree of grinding yields a powder of unit cell dimension, at which stage, however, it is no longer quartz with its stable three-dimensional network, but silica gel in its ideal form. Thus, even among the so-called silica gels, there are varying degrees of silica tetrahedral linkages[10], and the reactivity is greater, the nearer it approaches the ideal structure. Thus, it is not surprising that between different brands of silica gels themselves, the reactivity varies (Table 4).

Among the crystalline forms of silica, tridymite and cristobalite have slight distortion in structure. These are not stable forms of silica at ordinary temperature and where they exist at room temperature, there is always some lattice strain in these and hence they are more reactive than quartz. An example is the case of silica gel (Table 4) whose poor activity suggests that stable three-dimensional network of silica tetrahedra still persists in it to an appreciable degree, as in quartz. When this is heated to 1000°C. and cooled, white, bloated spheroids of varying sizes result. X-ray analysis showed them to be cristobalite. The lime reactivity of this product is higher (516 lb./sq. in.).

TABLE 3 — LIME REACTIVITY STRENGTH OF CLAYS AFTER CALCINATION

Clay	Lime reactivity strength (*lb./sq. in.*) after calcination at			
	400°C.	600°C.	800°C.	1000°C.
Tungabhadra clay	453	1512	1444	822
Kaolin I	—	1385	1452	889
Delhi kaolin	—	2015	1896	933

TABLE 4 — LIME REACTIVITY STRENGTH OF DIFFERENT TYPES OF SILICA

Material	Lime reactivity strength (*lb./sq. in.*)				
	Of material in the raw state	Of material burning at			
		400°C.	600°C.	800°C.	1000°C.
Powder containing 50% quartz +50% corundum	—	68	71	77	79
Silica gel (drying agent)	—	186	290	278	516
Precipitated silica (B.D.H.)	747	—	770	—	—
Pyrex glass	231	—	—	—	—

TABLE 5 — LIME REACTIVITY STRENGTH OF BAUXITES

Material	Lime reactivity strength (*lb./sq. in.*) after heating at			
	400°C.	600°C.	800°C.	1000°C.
Gibbsite	—	101	105	73
Aluminium hydroxide (B.D.H.)	83	129	116	88

Just as in the case of silica, it could be shown that, despite the high activity of some bauxites, not all forms of alumina show high reactivity. Lime reactivity strength for a sample of gibbsite and pure aluminium hydroxide (B.D.H.) is given in Table 5.

Similar arguments could be put forward to explain the poor activities of pure aluminium and iron oxides and hydroxides. Corundum, which is a stable form of alumina, has an orderly structure and hence powder containing 50 per cent quartz and 50 per cent corundum (Table 4) has poor reactivity. Aluminium and iron hydroxides are known to have varying degrees of orderliness in their structure depending upon the mode of preparation, ageing, etc.

Data similar to those of alumina could be given for iron oxides also. Lime reactivity strengths for some laterite soils, ochres and different types of pure iron oxides are given in Table 6.

Table 6 shows that ochres are highly reactive and that laterites vary in their reacti-

TABLE 6 — LIME REACTIVITY STRENGTH OF SOME FERRUGINOUS MATERIALS

Material	Lime reactivity strength (*lb./sq. in.*)			
	Of material in the raw state	After calcination at		
		600°C.	800°C.	1000°C.
Laterite 1790	—	248	235	423
Laterite 1832	—	1244	726	405
Laterite 1859	—	464	459	236
Laterite 1860	—	291	456	211
Y. ochre	—	1963	1837	674
R. ochre	—	1852	1496	592
Ferric oxide (red)	58	70	—	—
Magnetic oxide	70	71	—	52
Goethite	—	62	70	58

vity. Investigations on a number of red soils containing appreciable percentages of iron oxides show that while puzzolanas made from them are often very active and there is a greater possibility of getting a satisfactory puzzolana from a red clay than from a black cotton clay, not all red soils give good puzzolanas[11]. The high reactivity of yellow ochre could be due to 'limonite' present in it, which Kelly[12] has shown to have a poorly crystallized structure. Similar reasoning is possible in the case of red ochre also. Heating of these ochres merely drives out the hydroxyl ions in the lattice which seem to be essential for facilitating the entry of calcium ions into the disorderly structure.

Surface area and structural imperfections

The greater stress laid on the imperfections in crystal structure may perhaps lead to the wrong idea that no importance need be attached to surface area. There is generally an intimate relationship between structural imperfections and surface area. The finer a material is ground, the greater is the rupture in bonds and discontinuities in the structure which increase reactivity. But where a material has such a highly orderly structure that, despite grinding, ruptured bonds exist only along the surface of the individual grains while the internal structure still remains orderly, the increase in reactivity, due to increase in surface area alone, will not be appreciable. This is the case with materials like quartz. On the other hand, there can be cases where the surface area may not be very high, but the structural imperfections may be such as to impart high reactivity. In such cases increase in surface area could result in further increase in reactivity, though theoretically the opposite effect in some cases is also possible. In such cases, reduction in particle size may perhaps relieve the lattice strains and reduce the imperfections within a limited grinding range.

Thus the reactivity of a material could be due to its surface area and lattice imperfections. In some cases lattice imperfections may be absent and in such cases, the reactivity of the materials cannot be appreciably increased by merely increasing the surface area. Methods of inducing lattice defects, such as heating the material to its inversion temperature and cooling, may have to be tried and this can often increase the reactivity appreciably. This has been illustrated in the case of silica gel which after heating to cristobalite formation temperature has increased in reactivity. Hedvall has shown that the reaction between quartz and iron oxides show a sharp increase when the mixture is heated to the inversion temperature of quartz to cristobalite.

Reactivity of non-silicates with lime

It may be asked whether any material, irrespective of whether it is a silicate or not, could possess puzzolanic activity, if only it has structural imperfections. This is not so. Though arsenious oxide reacts with lime just like the silica in the puzzolana, the puzzolanic activity depends a great deal on the nature of the ions present in the structure, their ionic radius, whether they could accommodate the calcium ions in their structure and attain configurations satisfying the geochemical requirements as laid down in Pauling's rule and the exact nature of the structural defects. Thus, though apparently it may appear that any material with structural defects could react with lime, due to the consideration mentioned above, very few show such reactions.

Puzzolanic activity of glasses

It may be noted that in addition to disorderliness in structure, lattice strains have also been specially mentioned as a necessary requisite for puzzolanic activity. This can also explain how certain glasses, which are the main constituents of volcanic ash, fly ash, etc., possess puzzolanic activity. It is well known that puzzolanic activity of various glasses differ widely[13]. Glass, despite its disorderly structure, exhibits varying degrees of internal strains depending upon the degree and nature of the 'open spaces' in the structure, the type of ions that may be occupying

them, etc. It is likely that for puzzolanic activity the calcium ions should be able to enter these open spaces by diffusion and bring about a new configuration that may satisfy the geochemical requirements, reduce the internal strains and result in the formation of stable calcium silicates.

The role of moisture in puzzolanic action

In all the processes discussed so far, it is necessary that the calcium ions should be able to diffuse through the crystal structure of the puzzolana and reach a 'suitable' position. This may explain why moisture is always necessary for the progress of puzzolanic activity. It also explains why such a large variation is observed in the composition of calcium silicates formed[14]. The composition of the reacted products is mainly determined by the number of calcium ions which the puzzolana's structure could accommodate and this may vary.

Modified definition of puzzolana

Thus, there seems to be a need to give a new definition for a puzzolana which includes both aluminous and ferruginous materials which are often responsible for the reactivity in many of the common puzzolanic materials in use. The modified definition should also indicate the importance of the structural aspects. The following tentative definition is suggested: "*A puzzolana is a siliceous, aluminous or ferruginous material which by itself is not cementitious but which under certain states of crystallinity and structure could react with lime in the presence of moisture at normal temperature and pressure to yield cementitious products.*"

Acknowledgement

The author is thankful to Shri S. R. Mehra, Director, Central Road Research Institute, Delhi, and Shri P. J. Jagus, Assistant Director, for their keen interest in this investigation and for their helpful discussions and criticism. The author's thanks are also due to Dr. F. M. Lea, Dr. R. H. Bogue, Prof. J. D. Bernal, Dr. J. A. Hedvall and Dr. S. J. Gregg for their useful suggestions.

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Origin of Salt in Rajasthan

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VARIOUS theories have been proposed to account for the vast accumulation of salt in Rajasthan (*see* map). According to one of the most widely discussed theories[1] Rajasthan in general and Sambhar Lake in particular derive their salt by aerial transfer from the Rann of Cutch. This possibility has been critically examined by Pramanik and Ramakrishnan[2] and they found this theory untenable. A chemical examination of sea brine and inland brines in Rajasthan was made by Godbole[3] who found that Sambhar and Didwana brines did not contain potassium, calcium and magnesium salts which are characteristic components of sea salt. Godbole suggested that the transgressional phases of the ancient Tethys Sea might have reached the border of the Aravallies where, due to crustal adjustments portions of the sea were separated from the main body, and gradual evaporation of several such basins gave rise to salt deposits in Rajasthan. He has not, however, given any explanation for the absence of calcium, magnesium and potassium salts. The theories mentioned above have been formulated more or less on meteorological or geological evidence. The wind-borne salt theory seems to have been propounded without regard to chemical data. In his investigations Godbole (loc. cit.) carried out some chemical analyses of the salt deposits but he has not given details of the experimental methods adopted and did not explain his results and their bearing on his theory.

Semi-micro methods have now been employed for determining the (qualitative) composition of salt samples and brines. These have been used either through the conventional spot tests or in the form of paper chromatography. The latter has so far been carried out in inorganic chemistry using ascending or descending solvent methods. Quicker and equally efficient separations have now been obtained with horizontal circular paper chromatography originally suggested by Rutter[4] and used largely by Rao and others[5] for organic compounds.

Brine and salt samples from the following places have been analysed: Mandi (Himachal Pradesh), Kharagoda (Saurashtra), Didwana, Pachbhadra and Sambhar (Rajasthan). The results are given in Table 1.

Discussion

From the above results the five sources can be classified into two categories: (1) *Sambhar type* — Sambhar and Didwana brines come under this category. The characteristic features are (a) presence of sodium sulphate and sodium carbonate and (b) absence of potassium, magnesium and bromide ions. Absence of calcium salts in Sambhar and Didwana brines reported by Godbole (loc. cit.) seems to be the result of

TABLE 1 — ANALYSIS* OF BRINE AND SALT SAMPLES

Source	Acid-soluble part					Acid-insoluble part				
	Fe, Al, Ti, Ca	Mg	K	CO_3, SO_4	Br	Ca	Zr	Sb	PO_4	Al
Mandi	+	+	+	+	+	+	+	+	+	+
Sambhar	+	−	−	+	−	−	−	Traces	−	+
Didwana	+	−	−	+	−	−	−	do	−	+
Pachbhadra	+	+	+	+	+	−	−	do	−	−
Kharagoda	+	+	+	+	+	−	−	do	−	−

*Sodium and chloride ions not considered.

wrong observation. (2) *Oceanic water type*— Mandi, Pachbhadra and Kharagoda brines contain all the constituents present in sea brines, e.g. bromides, magnesium and potassium salts. Sodium carbonate and sodium sulphate present in Sambhar and Didwana brines are absent in brines of the oceanic water type.

According to the theories proposed by Holland and Christie (loc. cit.) and by Godbole (loc. cit.) the composition of brines at all places in Rajasthan should be very similar to that of Kharagoda brine. Both the theories fit in well in the case of Pachbhadra brine but appear to be untenable for Sambhar and Didwana brines. The criticism by Pramanik and Ramakrishnan (loc. cit.) of the wind-borne salt theory seems to be quite conclusive and hence that theory need not be discussed further. Godbole's theory seems to be applicable to Pachbhadra salt since besides agreement of chemical composition it is also corroborated by the presence of marine fossils in that area. No such evidence has been reported for Didwana and Sambhar and the chemical composition of salts from these places is also strongly against the possibility of dried up sea deposits being directly responsible for the salt, for if it were so it would be difficult to explain the absence of potassium, magnesium and bromide ions.

Godbole (loc. cit.) explained the presence of sodium carbonate at Sambhar by assuming the reduction of sodium sulphate by algae to sodium sulphide. The latter was then considered to be converted by atmospheric carbon dioxide into the carbonate.

$$Na_2S + CO_2 + H_2O \longrightarrow Na_2CO_3 + H_2S$$

There is no evidence, however, to support the conversion of sodium sulphide into sodium carbonate by atmospheric carbon dioxide, a conversion that has been much attempted without success[6]. Further, the strong odour evolved at Sambhar and considered by Godbole to be due to hydrogen sulphide given out in the above reaction may be due to a different cause[7]. It was shown by Haas[8] that the red algae, *P. fastigiata*, evolves a strong odour in air which is due to certain dimethyl sulphide derivatives. *P. nigrescens* also evolves this sulphide. The evolution of the organic sulphide derivatives has been shown by Simpson and Challenger[9] to be an enzymatic process. Sulphonium compounds have also been isolated by Challenger (loc. cit.) from two green algae, *Enteromorpha intestinalis* and *Spongomorpha arcta*. The smell around the salt lakes may be due to volatile organic sulphides and not to hydrogen sulphide. Further, it may be pointed out that Godbole's suggestion cannot be valid for another reason. At Didwana there is no alga but considerable quantity of sodium carbonate is present and hence there can be no cause and effect relationship between the two.

It is likely, in view of the above findings, that the origin of salt at Sambhar and Didwana is very different from that of salt at Pachbhadra. No evidence, geological or otherwise, has so far been obtained to suggest ancient existence of sea at Sambhar and Didwana. It is reasonable then to consider that salt at these places should have been, and is continuously being, transported to these places from some other place. Surface drainage of the surrounding country by rivers and streams, suggested by Agarwal[10] to be responsible for the accumulation of salt, was shown to be quite inadequate to account for the quantities of salt involved[11]. It has also been observed that the water brought in by these streams is much less saline and the salinity increases later on. This clearly shows that the transfer of salt is taking place not from above the surface but from below. A new and more correct theory should take cognizance of these features besides the chemical compositions mentioned earlier.

That in ancient times the sea covered the greater part of northern and north-western India is borne out by the presence of marine fossils, brackish water and rock salt deposits themselves (Khewra and Mandi). It is very likely that these dried sea deposits are being washed by sub-soil currents towards depressions. For centuries this process of washing has been transferring salt from the north and north-west towards Rajasthan. The saline sub-soil currents collect in shallow basins and rise up to the surface if the soil is porous. The whole catchment area of Sambhar and Didwana, and in fact a greater part of Rajasthan, is thus rich in salt which was never originally there but is the product of a washing down process of dried-sea deposits situated north and north-west. This transfer is continuing and explains the inexhaustible supplies of salt at these places.

Strong support for our view is lent by the observation, stated earlier, that water becomes more saline on standing in Sambhar Lake than it is when brought in by the feeding over-ground streams. It obviously shows that saline sub-soil currents rise to the surface through the porous bed of the lake. The presence of sub-soil brine is supported by the presence of brackish water 10 or 20 ft. below the surface in a large part of Punjab, Delhi and Rajasthan. In this connection it would not be out of place to mention that the manufacture of salt by solar evaporation of brine raised from wells was carried out on an extensive scale at a number of places in Punjab and Rajasthan: Gurgaon, Dig, Bharatpur, Falodi, Lonkaran and Kanod. These works, however, could not compete with Sambhar Salt Works and the manufacture slowly died out.

The chemical composition of Sambhar and Didwana brines can be explained without invoking any unacceptable and unverified chemical reactions or phenomena. The absence of potassium, magnesium and bromide ions may be due to their removal from the sub-soil brines before the latter reach Sambhar or Didwana. This may take place by (i) precipitation (e.g. magnesium as carbonate) and/or (ii) ion-exchange mechanism. The dolomite deposits in Rajasthan may be derived from magnesium so lost.

The formation of sodium carbonate can be easily explained on the basis of interaction between the very large excess of sodium chloride and limestone (present in considerable amounts in Rajasthan and also in Sambhar Lake mud).

$$2NaCl + CaCO_3 \rightleftharpoons Na_2CO_3 + CaCl_2$$

The large excess of sodium chloride will make the reversible reaction go largely in the right-hand direction. Such accumulations of sodium carbonate, known as trona, were first studied in the Nile deposits in Egypt and are a common feature of lakes in arid regions (Lake Magadi and Lake Natron in Kenya and Tanganyika respectively, Owens Lake and Searles Lake in California deserts). The presence of sodium sulphate in the Rajasthan brines has been established by actual isolation. This can also be explained in a similar manner, reaction between gypsum and common salt being involved:

$$CaSO_4 + 2NaCl \rightleftharpoons CaCl_2 + Na_2SO_4$$

In order to test the validity of the above theory of the origin of salt in Rajasthan we have attempted to collect samples of well water from a number of places situated in the route of sub-soil currents from the north and north-west. We have not been fully successful because of lack of resources for making the collection of samples. However, we have been able to get a number of samples of well water from Bikaner and carry out their qualitative analysis. The results given in Table 2 show that they have all the usual components of sea water.

TABLE 2 — ANALYSES* OF WELL WATER SAMPLES

Source	*p*H	Fe	Ca	Mg	K	$CO_3^{=}$, $SO_4^{=}$	Br^{-}
Mandi, Himachal Pradesh	7·1	+	+	+	+	+	+
Lakhusar, Bikaner	8·0	+	+	+	+	+	−
Barju, Bikaner	8·1	+	+	+	+	+	−
Tokle, Bikaner	7·3	+	+	Large quantity	+	+	+
Kismidesar, Bikaner	7·1	+	+	do	+	+	+
Sainsan, Bikaner	8·3	+	+	do	+	+	−
Dharamshala, Bikaner	8·0	+	+	do	+	+	−
Silva, Bikaner	9·0	+	+	+	+	+	−
Dane, Bikaner	9·0	+	−	+	+	+	−

*Sodium and chloride ions not considered.

Methods of analysis

The salt samples and brine samples were analysed following the conventional spot-test technique. The presence of potassium was confirmed chromatographically. The large excess of sodium chloride was first removed by two fractional crystallizations and the mother liquor was used for chromatography. R_f values for lithium, sodium and potassium ions using circular paper chromatography were determined using methanol as solvent and silver nitrate-fluorescein mixture as developer. R_f values for the three ions at 28° were found to be: lithium 0·86, sodium 0·53 and potassium 0·46.

Summary

The huge quantities of salt available in Rajasthan salt lakes are considered to be carried by underground flow of water from the north and north-west areas which were originally covered by sea and hence are rich in salt. The underground streams not only get laden with salt but in their passage through certain areas suffer base exchange losing potassium, magnesium and bromide ions. These elements, normally present in sea water, are found in deep well waters of the areas mentioned above but are absent in the Sambhar and Didwana brines. The presence of carbonates and sulphates of sodium in Sambhar and Didwana brines is attributed to the lime and gypsum strata in the areas through which the brine has to pass.

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Moulding Characteristics of Madras Silica Sand

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THIS investigation was undertaken to study the suitability of Madras silica sand as a base for synthetic sand mixtures for steel moulding purposes. The sand sample, supplied by the southern circle of the Geological Survey of India, Madras, was collected (as coarse sand grade) from alluvial deposits near Ennore, in Chengalpat district. Geologically the deposits are of recent and post-pliocene origin.

Materials and methods

Standard methods, as specified by the American Foundrymen's Association, for sand testing, were followed throughout this investigation, using Dietert sand testing equipment.

Chemical analysis of the sand was done in duplicate after standard sampling and drying at 110°C.

Refractoriness of the sample was judged by the standard pyrometric cone equivalent test. The fusion temperature of the sand sample cone was further checked by ' Pyro ' optical pyrometer.

High temperature tests were conducted by firing A.F.A. standard 2 × 2 in. test pieces bonded with 5 per cent Bihar bentonite at 1350°, 1450° and 1550°C. The fired test pieces

were cooled to room temperature and examined for volume changes, surface characteristics, etc., and tested for crushing strength. The approximate sintering range has been indicated, in the light of the above findings.

Microscopic examination of the washed sand grains was also made.

Moulding characteristics of the sand were studied by preparing synthetic sand mixtures with Madras silica sand as base and employing Bihar bentonite and dextrine as binders in suitable proportions. Linseed oil and silica flour were also added for making core sand mixtures. The following sand mixtures were investigated to determine their suitability in the steel foundry.

Mixture No. 1 (*for moulds*) — Madras silicas and 2000 g. + Bihar bentonite 100 g.

Mixture No. 2 (*for moulds*) — Madras silicas and 2000 g. + Bihar bentonite 100 g. + dextrine 40 g.

Mixture No. 3 (*for cores*) — Madras silica sand 1900 g. + silica flour (— 200 mesh) 300 g. + wheat flour (— 200 mesh) 25 g. + linseed oil (double boiled) 20 g.

The standard 18 in. Simpson laboratory sand mixer was employed for preparing the sand mixtures.

In the case of the sand mixtures for moulds, the base sand was first milled with the dry additions for 2 min. The requisite quantity of water was then added to the sand mixture in the muller itself, and milling continued for 5 min. with scraping done at the end of the second and fourth minute. The total milling time was 7 min.

In the case of the sand mixture for cores, however, the base sand was first milled with the dry additions for 2 min., tempered to the desired moisture content in the muller itself and milled for 4 min. Requisite amount of oil was then added and the mixture milled for another 4 min. with scraping done after every minute. The total milling time was 10 min.

The sand mixtures after milling were aerated, allowed to stand for 3 hr. in airtight jars and then tested for physical properties.

Moisture content of the sand mixtures was determined prior to testing and expressed as percentages of the wet sand mixture. All physical test properties reported are averages of three tests.

Casting characteristics of all sand mixtures were studied by casting 3 × 3 × 3 in. test blocks with steel. The cast blocks were examined for surface characteristics and other casting defects.

Results

The sand sample in the as received condition was pale white in colour. Standard A.F.A. fineness test conducted on the sand sample revealed it to be of a medium coarse variety. There was no A.F.A. clay grade matter. The sand had an A.F.A. fineness No. of 26·4 and A.F.A. grain class No. 8. The results of size grading are given in Table 1 and Fig. 1 gives the cumulative grading curve.

Petrological examination of raw sand revealed abundance of quartz and a small amount of feldspar. The heavy minerals, viz. ilmenite, magnetite with traces of garnet and rutile, constituted only 2·7 per cent of the total sample. No calcareous material was present.

Microscopic examination of the washed sand grains showed them to be mostly subangular to round on all the different mesh

TABLE 1 — SIZE GRADING

U.S. SIEVE SERIES EQUIVALENT No.	SAND RETAINED %
6	nil
12	0·76
20	18·44
30	28·91
40	29·82
50	16·91
70	3·62
100	0·75
140	0·20
200	0·06
270	0·03
Pan	0·11
Maximum retention on three adjacent sieves (20, 30 and 40 meshes)	77·17
Fines	0·20

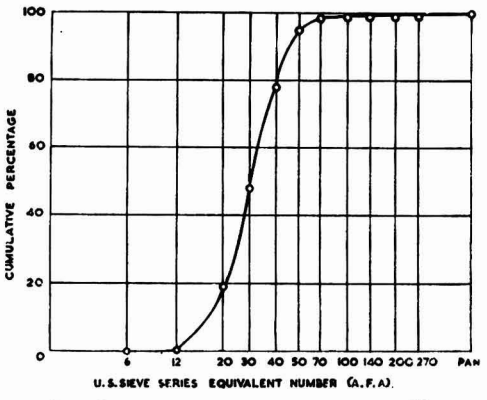


FIG. 1 — CUMULATIVE GRADING CURVE OF MADRAS SILICA SAND AS RECEIVED AND AFTER WASHING [The same curve represents the cumulative grading of the sand under both conditions]

fractions (Fig. 2). Some grains were quite transparent.

Complete chemical analysis of the sand as received is furnished in Table 2.

TABLE 2 — CHEMICAL ANALYSIS OF SAND AS RECEIVED

	%
SiO_2	97·10
Al_2O_3	1·15
Fe_2O_3	0·42
TiO_2	0·21
CaO	0·18
MgO	0·15
Na_2O, K_2O	0·82
Loss on ignition	0·12

Standard P.C.E. test conducted on the raw sand showed its refractoriness to be fairly high, the fusion point being 1710°C., corresponding to Orton cones 32-32½.

A.F.A. standard 2 in. × 2 in. diam. test pieces fired at 1350°, 1450° and 1550°C. showed that vitrification commenced at 1450°C. and was complete before 1550°C. as was shown by the sudden increase in the ultimate crushing strength of the test pieces after firing at that temperature. Slight cracks appeared on the test pieces fired at 1350°C. The results of the above tests are given in Table 3 (Fig. 3).

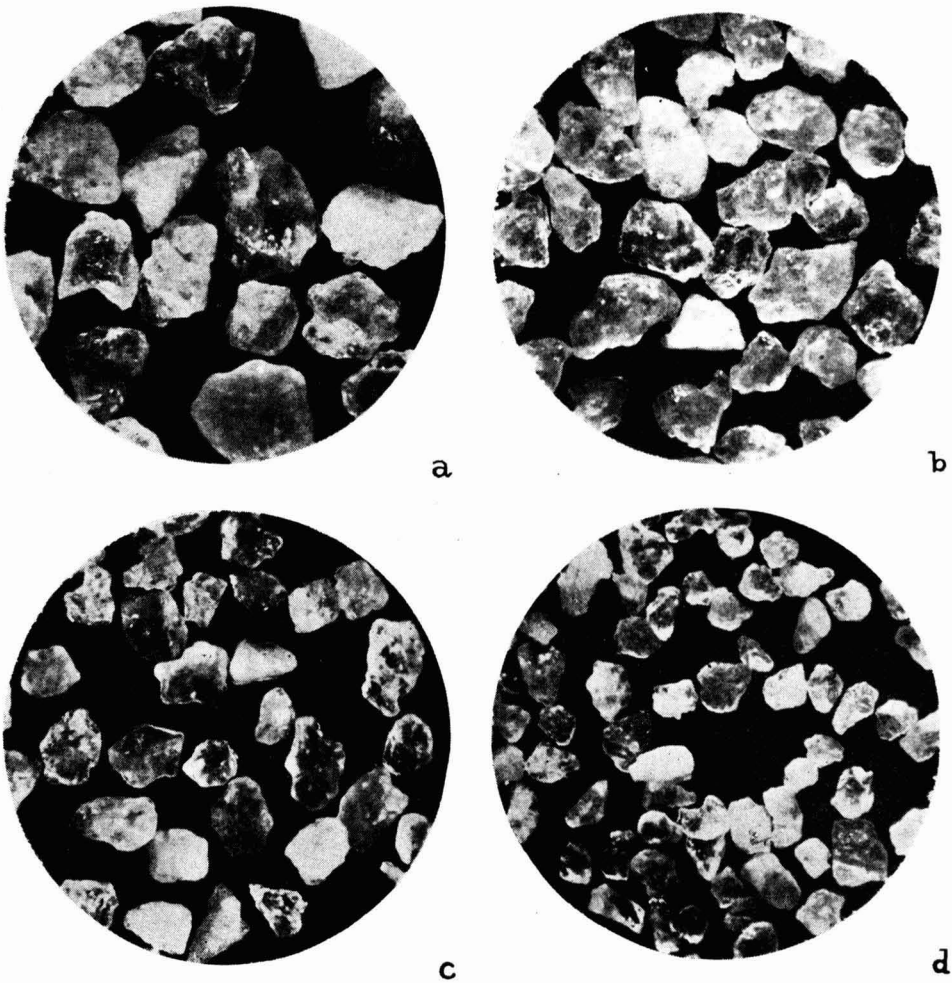


FIG. 2 — WASHED SAND GRAINS RETAINED ON (a) 20 MESH, (b) 30 MESH, (c) 40 MESH AND (d) 50 MESH ×25

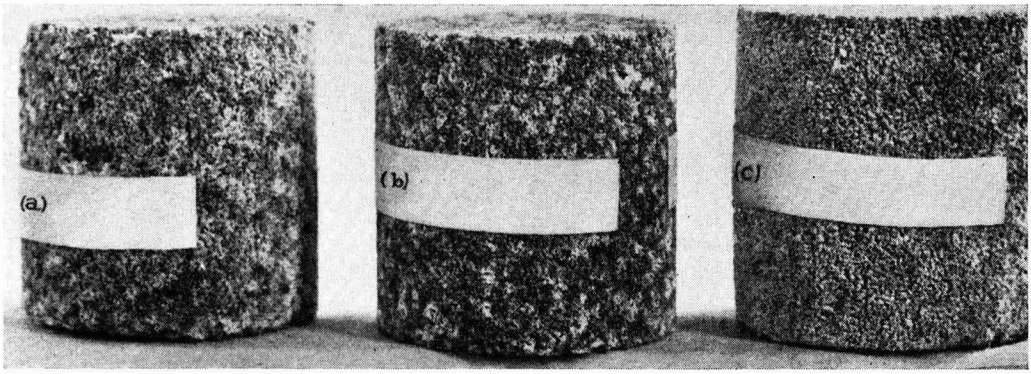


FIG. 3 — SURFACE CHARACTERISTICS OF TEST PIECES MADE FROM MIXTURE NO. 1 AFTER FIRING AT (a) 1350°C., (b) 1450°C. and (c) 1550°C.

TABLE 3 — HIGH TEMPERATURE TESTS

(Test pieces made from mixture No. 1)

TEMP. OF FIRING °C.	SOAKING PERIOD hr.	VOLUME OF TEST PIECE* AFTER FIRING cu. in.	CHARACTERISTICS OF TEST PIECE AFTER FIRING	ULTIMATE CRUSHING STRENGTH lb./sq. in.
1350	1½	6·735	Sand grains loosely adhered at places which fall off when rubbed; slight cracks on the surface which show a mottled texture (white spots in a pale yellowish brown matrix); dull sound when struck	79·0
1450	1½	6·787	Sand grains more adherent which show signs of fritting; dense mottled texture on the surfaces (white spots in a pale brown matrix); slight metallic sound; sintering range 1450°-1500°C.	254·7
1550	2	7·683	Considerable bulging; grains show positive signs of fritting; dull white, clear metallic sound	624·0

*A.F.A. standard 2×2 in. test piece rammed by 3 blows was employed; volume of test piece before firing, 6·284 cu. in.

TABLE 4 — MOULDING CHARACTERISTICS OF MIXTURE No. 1

	CHARACTERISTICS OF TEST PIECES MADE OF MIXTURE CONTAINING A MOISTURE CONTENT OF		
	2·4 %	3·4 %	4·0 %
A.F.A. green permeability No.	740	590	570
Green compressive strength, lb./sq. in.	6·600	3·900	2·900
Green shear, lb./sq. in.	1·500	0·900	0·700
Mould hardness	83	80	77
Flowability	78·500	80	84
Shatter index	32·950	24·420	17·140
Dry compressive strength, lb./sq. in.	36	42	49
Dry shear, lb./sq. in.	—	9	12·500
Relative density	1·553	1·603	1·621

Moulding characteristics

A.F.A. standard test pieces (2 in. × 2 in. diam.) rammed by 3 blows were used in all the tests except in the case of shatter index test where the test pieces were rammed by ten blows. The test pieces employed for dry strength determination were dried in a Dietert core drier for 2 hr.

Mixture No. 1 (Table 4 and Fig. 4) has a maximum permeability of 740 and a maximum green compressive strength of 6·6 lb./sq. in. at 2·4 per cent moisture content. Dry strength was maximum (49 lb./sq. in.) at 4 per cent moisture content. Flowability was fair within the range of moisture contents studied but the shatter index was poor. The mixture rammed hard in the specimen tube and showed signs of stickiness. The surfaces of the test pieces were friable. Full results are furnished in Table 4 (Fig. 4).

Mixture No. 2 (Table 5) — The dry strength and shatter values of the mixture were better than those for mixture No 1. A maximum dry strength of 75 lb./sq. in. was recorded at 3·4 per cent moisture while the maximum shatter index (68·55) was noted at 2·5 per cent moisture content. The flowability of the sand mixture was slightly impaired.

Mixture No. 2 was also studied for its air setting properties by exposing the rammed test pieces to laboratory atmosphere and then testing them for compressive strength at

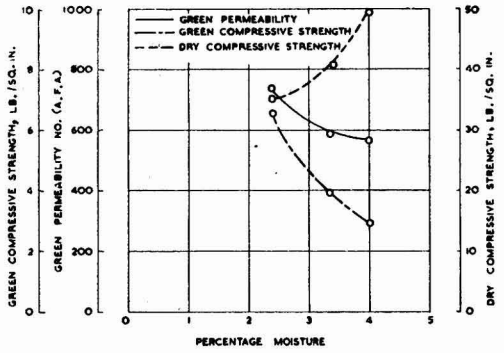


FIG. 4 — MOULDING CHARACTERISTICS OF MADRAS SILICA SAND BONDED WITH 5 PER CENT BIHAR BENTONITE

TABLE 5 — MOULDING CHARACTERISTICS OF MIXTURE No. 2

	Characteristics of test pieces obtained with mixture containing a moisture content of	
	2·6%	3·4%
A.F.A. green permeability No.	800	650
Green compressive strength, lb./sq. in.	7·100	4·800
Green shear, lb./sq. in.	2·050	1·350
Mould hardness	80	82
Flowability	68	79·500
Shatter index	68·550	50·880
Dry compressive strength, lb./sq. in.	65	75
Dry shear, lb./sq. in.	16	18
Relative density	1·553	1·573

TABLE 6 — CRUSHING STRENGTH OF TEST PIECES AFTER EXPOSURE

(Initial moisture content to which the sand mixture was tempered was 3·2%)

Exposure period *hr.*	Crushing strength *lb./sq. in.*
—	5·1
½	7·9
1	9·7
2	11·6
3	13·7
4	16·5
24	56·0

regular intervals of exposure. The crushing strength values of the test pieces are given in Table 6.

Table 6 shows that the green strength of the sand mixture was doubled after 2 hr. exposure and was ten times the original value after 24 hr. exposure.

Mixture No. 3 for cores — Silica flour was incorporated in this mixture with a view to reduce the surface friability of the test pieces

TABLE 7 — MOULDING CHARACTERISTICS OF MIXTURE No. 3

(Moisture content, 4·3%)

A.F.A. green permeability No.	220
Green compressive strength, lb./sq. in.	4·400
Green shear, lb./sq. in.	1·000
Mould hardness	75
Flowability	77
Shatter index	28·650
Dry compressive strength, lb./sq. in.	246
Relative density	1·767

which was mainly due to the coarse grain size of the base sand and also to reduce their permeability to the optimum range of 200-300. Linseed oil was added to enhance the dry strength of the test pieces. The moulding characteristics of test pieces obtained with the mixture tempered to 4·3 per cent moisture are recorded in Table 7.

A remarkably high dry strength of 246 lb./sq. in. was noticed in this case. However, the surface of the test pieces was friable in spite of the silica flour addition to the mixture.

Casting characteristics — The casting characteristics of the sand were determined by casting standard 3 × 3 × 3 in. steel blocks in sand moulds employing the above sand mixtures. The cast test blocks revealed rough surfaces, presumably due to the coarse grain size of the base sand.

Summary

Madras silica sand is a medium coarse sand with an A.F.A. fineness No. of 26·4. It has a fairly good grain distribution as 77·17 per cent of the grains were retained on three adjacent sieves, viz. 20, 30 and 40. The percentage of fines present was only 0·2. The grains are mostly sub-angular to round in shape. The raw sand contained abundant quartz with a little feldspar and heavy minerals. No calcareous matter was present in the sample. The sand assayed SiO_2, 97·10 per cent; alumina, iron oxide, titania, lime, magnesia and alkalies were present only in small amounts. The sample revealed a fairly high refractoriness, the fusion point being 1710°C. High temperature tests with sand mixture bonded with 5 per cent Bihar bentonite revealed its sintering range to be between 1450° and 1500°C. A study of the moulding characteristics of selected synthetic sand mixtures employing Madras silica sand as base and Bihar bentonite and dextrine as binders gave satisfactory results. However,

its green permeability was high. Mixture No. 2 also exhibited excellent air setting properties which shows that the moulds can be used with advantage after atmospheric curing. Mixture No. 3 possessed desirable moulding characteristics required for a core sand mix.

Experiments on casting characteristics of the mixtures resulted in cast test blocks with rough surfaces, presumably due to coarse grain size of base sand.

The sand may be suitable for medium and heavy steel castings, both in the green and the dried states but a finer grade will be required for light castings. Surface friability of the sand mixtures, however, requires special attention. It may be reduced by suitable surface coating or wash.

Acknowledgement

The authors wish to thank the Geological Survey of India, Madras, for supplying the sand sample. Their thanks are also due to Mr. U. C. Sharma, Senior Scientific Assistant, General Metallurgy Division, for assistance and to Mr. V. Jagannathan of Chemical Division for the chemical analyses.

Exploration of the Antarctica

THE fascinating story of the exploration of the Antarctica and the prospects of harnessing the resources of this vast continent formed the subject of the presidential address of Sir Raymond Priestley to the British Association for the Advancement of Science, at its annual meeting held at Sheffield during August 1956.

Antarctica is vast and very remote. Its area is 6 million sq. miles, nearly as large as Europe and Australia put together. The greater part of the continent is covered with ice several thousand feet thick. The surrounding oceans teem with life as do no other waters in the world. Over most of the continent, there is no single month in the entire year in which the mean monthly temperature exceeds 0°C. The continual prevalence of sub-zero temperature throughout the continent and its extreme remoteness were mainly responsible for the delay in its exploration till comparatively modern times.

The first phase (1900-1908) of antarctic exploration was characterized by a surge of geographical discovery. From the temporary locations on the more accessible parts of the antarctic coastline, biological and geological investigations were carried out and the first slight knowledge of physical conditions of the antarctic ice and atmosphere was made available. The second phase (1908-14) of antarctic exploration was a race in quest of the South Pole, but few scientific results of significance were added.

Scientific contributions of pre-war exploration

Polar geological research has revealed considerable, though not conclusive, evidence of past changes of climate on the continent. We cannot still be certain whether the severence between East and West Antarctica is complete or not. However, evidence from recent air surveys indicates a greater probability of Antarctica being a single continent than two. Important among the different geological samples collected by various parties and the evidence they yielded were: *Archaeocyathus*, a common ancestor of sponges and corals occurring in Cambrian limestone-stunted forms; coal seams 7 ft. thick of Permo-Carboniferous to Rhaetic Age found in the Beacon sandstone in the Victoria Land; part of a Rhaetic tree, collected from the Priestley Glacier, containing in its tissue, a tiny-winged spore; priceless specimens from the upper ranges of the Beardmore Glacier including *Glossopteris indica* type fossil of the Permo-Carboniferous, so widely spread in Australia and elsewhere; Jurassic, Cretaceous and Tertiary floras from the fold ranges of West Antarctica. No single formation of undoubted glacial origin was found older than late Tertiary age. This remains the classic problem of antarctic geo-

logy — the missing link for which may be supplied by paleomagnetism. It may lead either to the justification or to the setting aside finally of Wegener's theory.

Whaling and antarctic exploration

During the past half century, whaling man has followed the explorer's track and farmed the antarctic seas. Whaling and exploration, each had reciprocally gained from the other, particularly in the initial phases of antarctic exploration. An example of this mutual valuable contribution was the oceanographical research carried out by the Royal Research Ships, *Discovery* I and II. More than 4000 whales were marked and the researches carried out on breeding and life-cycle, distribution, migration and habits of the whale have proved of infinite value to the whaling industry. The efforts of the *Discovery* party resulted in covering the southern charts with a complex network of courses, encircling the globe. Valuable scientific data were obtained during the course of the next 12 years (1914-26). The oceanographic survey has revealed the broad structure and the mechanics of the principal water masses and currents and certain basic features of the distribution of the ocean plankton.

Inter-war years

The inter-war years have registered remarkable progress in many directions in antarctic exploration. America began to appreciate the importance of antarctic exploration and mobilized all the resources of modern mechanical and biological sciences. A major expedition embracing, for the first time, both East and West Antarctica was planned during 1939-40.

Antarctic exploration and exploitation after World War II tended to become more and more an affair of Governments than that of individual explorers or scientific societies with the result that much of the exploratory work carried out was not published.

In spite of this restriction, considerable progress was made in systematic investigation and data collection. The Falkland Islands Dependencies Survey set up by Britain came into existence in 1944. Britain has now 10 permanent bases in West Antarctica. The mainland stations are maintaining a complete meteorological record and ionospheric and seismological programmes and geological and topographical surveys are in full swing at some of them. The Americans in the last 10 years have planned operations on a war scale under Admiral Byrd with many ships and thousands of officers and men. France has built, in Kerguelen, a first-rate sub-antarctic scientific outpost and is preparing large-sized airstrips. From the Adelie Land base they have widely explored the antarctic coast and to some distance inland. Australia has established permanent stations at Macquarie Island and at Mawson (on the mainland), which have been concentrating on specific scientific problems and have done scientific work of a high order. They dealt with such problems as: investigations on the inland ice of Queen Maud Land (to a depth of 100 m.); radio-sonde ascents (up to a height of 72,000 ft.); seismic profile of the inland ice (up to 390 miles inland) and aerial surveys of the continent.

Antarctica today

Today, there is again a fresh resurgence of interest in Antarctica inspired by the spirit of 'science for its own sake'; preparations on a large scale are being made by more than 45 nations to participate in the International Geophysical Year (I.G.Y.) for 1957-58. The programme includes, studies in meteorology, aurora and airglow, geomagnetism, ionospherics, cosmic rays, glaciology, oceanography and seismology, variation in longitude and latitude and solar activity. With chains of stations from pole to pole, the systematic exploration of the physical phenomena of the Antarctica is a striking component of the plan. In and around Antarctica there will be more than 40 stations. Of these, three will be situated respectively at the Geographic Pole, Geomagnetic Pole and the Pole of Inaccessibility.

Examination of the upper regions of the atmosphere is given high importance and attempts to reach out into space farther than ever will be made by dispatching man-made satellites to a height of up to 800 miles by means of 3-stage rockets. Large and small rockets and balloons carrying heavy loads of scientific instruments will be used for exploring lower altitudes. Automation will be an essential element in the instrumentation of the air-borne equipment and they will be tracked by observers throughout their course, or they will send signals which actuate ground-based automatic recorders. A trans-

antarctic expedition across the continent from west to east, which also indirectly contributes to I.G.Y., has been planned. During this expedition, it is intended to take seismic soundings of ice depth along with a continuous gravity traverse. Modes of transport like tractors, aircraft, and electronic homing (up to 25 miles) devices will be mainly used. Also rock exposures which may be met along the unknown country traversed will be examined.

Exploitation of antarctic mineral resources

The prospects of atomic power being bright, the possibility of valuable mineral deposits in a continent of the size of Antarctica cannot be ignored though nothing significant has been reported so far. Future prospecting must be carried out with the help of helicopter-borne ground parties equipped for high-speed core drilling and rock sampling in co-ordination with air-borne surveyors equipped with magnetometers and stereoscopic cameras. Attention should be concentrated, initially, on the relatively few exposed rock surfaces where mining is not complicated by frequent ice movements. Once the ore is located, tunnel or adit entry may be adopted. Floating power stations that could be withdrawn during the ' closed ' season might serve well in the beginning and, with success, can be gradually replaced by permanent land-based stations. With the advantages that atomic power is capable of, the establishment of atom-powered settlements may be possible, if a worthwhile economic method is discovered to make use of atom-powered ice-breakers. Another possible source of power lies in the harnessing of antarctic gales. But no means of putting these possibilities into practice is within sight, at the moment. From present indications, it is likely that for the remainder of the century so much remains to be known that investigations will be confined to pure rather than applied sciences. However, man may, by discovering a way to overcome the latent heat of ice, make the continent habitable.

Fuel Cell—Its Possibilities & Applications

THE need for augmenting power production necessitates search for new ways of obtaining power. One of the less familiar means of obtaining power is by an electrochemical process. Electrochemists have long been engaged in producing an electrochemical cell in which some kind of ' fuel ' combines with oxygen from the air and generates utilizable electrical energy. In an article in the *Times Science Review* [No. 20 (1956), 6], F. T. Bacon, Department of Chemical Engineering, Cambridge University, England, has reviewed the development of fuel cell research, and discussed the present status of the fuel cell as a source of power and its future uses.

The familiar Leclanché cell is a typical example of such a cell. But its ' fuel ' is expensive and it can be used only in cases where the source of energy can afford to be in an isolated place for local use. Hydroelectric installations apart, many large-scale power systems of the world rely on heat engines. But the maximum efficiency of such systems is about 30 per cent at present and is not likely to exceed 40 per cent. A fuel cell, being not subject to the limitation in efficiency which the Carnot cycle imposes on heat engines, has a relatively high theoretical efficiency. For example, in the case of the hydrogen-oxygen cell, the efficiency is 83 per cent and for a carbon-oxygen cell it almost approaches 100 per cent. A practical cell to be economic should use a cheap and abundantly available fuel like raw coal, coke or crude oil, natural gas, town-gas or coke-oven gas.

Gas cells

Fuel cells using solid or liquid fuels have been found to be impractical due to a number of technical difficulties in their construction and operation, chiefly in reducing the energy losses at various stages. Gas cells offer con-

siderable advantage in that all the solid impurities such as ash can be easily eliminated and hence work being done on fuel cells is mostly confined to the development of this type. A number of fuel gases like hydrogen, carbon monoxide, methane and other hydrocarbons are readily obtained from coal. The efficiency of conversion of coal into one or more of these gases ranges between 55 and 100 per cent. With the prospect of large amounts of cheap gas of relatively low calorific value becoming available through underground gasification of coal, the development of a gas cell utilizing these gases for producing power assumes importance. The problem resolves itself into how to combine one or more of these gases electrochemically with oxygen obtained from the air, the energy of combination being released mainly in the form of electrical energy.

Air electrode

In recent years, it has been found that an ' air electrode ', using oxygen direct from the atmosphere, can take the place of the oxidizing electrode, i.e. manganese dioxide in the conventional primary cell. Oxygen is adsorbed on the surface of an activated carbon conductor which with its immense surface area acts as an effective oxygen carrier and also catalyses the reaction. The same principle is used in the design of gas fuel cells. The gases are adsorbed on to the surface of a conducting solid which forms the body of the electrode and also serves to conduct away the current. Electrolytes take the form of aqueous solutions and must be ionic (and not electronic) conductors.

Development of the gas cell

The earliest attempt to construct a gas cell was made by Sir William Grove in 1839 in which hydrogen was electrochemically combined with oxygen using platinized platinum electrodes. But the Grove cell could only handle very small currents and served only to demonstrate the principle of the gas cell. Later Mond and Charles Langer in 1889, using similar principles, succeeded in obtaining larger outputs (*c.* 6·5 ma./sq. cm.) by increasing the exposed platinized area. But the prohibitive cost of platinum rendered it impracticable. Since then, Prof. Baur has devoted considerable attention to the subject which has become the basis of present high temperature gas cell development. The work of O. K. Davtyan of the Academy of Sciences, Moscow, on high temperature gas cell using certain kinds of glasses as electrolytes, also deserves mention. But the current densities attained (21-32 ma./sq. cm.) are considered low for any practical use.

Further work on high temperature cells is being conducted, at present, at a number of places, notably at Sondes Place Research Laboratories at Dorking and the Chemistry Department, Birmingham University, in England; Central Laboratory of Staatsmijnen and the Amsterdam University in Holland; and the Technical High School, Brunswick, in Germany.

The efforts being made at these places, though they may not be successful to the point of practical application, are worth pursuing because of the great advantage that impure industrial byproduct gases like methane, carbon monoxide, hydrogen, etc., can be used as fuel and air can take the place of oxygen. A c.d. in excess of what Davtyan obtained has not been claimed so far, except with cells of very short life. A large proportion of the on load running losses can be traced to the effective resistance of the 'solid electrolyte' which acts as a diaphragm preventing the two gases from mixing. Efforts are being made to reduce this resistance.

High-pressure hydrogen-oxygen cell

A simple system consisting of a cell consuming pure hydrogen and oxygen, evolved at Cambridge University, has given promising results. Rare metals have been avoided in the cell to keep the cost low and accordingly nickel electrodes and an alkaline electrolyte have been used. The extreme sluggishness of the nickel gas electrodes, at temperatures below the boiling point of aqueous solutions, necessitated the use of higher temperatures, which in turn required employing pressures well above the atmospheric pressure to prevent electrolyte evaporation. The main cell parts were made of nickel-plated steel and the pipe-work of nickel.

The essential parts of the apparatus are the porous nickel electrodes and the electrolyte cell which serves to maintain a column of strong caustic potash electrolyte in the narrow space between the electrodes. The gases are confined to the backs of the electrodes, which are 4 mm. thick and have a

pore size of 30 μ on the gas side for presenting a very large surface for adsorption of gas, and a thin layer of much smaller sized pores on the liquid side.

The optimum temperature and pressure for best performance ensuring a life of a few thousand hours have been found to be 200°C. and 600 lb./sq. in. respectively. Maximum output per cu. ft. of internal volume is about 9 kW. and the energy efficiencies at 0·9 and 0·8 V. and the above temperature and pressure are 75 and 66 per cent respectively.

The breakdown of the oxygen electrode due to gradual oxidation has been overcome by subjecting it to a pre-oxidation treatment in air.

A battery of 6 cells in series built up like a filter-press and having a maximum output of 150 W. was exhibited at the Production Exhibition at Olympia in July 1954. The unit was found suitable for running small 6 V. motors and light a number of motor car headlights.

Applications

Fuel cells are unlikely to compete with established systems of power production. But, in course of time, the high temperature gas cell may come into use in the electrochemical desalting of water for irrigation and other purposes, and metallurgical industries where heavy low-voltage d.c. is required. They should be particularly suitable and economic if underground gasification of coal on a large scale becomes a practical proposition.

The high-pressure oxygen-hydrogen cell could be used mainly as a kind of storage battery using the gases generated electrochemically from water, with power from the grid. At present the disadvantages are the low overall efficiency of the electrolysis and the subsequent recombination. The most probable application is in railway traction for which d.c. is particularly suitable. Rail cars on those routes whose electrification is uneconomic with overhead lines can be run with such cells as is being done now on the German State Railways. Silent operation and the absence of fumes make their use in road traction over short distances in urban areas an attractive proposition. But, at present, their prohibitive weight and volume do not allow them to compete with the modern diesel engine.

When nuclear energy becomes available, the cost of electricity will be mainly due to the capital cost and not due to cost of fuel, i.e. uranium. Then some kind of large-scale storage device will become essential because there will be no advantage in shutting down the plant during the light load period. This kind of fuel cell will be well suited for such a purpose. The excessive weight of the storage cylinders (for the two gases) of a gas cell for such an application may appear to rule out such a possibility. But it is estimated that the total weight of a complete installation of cells and cylinders on the basis of a discharge time of 5 hr. would be only a quarter that of lead accumulators.

REVIEWS

DYNAMIC FACTORS IN INDUSTRIAL PRODUCTIVITY by Seymour Melman (Macmillan & Co. Ltd., London), 1956. Pp. xii + 238. Price 22*s*. 6*d*.

During the post-war years, ' Productivity ' has developed into an important subject of scientific study. A good deal of specialist attention has been devoted to it by many industrially advanced countries, both nationally and internationally. Seymour Melman's book *Dynamic Factors in Industrial Productivity* makes a good contribution to the study of the subject.

The author enunciates three related hypotheses and makes a systematic approach to test them on the basis of data mainly drawn from the automative and allied industries of England. The three hypotheses are:

(1) The degree of mechanization of industrial work is controlled by the ratio of alternative labour to machine costs.

(2) Labour productivity is governed by the degree of mechanization.

(3) The growth of administrative overhead in industrial firms has limited the effect of raising labour productivity.

There are a large number of other factors, tangible and intangible, that affect productivity, but the author seeks to explore the extent to which the particular elements defined in the hypotheses as dominant, controlling factors do, in fact, account for productivity trends.

Among the determinants of changes in production methods adopted by the post-war England, the changing nature of the market for British goods and the conditions of full employment there do not seem to have been given due consideration. However, with the data on materials handling in the British automobile industry, the author establishes that the rise in 1938-50 of the ratio of the man-hour to machine-hour costs was the principal determinant in the mechanization of work in the motor vehicle industry of England. Increased mechanization certainly results in increased productivity, but what is of real interest is the net increase in productivity measured as a ratio of the output of goods to the input of all agents of production. As a matter of fact, this measurement should extend further and include all social costs not generally included in business accounting. This is particularly important in countries with large unemployment.

The author treats labour cost as an independent variable and links it functionally with industrial productivity. But the cost of labour is governed, among other things, by the ability of industry to pay, and this ability is definitely enhanced by increased productivity through mechanization of production methods. If rising labour costs have led to increased mechanization of production methods, certainly mechanization, in turn, has made possible further increases in labour costs. This raises the question, " To what extent is the cost of labour an independent variable ? " The pertinence of the question and the lack of the controlling effect of labour cost on productivity are confirmed by the author himself in his analysis presented in Fig. 12 where for a given level of alternative costs there is a lower productivity response in England as compared with the U.S.

On account of the changing financial, commercial and production conditions, the management personnel has expanded due to addition of new functions and extension to the existing ones. Over the period 1907-48, the author shows a persistent rise in the functional composition of labour force. The proportion of employees engaged on administrative, technical and clerical activities rose from 8·6 to 20·0 per 100 production workers. This is an important study and its effect on the gains of increased productivity of direct labour has been very clearly brought out.

" Productivity changes are the joint product of industrial employees and workers ", says the author. The policy of Government, the level of available technical and managerial knowledge, and the current economic conditions can be added as other contributory factors. Productivity improvement may be said to be the common interest of all the occupational groups concerned with industry. The author rightly points out that no unilateral line of action is possible by any one interested group to raise productivity.

The methodology of analysis and treatment of subject used in the book are interesting. The book constitutes a systematic probe into some important aspects of industrial productivity.

R. MISHRA

NEUTRAL GROUNDING IN HIGH VOLTAGE TRANSMISSION by R. Willheim & M. Waters (Elsevier Publishing Co., New York), 1956. Pp. xviii + 669. Price 90*s*.

Neutral grounding is an important feature in the design of a power system and is perhaps more difficult to select than any other feature. This is due to the large number of factors involved in its application and the difficulty of assessing the money value of these factors. Some of the factors affected by the method of grounding are: (1) apparatus insulation, (2) relaying, (3) fault to ground current, (4) safety from voltage gradient considerations, (5) stability, (6) localizing faults, (7) lightning protection, (8) inductive co-ordination, (9) radio interference, (10) circuit breakers, (11) operating procedure, (12) adaptability to interconnection and (13) cost. Opinions on neutral grounding often show wide diversity and, as is common in design problems, the solution is usually an attempt to get the best compromise between conflicting factors.

The main schemes of system grounding available are the following: (i) ungrounded systems, (ii) resistance grounded systems, (iii) reactance grounded systems, (iv) effectively grounded systems, and (v) resonant grounded systems. Broadly speaking the trend in American practice has been from ungrounded, to solid or effective grounded systems. In Europe, on the other hand, during the last three decades, considerable use of resonant reactors (Peterson coils) has been made. In recent years, however, a number of European large power systems have adopted the solid grounding technique, while in the U.S.A. resonant grounding is being increasingly introduced.

The book under review treats comprehensively and critically the various methods of neutral grounding and other measures designed to reduce the fault rate in high voltage transmission systems. The advantages and disadvantages of these schemes as well as the conditions under which a particular scheme can be usefully employed are fully discussed. An attempt has been made to co-ordinate American experience with that gained in Europe during the last three decades and to arrive at conclusions which will put the various methods of grounding in the right perspective. The subject matter dealt with in the book covers a more extensive field of transmission engineering than the title indicates.

The book is divided into two parts, Part I dealing with ground faults and grounding practices and Part II with resonant grounding. Topics discussed under Part I are (1) charging currents in high voltage systems, (2) high voltage systems under normal and ground fault conditions including theory of neutral grounding, (3) transient phenomena associated with ground faults in three-phase systems and (4) development and present trend of ground fault suppression. Part II is a comprehensive treatment of the subject of resonant grounding and deals with (1) the general theory of the ground fault neutralizer, (2) special problems connected with it, (3) comparison of resonant grounded system performance with alternative methods of reducing the fault rate, (4) design and planning of the ground fault neutralizing equipment, (5) testing and commissioning of ground fault neutralizers, (6) supervision and automatic control of tuning in resonant grounded systems, and (7) resonant grounding in the practices of various countries. The comprehensive bibliography included at the end of each chapter enhances the value of the book as a reference book.

In the opinion of the reviewer, the book is a valuable contribution in the English language on an important branch of transmission engineering and will be most useful both to the transmission engineer and to the postgraduate student. The printing and get-up of the book are excellent.

H. N. RAMACHANDRA RAO

ELECTRONIC MEASUREMENTS AND MEASURING INSTRUMENTS by F. G. Spreadway (Constable & Co. Ltd., London), 1956. Pp. ix + 459. Price 50*s*.

This is a valuable addition to the existing literature on the subject. Electronic instrumentation, although relatively new, has now become quite important to all branches of science and engineering, and a standard text-book giving a comprehensive but brief résumé of the subject has been a long-felt want.

The book is divided into 13 chapters. Basic ideas of valves and components are explained to the extent necessary for the person with a basic knowledge of electronics. This is followed by descriptions of valves and volt-meters, ammeters and wattmeters. Electronic methods of measuring frequency and time, electronic stroboscopes and flash-lamps, cathode-ray oscillograph, the photo-electric cell, etc., are described with their applications. Oscillators, amplifiers, electron optical systems and instruments, etc., are also discussed in relation to their utility in electronic instruments. There is a useful chapter on power supplies for electronic instruments. Transformers, meters, components, etc., and their importance in electronic instrumentation have been adequately dealt with.

The book is nicely printed and the reproduction of diagrams and photographs is good. The bias in the treatment appears to be towards giving a precise mathematical description although some of the practical points are not neglected.

The book can be strongly recommended to students of electrical engineering and physics, and should find a place in every engineering and science college library.

S. V. CHANDRASHEKHAR AIYA

METALLURGICAL THERMOCHEMISTRY by O. Kubaschewski & E. L. Evans (Pergamon Press Ltd., London), Second Edition, 1956. Pp. xiv + 410. Price 55*s*.

This is Vol. I of the International Series of Monographs on " Metal Physics and Physical Metallurgy " brought out under the editorship of G. V. Raynor. This volume, entitled " Metallurgical Thermochemistry ", was first published in the year 1951 and is already familiar to the metallurgical chemist, as a masterly exposition of the application of fundamental principles of chemical thermodynamics to metallurgical processes and also as a reference book for thermochemical data.

This revised edition is an improvement over the previous edition, for up-to-date and authentic thermochemical data are included in the extensive tables and improvements and additions have been made to some of the chapters. The original plan of the book, under five parts, has been retained in the present edition.

The first part, ' Theoretical Basis ', contains the necessary formulae for applying the fundamental data to reaction problems. The second part deals with ' Experimental Methods '; some of the methods touch upon new devices and special techniques of practical value. The third part deals with methods for the ' Estimation of Thermochemical Data '.

The fourth part deals with the tabulation of ' Thermochemical Data ', viz. heats of formation, standard entropies and structures, heat capacities, vapour pressures, standard free energies of reaction, thermochemical data for certain binary metallic systems and for some dilute solutions. The extensive data presented in the tables, which cover about a third of this monograph, are the most useful part of this book especially for the process metallurgist and the research worker.

The fifth part deals with interesting ' Examples of Thermochemical Treatment of Metallurgical Problems '. Some of these, such as reduction of magnesium oxide and chloride with silicon and hydrogen respectively, deoxidation of steel with silicon and manganese, oxidation of alloys of platinum and of gold, etc., are typical, and their treatment in this part of the book is very instructive to the research worker.

This monograph is undoubtedly a valuable work, and, coupled with the other book, *Thermochemical Data of Alloys* by O. Kubaschewski and J. A. Catterall, will prove indispensable to the metallurgical chemist, whether he is a production executive or a research worker.

A. JOGARAO

RADIATION BIOLOGY: VOL. III—VISIBLE AND NEAR-VISIBLE LIGHT. Edited by A. Hollaender (McGraw-Hill Book Co. Inc., New York — Toronto — London), 1956. Pp. viii + 765. Price $ 10.00.

This is the last of the three-volume work of reference comprising radiation biology, published under the sponsorship of the National Research Council. Together they provide a more or less complete, detailed and authoritative discussion by many leading scientists of the biological effects of radiation from the physical chemical and biological points of view. The earlier volumes cover ionizing and ultraviolet radiations while Vol. III discusses the effects of visible and near-visible light. Although it does not deal with the cytological and genetical effects of radiation damage, it is of interest to photobiologists and especially to plant physio-

logists and to those interested in photosynthesis and other topics important to biological growth and energy.

Of the fifteen chapters, the first three are general and deal with energetics of the visible radiations and of the reactions induced by it. These are followed by an exhaustive discussion, in five chapters, of photosynthesis. Other chapters describe phototropism, photoperiodism, photoblastism, influence of light on protolasmic properties, mechanism of vision in higher animals as well as in invertebrates and photodynamic action.

Aparently the manuscripts for the different chapters were completed by the respective contributors quite some years before the volume came into print and although there are rather sketchy addenda to some of the chapters, it is unfortunate that there are many important omissions probably because of the very rapid progress in photobiology during the last three years. For example, one would be disappointed if he were to seek in this authoritative volume a mention of recent discoveries such as the role of thioctic acid in photosynthesis and of the molybdenoflavoprotein enzyme in nitrate reduction. Nevertheless this monograph and its predecessors should be a welcome addition to the shelf of the specialists in this field.

A. SREENIVASAN

GASEOUS NEBULAE: VOL. III — The International Astrophysics Series by L. H. Aller (Chapman & Hall Ltd., London), 1956. Pp. 322. Price 53*s*.

The knowledge of astrophysics has rapidly advanced during recent years due to the development of radio-astronomy. It is, therefore, an opportune moment for an established author and reputed scholar like Prof. L. H. Aller to bring out this volume. The book will no doubt be of great use to research workers, teachers and students of astronomy and astrophysics.

After introducing the various types of galactic nebulae to the reader the author has dealt with different methods of observation and study of the gaseous nebulae with which the present volume is primarily concerned. Prof. Aller has described in detail the direct photographic method of study as also the principle of slitless spectrograph along with the spectrophotometric and more recent photoelectric photometric methods of observations and delineation of the isophotic contours.

After defining the two distinct classes of the nebulae formed by the planetaries and diffuse objects, Prof. Aller presents a discussion of the distances and dimensions of the gaseous nebulae, followed by discussion of the physical processes involved in the formation of the gaseous nebulae and the process of radiative equilibrium. Besides the astrophysical methods, quantum mechanical treatment of the forbidden line radiation from the nebulae is also given. A discussion on the stellar nebulae which illuminate the gaseous ones is next presented and it has been explained how the excitation and ionization of gaseous nebulae are intimately controlled by the Lyman limit in the spectra of the illuminating stars. Dealing at length with the isophotic contours of monochromatic images of planetary nebulae for the study of their structure and internal motions, the author has shown the limitations of the method.

Although it is difficult to present the technique of radio-astronomy in a single volume like this, Prof. Aller has given a comprehensive account of the gaseous nebulae as sources of radio-frequency radiations and has pointed out that useful results may be obtained in future with improved radio techniques. The book summarizes our present knowledge on gaseous nebulae and includes a large number of interesting photographs obtained with the 100 in. Hale telescope and others at the Mt. Wilson and Palomar Observatories. The exhaustive bibliography presented at the end of each chapter will be of immense value to research workers in this field.

S. S. BANERJEE

NOTES & NEWS

Processing under extreme conditions

A SYMPOSIUM ON "PROCESSING under extreme conditions" was recently arranged by the Division of Industrial and Engineering Chemistry during the 128th meeting of the American Chemical Society when a large number of papers were presented on the criteria for processing under high pressures and temperatures. Some of the papers described a few of the recent developments and processes employing high temperatures and pressures.

Working under extreme conditions, i.e. high temperatures and pressures, for carrying out a number of reactions is being increasingly appreciated both in research and industry. A proper study of materials and construction, design of equipment and reactors, control and protection of workers has to be made when working under such extreme conditions to avoid explosion hazards.

Vessels for carrying out reactions under extreme conditions are divided into two main groups — agitated vessels or autoclaves and continuous flow vessels or reactors. Special alloys for retention of strength at elevated temperatures have been developed to match the shape and exacting conditions of operation. A simple Duplex design for the reactor shells employing two different alloys for the inner and outer shells offers a satisfactory solution. The inner shell would be made of an alloy with moderate creep strength and capable of extended creep before rupture. Materials for the outer shell could be of a much more refractory alloy with limited ability to redistribute stresses by creep. It would need to have only a few per cent elongation before fracture.

For processing under extreme conditions, it is often necessary to supply gas at elevated pressures continuously. This problem is solved by feeding gas in stored accumulators at pressures above the desired operating pressure, or gas is compressed continuously in a multi-stage plunger type compressors, e.g. automatic booster compressors, able to develop a final gas pressure as high as 140,000 lb./sq. in. Appropriate filters on the inlet streams and regular valve inspection will minimize faulty valve performance.

An important factor in processing under extreme conditions is adequate safety of operating personnel. The types of barricades that have been used in the past range from pits into which the equipment is lowered, sand bags piled around the equipment and steel or rope matting hung between the equipment and operator to the more modern types of barricades composed of steel or concrete fortification-type walls. Probably the simplest and most commonly used barricades consist of boiler plate (in some cases armour plate) mounted on a self-supported structure which surrounds the equipment. An improvement in the single steel-plate design is to back up the plate with a layer of wood about 2 in. thick. Concrete walls and steel sandwich type of construction have also been widely used; the space in between the steel sandwich is filled with sand, cotton or wood. For safety, the high pressure equipment contained within the cell should be adequately supported and should not be attached to the wall. Readings of the pressure gauges can be obtained either through peep-holes or by means of pneumatic transmitters.

For small-scale operations, where the volume of the reactor does not exceed 200 ml. and pressures up to 5000 atm. and temperatures up to 450°C. are employed, batch reaction cubicles have been popular. The construction of a typical cubicles is as follows: two layers of interlocking steel piling, $\frac{3}{8}$ in. thick, spaced 12 in. apart on the sides and 30 in. apart on the front. The spaces between sides and front are filled with sand. The steel roof is attached to the sides and front by welding. The back of the cubicles is enclosed with a thin sheet of ethylcellulose plastic mounted on a wooden frame which serves as a safety blowout panel.

An example of extreme condition processing is provided by the processes developed for upgrading heavy petroleum crudes and residuums. The exploratory study of high pressure hydrogasification of petroleum oils in a laboratory reactor has indicated that it is practical to produce high methane content gases of 900-1100 B.t.u. per stand. cu. ft. and 0·5-0·6 sp. gr. by direct hydrogenation of the low cost residual oils.

Hydrogenation of coal provides another example of processes carried out under extreme conditions. An exploratory study of coal hydrogenation at temperatures 1200°-1350°F. and pressures 1400-3200 lb./sq. in., in a laboratory batch reactor, has indicated that gas can be produced by direct hydrogenation of bituminous coal.

With the tremendous increase in the demand for natural gas, the economic production of a synthetic high B.t.u. gas from coal has been of considerable interest. The British Gas Research Board has carried out a series of investigations on the use of a supported nickel catalyst for the synthesis of methane. An increase in reactor pressure (to a maximum pressure studied of 1040 atm.) increases the amount of coal hydrogenated to hydrocarbons and the ratio of methane to carbon dioxide in the product. Hydrocarbons heavier than propane are not obtained under these conditions. The B.t.u. value of the carbon dioxide free product gas, produced from a carbon monoxide-hydrogen feed, was increased from 558 B.t.u. at 37 atm. to 815 B.t.u. at 1040 atm.

Another process operated under extreme conditions is the vapour phase hydration of 2-butene to 2-butanol. A substantial economic advantage favours direct hydration of the lower olefines in the vapour phase as against the esterification in the liquid phase with sulphuric acid followed by hydrolysis. Boric and phosphoric acids on silica gel have been used as catalysts and a 64 per cent of equilibrium conversion could be obtained at 730°F. and at a pressure of 612 atm., using a mol ratio of 0·19 of butane to steam [*Industr. Engng. Chem.*, **48** (1956), 826].

New cis-synthetic rubbers

SYNTHETIC RUBBERS MADE FROM butadiene and styrene by emulsion polymerization have rela-

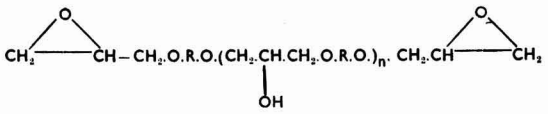
tively low resilience as compared to natural rubber. This is considered to be due to the differences in their structure. Natural rubber consists essentially of *cis*-units of the polyisoprene type, formed by 1:4-in head to tail fashion, whereas the synthetic diene rubbers possess structures which are mixtures of *cis* and *trans* units formed by 1:4-addition or of units formed by 1:2-addition. Considerable interest has, therefore, been created by recent announcements by three major American rubber manufacturing organizations to the effect that they have now produced polyisoprenes with a molecular structure similar to that possessed by natural rubber.

Details of this new type of synthetic rubber have been released by the Goodyear Rubber Company. A heterogeneous catalyst system of the Ziegler type has been used in effecting the synthesis. The principal ingredient of the catalyst is aluminium triethyl mixed with a suitable co-catalyst; this catalyst is produced under carefully controlled conditions so that a suspension of solid material is formed with the specificity of surface essential for the formation of a highly regular structure in the polymer. Coral rubber, manufactured by the Firestone Rubber Company, uses as a catalyst, a 35 per cent dispersion of lithium in petroleum jelly; this is obtained by melting the metal in the jelly dispersant and agitating the molten mass at 18,000 r.p.m. at 200°C. for about 30 min. in an atmosphere of helium. Coral rubber has a crystalline X-ray pattern and is stated to be a mixture of 93 per cent *cis*-1:4 polyisoprene and 6·1 per cent 3:4 *cis*-polyisoprene, with no *trans* 1:4 or 1:2 structures. In comparison, figures for natural Hevea rubber are *cis*-1:4, 97·8 and *cis*-3:4 2·2 per cent [*Industr. Chem.*, **32** (1956), 277].

Epoxide resins

THE PLASTICS AND POLYMER Group of the Society of Chemical Industry organized a symposium in London during 11-13 April 1956 on epoxide resins, their chemistry and structure in relation to their properties and applications. A brief summary of the proceedings is given below.

The essential step in the preparation of epoxide resins is the



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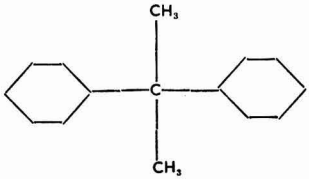


reaction of epichlorhydrin with a bifunctional phenol, of which diphenylolpropane is the commonest example. The type of molecule obtained is represented by (I).

The value of n will depend on such factors as ratio of reactants and time of condensation. The commercial production of epoxide resins depends on the large-scale availability of epichlorhydrin. This compound is now made as an intermediate in the synthesis of glycerin through hot chlorination of propylene and the product is likely to be undertaken in Europe later this year.

As regards the hardening of epoxide resins, aliphatic and aromatic amines are frequently used because they can induce hardening at low temperatures. Further, if polyfunctional amines, like diethylenetriamine and triethylenetetramine, are used, they can cause ready cross-linking but suffer from the defect that they develop high exotherm during hardening, whereby bubbling is caused in the resin. For general use, aromatic amines such as *m*-phenylenediamine and 4:4′-diamino-diphenylmethane are satisfactory, leading to high heat distortion temperatures and good mechanical properties. Aniline-formaldehyde resins are suggested as curing agents and their action seems to be similar to that of 4:4′-diaminodiphenylmethane. They have also the advantage of being relatively cheap.

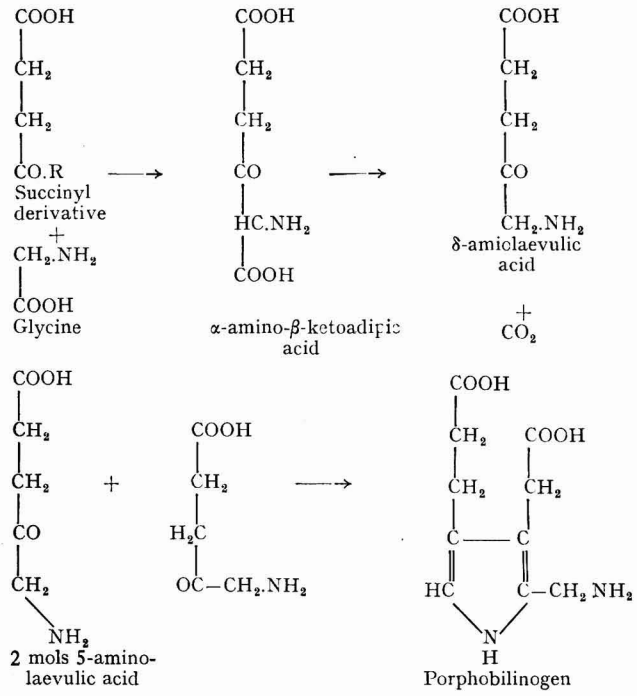
The so-called ' polyepoxide resins ' are essentially phenolic resins in which the hydroxyl groups have been combined with epoxide residues. They yield a rigidly cross-linked system and cure much more rapidly with primary amines. Another type of modified resins, the rubber-modified resins are also described. Nitrile rubbers containing sulphur react through thiol groups, whereby mixed polymers are formed. The epoxide constituent acts as a reinforcing agent and confers improved solvent resistance and increased tear-strengths.

Epoxide resins are excellent adhesives and they show great promise in the glass laminating field and for potting and encapsulating of electronic equipment. They have also been considered good stabilizers for polyvinyl chloride [*Nature*, **117** (1956), 962].

Biosynthesis of haemoglobin

GLOBIN AND HAEM, THE TWO moieties of the haemoglobin molecule are known to be synthesized independently within the bone marrow. While their structures have been established, very little is known regarding their biosynthesis. Globin consists of 5 layers of coiled polypeptide chains and 4 haem units present in each molecule of haemoglobin, attached to the surface of the globin structure like flat plates in a symmetrical distribution and each with one free co-ordination axis of the iron atom projecting outwards from the molecule as a whole. The haem portion is ferroprotoporphyrin IX.

From extensive studies involving degradations, radioactive tracer analyses and syntheses, Prof. C. Rimington of the London University has proposed a tentative scheme for the biosynthesis of haem. Glycine and the succinate unit (from the tricarboxylic cycle) are considered to be the simple precursors of haem, while δ-aminolaevulic acid and porphobilinogen are the main intermediates. Condensation of glycine and the succinate unit gives α-ketoglutaric acid, a homologue of



pyruvic acid. α-Ketoglutaric acid is next decarboxylated to succinate after which a transferring enzyme passes it on to coenzyme A, forming succinyl CoA and reduced lipothiamide. Succinyl CoA is then reoxidized through the diphospho-pyridine nucleotide system so that it becomes available for a further molecule of α-ketoglutarate and the operation of the cycle is preserved. Succinyl CoA and glycyl CoA condense in the head to tail reaction giving α- and β-ketoadipic acid. One molecule of CoA becomes free in this process and returns to pick up another molecule of succinate.

Decarboxylation of α-amino-β-ketoadipic acid gives δ-amino-laevulic acid and condensation of two molecules of the latter gives porphobilinogen, the first pyrrole derivative in the scheme. The main steps involved up to the formation of porphobilinogen are shown in the chart above.

The next phase of the biosynthesis comprises conversion of porphobilinogen to uroporphyrin which by stepwise decarboxylation and finally dehydrogenation and iron incorporation leads to protoporphyrin and haem [*Brit. med. J.*, **2** (1956), 189].

New potent analogue of oxytocin

THE SYNTHESIS OF 'VALYL-OXYTOCIN' and its properties are described. The method employed is the same as that employed by Boissonnas *et al.*, except that the isoleucyl group in oxytocin is replaced by valyl group. The steps in the synthesis involve the coupling of N-CBO-S-benzyl-4-cysteinyl-4-tyrosine with 4-valine methyl ester in tetrahydrofurane, using the mixed anhydride procedure. The resulting tripeptide ester was transformed through the hydrazide into the azide, which by reaction with a suitable hexapeptide gave a nonapeptide. The nonapeptide was reduced with sodium in liquid ammonia, ammonium chloride added, ammonia evaporated off and the residue added to water. The cyclic octapeptide was finally obtained by bubbling carbon dioxide-free air through the solution at a suitable *p*H.

The effect of valyl-oxytocin on the blood pressure in chicken and on rat uterus was found to be equivalent to that produced by 3 I.U./ml. of oxytocin; the effect on milk ejection pressure in rabbit mammary gland, the effect was equivalent to 15 I.U./ml. of oxytocin. Its anti-diuretic effect on non-anaesthetized rats and pressor activity on spinal cats were equivalent to 0·03 I.U./ml. and 0·015 I.U./ml. of oxytocin [*Nature*, **178** (1956), 260].

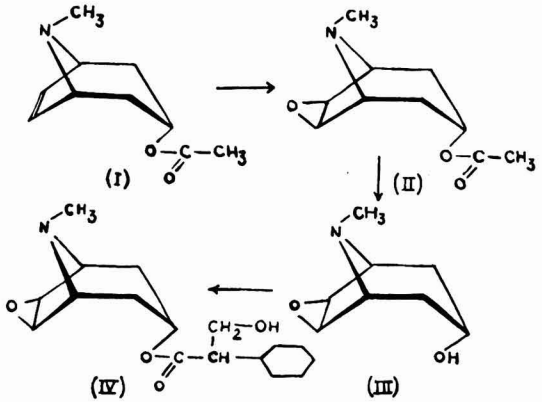
A new synthesis of hydroxylamine

A NEW PROCESS DEVELOPED BY Du Pont for the commercial synthesis of hydroxylamine is considered to be cheaper than the present process employing acid hydrolysis of nitroparaffins. The new synthesis — catalytic hydrogenation of nitric oxide — starts from relatively cheap raw materials and gives high yield of hydroxylamine.

A platinum-on-carbon catalyst is preconditioned with hydrogen in 10 per cent hydrochloric acid for 15 min. at 35°-50°C. The mixture is then cooled to 0°-5°C. and a stream of nitric oxide-hydrogen passed through it. The resulting solution after filtration and evaporation yields hydroxylamine hydrochloride (95 per cent) as a white crystalline solid; yield 67-73 per cent. The catalyst life is long enough to suggest its use in a continuous process involving simultaneous withdrawal of hydroxylamine solution and addition of fresh acid [*Industr. Engng. Chem.*, **48**(7) (1956), 18A].

Total synthesis of scopolamine

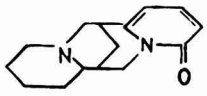
THE FIRST TOTAL SYNTHESIS OF scopolamine (IV) has been reported by G. Forder and co-workers of the Institute of Organic Chemistry, Szeged University, Hungary. Epoxydation of 3(α)-hydroxytrop-6-enyl acetate (I) (after protonation with a strong acid) with an excess of monoperphthalic acid, gave the N-oxide of scopyl acetate which, on hydrogenation, afforded 3(α)-acetoxy-6(β)-hydroxytropane. A better approach to scopine, however, is the oxidation of the trifluoroacetate of (I) in acetonitrile, with a solution of trifluoro-peracetic acid in methylene chloride to give scopyl acetate (II). Kunzhydrolysis of (II) furnished crystalline scopine (III) together with some oscine. When treated for 4 days at 60° with a large excess of this acyl chloride in suspension in nitrobenzene, scopine hydrochloride yielded acetylscopolamine.



This was deacetylated with hydrochloric acid giving scopolamine as the hydrochloride. Both the base and its picrate were identical in all respects with authentic scopolamine and its derived picrate [*Chem. & Ind.*, (1956,) 764].

Synthesis of new alkaloids

THE SYNTHESIS OF ANAGYRINE, an oxygenated tetracyclic lupin alkaloid, is reported from the University of Wisconsin. The method consists in condensation of Δ′-piperidein and 2-(α-pyridyl) allyl malonic acid giving a tricyclic intermediate, which has all the carbon and nitrogen atoms of the desired alkaloids properly placed. This is immediately esterified, reduced with lithium-aluminium hydride, and converted to the primary bromide, which cyclizes spontaneously to the tetracyclic pyridinium salt. Oxidation with ferricyanide yields



anagyrine. Partial synthesis from anagyrine yields other alkaloids [*Chem. Engng. News*, **34** (1956), 3665].

Isolation of viruses

QUICK AND EASY ISOLATION OF viruses from cancerous animal tissue homogluates is possible in a new method reported from the International Corporation, New York [*Trans. N.Y. Acad. Sci.*, **18** (1956), 701]. In this method fluorocarbons, particularly Freon (CCl_2 F-CCl_2F) and Genetron (CF_2Cl-CCl_2F) are used as organic solvents. Their sp. gr. of 1·6 allows easy adjustment with an admixture of *n*-heptane to resemble the sp. gr. of proteins while their low surface tension helps in their emulsions with water to break easily and clearly upon standing or at low speed centrifugation.

The virus infected tissue (2 g.) is mixed with Freon-heptane mixture (5 ml.) and 1 : 50 McIlvaine's citrate buffer (10 ml.) and homogenized in a homogenizer. The milk-like foamless homogenate is centrifuged at 1800 r.p.m. for 5 min. (or it is allowed to stand in a refrigerator for a few hours) as a result of which it separates into 3 sharply defined layers. The aqueous middle layer containing the virus particles is carefully removed. To get a further crop of virus particles the top and bottom layers can be mixed with a further 10 ml. of the buffer solution, homogenized and centrifuged. To obtain the virus in a high state of purity the aqueous layer is mixed with 5·0 ml. of fresh Freon-heptane mixture, homogenized at 23,000 r.p.m. for 10 min. and centrifuged at 1800 r.p.m. for 5 min. The water-clear supernatant contains the virus in a state of high purity and free from liquids and non-viral proteins contained in the tissue.

New complex phase in high-temperature alloy

X-RAY DIFFRACTION STUDY OF the grain boundary phase in the alloy A-286 (Allegheny-Ludlum Steel Corp.), obtained electrolytically, has revealed the existence of a new complex phase, arbitrarily designated as the G-phase, in the alloy system. The composition of the alloy is: C, 0·05; Cr, 15·0; Ni, 26·0; Mo, 1·15; Si, 0·50; Fe, 53·5; Ti, 2·0; Al, 0·17; and V, 0·2 per cent. Semi-quantitative chemical analyses as well as microscopic studies reveal a direct relation between silicon content and the abundance of this phase, and indicate that silicon plays a fundamental role in the existence of the G-phase. The fact that this phase has been found to be more acid-resistant than TiC also points to a similar conclusion.

Powder diffraction photograph patterns obtained with copper K_α radiation are unusually clear and contained as many as 55 lines. It has been found that all the lines could be indexed on the face-centred cubic lattice. No systematic absence of lines other than that imposed by face-centred symmetry has been observed. The possible space groups have been deduced as : F_{23}, Fm_3, F_{432}, $F\bar{4}3$, and Fm_3m. This space group limitation while ruling out the η-carbide structure (Fd_3m) allows that of $M_{23}C_6$ carbide (Fm_3m). But the lattice parameters and X-ray intensities of this space group do not tally with those of the grain boundary phase as obtained from diffractometer recording measurements and integrated intensity studies. Thus, this phase appears to have a structure of its own. The G-phase has been observed to be present in residues from several alloys subjected to heat treatments below the solution temperature (1000°C.). Identical inter-planer spacings and intensities have been obtained in all these cases [*Nature*, **178** (1956), 208].

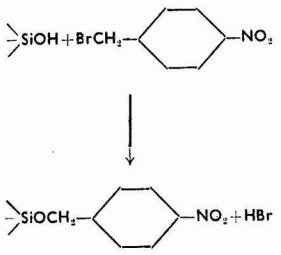
Modification of glass surfaces

THE SURFACE OF SILICATE GLASS becomes permanently hydrophobic after treatment for 1 hr. with a dry 30 per cent toluene solution of *p*-nitrobenzyl bromide at a temperature of 100°C. The hydrophobicity of glass surface thus treated decreases slightly during the initial period of exposure, reaching a terminal value after 60 hr. after which no decrease of hydrophobicity is observed. This is in contrast with the behaviour of an aqueous solution of quaternary ammonium compound cetyl pyridinium hydrochloride, on

glass surface, in which case, hydrophobicity decreases with time.

The permanent hydrophobicity produced in the first case suggests the presence of an organic surface derivative of glass rather than an ion-exchange or adsorption layer, as is known to be the case with glass surfaces treated with quaternary ammonium compounds. The fact that no hydrophobicity could be obtained on glass surfaces by using *p*-nitrotoluene instead of *p*-nitrobenzyl bromide shows that CH_2Br group and not the NO_2 group of *p*-nitrobenzyl bromide is involved in the formation of surface derivative. Further by using the glass surface with the largest number of hydroxy groups per unit surface area, the most hydrophobic products were obtained on treatment with *p*-nitrobenzyl bromide.

On the basis of the above experiments, the mechanism of the reaction between glass surface and *p*-nitrobenzyl bromide can be put down as follows:



[*Nature*, **178** (1956), 376].

Tantalum solid electrolytic capacitors

A NEW TYPE OF ELECTROLYTIC condenser with superior low temperature characteristics and shelf-life has been developed by research workers at the Bell Telephone Laboratories. In these capacitors, a solid semiconductor replaces the usual aqueous electrolyte. No hermetic seal is required for ordinary applications as all the materials used are inorganic non-volatile solids. They are especially suitable for transistor circuitry, in view of their small size.

Electrolytic capacitors, though satisfactory and popular for a number of electrical circuits where large blocks of capacitance are required, suffer from low electrical quality in some respects which limits their application in electronic circuitry. An important advance, in recent years, has been the introduction of the tantalum anode, as a supplement to the usual aluminium anode. The high dielectric constant and the chemical stability of the tantalum and its oxide help miniaturization and improvement in shelf-life and operating temperature range respectively.

Capacitors have been made with both porous and dense tantalum anodes, but the development of the porous type has reached commercial production stage. A porous sintered pellet, used as an anode in making solid electrolytic capacitors, is prepared by pressing tantalum powder to shape in a die and sintering at high temperature under vacuum to weld the particles together. Tantalum purity, particle size-distribution and the condition of sintering are important factors. The high internal surface of the sintered pellets affords a large area and consequently gives high capacitance (10 μF./g. of tantalum for a formation voltage of 100 V.). An anode lead of dense tantalum is attached to the porous tantalum body (by embedding it in the porous block during pressing). A layer of tantalum oxide which serves as the dielectric in the capacitors is formed on the tantalum surfaces electrochemically, making the tantalum the anode. A layer of semiconductor — manganese dioxide formed by the pyrolysis of manganous nitrate — is deposited, in several coats, over the entire dielectric surface. The unit is then coated with a layer of carbon from a graphite dispersion. This coating ensures intimate electrical contact with the manganese dioxide and guards against thermal and mechanical shock of the underlying layers in subsequent operations. A metallic cathode encasement is applied by metal spraying with a coating of lead-tin alloy. The tantalum anode lead is cut short and a solderable nickel terminal welded on to it. Tinned copper wire is soldered to the metallic cathode coat to provide a cathode terminal. Finally the capacitors are electrically aged by applying a d.c. voltage, in excess of the ultimate working voltage for 24 hr. or more when they will be ready for use.

An interesting feature of the solid capacitors is that they can be of any shape — rectangular, disc or oval — whereas those using liquid constituents is usually cylindrical for ease in making the seal. Another important advantage of the solid capacitor is its excellent electrical performance at low temperatures. This type of capacitors exhibited no significant variation in power factor (measured at 1000 c/s.) and capacitance down to −75°C. whereas other types showed large increases of these parameters in the same temperature range. Also at a given capacitance and voltage rating, the high frequency limitations of the solid types are less pronounced than those employing liquid electrolytes. Among those of the solid type, the low capacitance and higher voltage rated ones have shown the best characteristics. General indications are: shelf-life test with the capacitors has shown that they possess adequate stability in respect of power factor, capacitance and leakage current when maintained at fixed but moderate temperatures. Their use up to an operating temperature of 65°C. is recommended [*Proc. Inst. Radio Engrs., N.Y.*, **44** (1956), 872].

Irradiated polythene

WANDLESIDE CABLES WORKS Ltd., London, have produced a modified polythene as an insulant for use in cable manufacture, by irradiating polythene. Irradiated polythene, in common with polythene, has low power factor, high resistivity and ease of processing. In addition, it has a higher melting point, 200°-300°C., depending on the intensity of irradiation, as compared to 110°C. of ordinary polythene.

Other important characteristics of irradiated polythene are: high creep resistance and Rockwell hardness and a certain hardness is maintained even above the melting point of polythene. Whereas ordinary polythene carbonizes in boiling sulphuric acid, irradiated polythene is attacked only on the surface [*Atomics Engng. Tech.*, **7** (1956), 261].

Thermenol, a unique new metal alloy

THE U.S. NAVAL ORDNANCE Laboratory has developed a new alloy, named 'Thermenol', possessing some unusual properties. The metal is superior to the alloys

presently used for heating units. It is 20-25 per cent lighter than stainless steel and has a better tensile strength even at temperatures up to 1200°F. Its corrosion and oxidation resistance are excellent. These properties of the alloy offer great scope for its use in place of stainless steel in applications where high temperature and corrosive atmospheres are a problem to be tackled, e.g. as in turbine blades of jet aircraft. The metal retains a high gloss polish indefinitely. The most attractive feature of thermenol is that it contains no strategic or critical materials of considerable importance in national defence [*J. Franklin Inst.*, **262** (1956), 92].

Anodized aluminium magnet wire

THE ALUMINIUM CO. OF CANADA Ltd. has announced recently the development of a continuous process for the production of insulated magnet wire by building up a ductile anodic coating on the aluminium wire. The use of anodized aluminium magnet wire, in place of copper wire insulated with organic films, offers the possibility of building equipment that is cheaper, lighter, and most important, which could run hotter.

The breakdown voltage which can be achieved depends on the thickness and density of the oxide film that is built up on the wire. Under dry conditions, breakdown voltages up to 500 V. are obtainable but at this level the necessary oxide coating has reduced ductility and adhesion. For 200 V. insulation, the thickness of the coating is approximately 10 μ.

The main advantage of aluminium magnet wire is its ability to withstand high temperatures without deterioration of its electrical properties. The oxide film, unlike organic films, does not deteriorate with age, nor does time change the electrical characteristics of the film at normal or elevated temperatures.

There are still some problems to be solved before the anodized aluminium magnet wire can be safely recommended for use in electrical insulation practice. All aluminium oxide films have high moisture absorption characteristics and the breakdown voltages which have been outlined are obtainable only in atmospheres of low humidity. It is also difficult to evaluate the abrasion resistance of the anodic coating by standard methods since the nature of the two types of films is entirely different. In its present stage of development, aluminium magnet wire may be directly applied to equipment where moisture is excluded, to coils which are oil-immersed in normal operation, and to coils which are coated with a moisture excluding compound [*Aluminium News*, July 1956, 7].

Microwave spectroheliograph

A NEW TYPE OF RADIO TELESCOPE, called 'microwave spectroheliograph', is being installed at the Radio Propagation Laboratory, Stanford University, U.S.A., which is expected to throw more light on the nature of the chromosphere. The heliospectrograph consists of 32 parabolic aluminium antennas, known as 'dishes' which will be aligned in two rows to form a huge cross occupying a 2-acre meadow. The 'dish' antennas scan the sun's surface and by picking up solar microwaves radiations in a range around 3000 Mc/s., produce an image of the chromosphere. The 32 antennas scan the sun's surface in unison, and follow the sun automatically as it crosses the sky. A photograph of the entire solar orb is completed in about 2 hr. The antenna efficiency is not impaired by clouds. The project aims at accomplishing the scanning of solar regions as small as three-thousandth of one square degree, an unprecedented definition in radio astronomy or radar [*J. Franklin Inst.*, **262** (1956), 88].

Ultraviolet television microscopy

ORDINARY ULTRAVIOLET TELEVISION microscopy suffers from the disadvantages of considerable background noise other than that due to statistical arrival of photons as well as of noise contributed by the first valve between the photocathode and its amplifier.

Applying television principles to the production of absorption images of living cells by the flying-spot technique employing two locked cathode tube rasters, the distinct advantages resulting from such a combination of optical and electronic techniques have been demonstrated by J. Z. Young and F. Roberts of the University College, London. The flying-spot television microscopy using photomultiplier tubes which are not subject to these disadvantages minimizes these sources of noise and contributes to an increase in the signal-to-noise ratio. The higher quantum efficiency of the photomultipliers permits considerable reduction in the amount of ultraviolet radiation required for image production. These advantages have been partly realized in the first flying-spot microscope model constructed by them.

Subsequently, new types of deep ultraviolet scanning cathode rays tubes and ultra-violet photomultipliers with higher quantum efficiency have been developed. In these tubes, a monochromatic ultraviolet spot at 2600 A. with a bandwidth of 100 A. is employed to scan the specimen. These developments in conjunction with certain recent techniques devised by research workers at Southwestern Medical School, University of Texas, U.S.A., have now made the practical realization of the full potentialities of the flying-spot technique possible. These developments consist of the employment of a 4-sec. frame-sweep speeds, 60-cycle line presentation on a radar tube and photographic integration of the image on the monitor tube. The 4-sec., 60-cycle line enables a reduced amount of radiation to be employed for specimen illumination. While obtaining the maximum signal-to-noise ratio on the presentation tube, photographic integration further increases signal-to-noise ratio. The definition of the built-up integrated image is directly proportional to the number of frames integrated and the statistically random distribution of noise allows it to be built up as the square root of the number of frames. The two criteria which govern the limits of the total integration time are: (a) the signal-to-noise ratio of the monitor tube image should be sufficient to allow easy focussing of the microscope and (b) the total integration time should be short compared to particle movement within the living cell.

The integration time allowable ranges from a second as in the observation of biological phenomena, e.g. mitosis, to virtually infinite time while observing non-living matter. The latest improved tubes minimize the amount of photographic integration or may even eliminate it if the image-forming characteristics of the

specimen are good [*Nature*, **177** (1956), 1172].

Flying-spot X-ray emission microscope

A FLYING-SPOT X-RAY MICROscope of the emission type has been built and used for microanalysis successfully at the Cavendish Laboratory, Cambridge, England. The apparatus differs from the Castaing's electron probe microanalyser in that, while in the latter the specimen is moved under a fixed spot (1 μ in diam.) and an electrostatic lens system is used, the present instrument employs a moving electron spot scanning the specimen and utilizes magnetic lenses. The magnetic lenses give a smaller electron spot or a greater beam current for the same spot size than with electrostatic lenses. A proportional counter is used for collecting part of the emitted X-rays from the region under examination. The signal from the counter is transferred to a cathode ray tube scanned in synchronism. The proportional counter selects a particular X-ray line as the imaging signal. The picture displays only those parts of the surface which contain a given element as bright. The magnification and the contrast as well as the area of the region scanned can be controlled at will. By stopping the electron probe over a selected point on the surface and varying the band accepted by the pulse analyser, the X-ray spectra emitted by individual inclusion elements can be mapped and the identity and the concentration of the elements estimated. The use of the proportional counter introduces considerable broadening in the natural width of a characteristic line and limits the ability to discriminate between elements with close atomic numbers. The accuracy is greatly improved by employing a simple crystal spectrometer for initial analysis of the X-rays. In a new design the apparatus is modified to achieve the improved accuracy. It provides two portholes, one to allow X-rays to the crystal spectrometer and a second port-hole to route another portion of the X-rays emitted from the surface via a scintillation counter for the purpose of image formation. Direct quantitative estimation of concentration of elements and identification of neighbouring elements in the periodic table have been made possible [*Nature*, **177** (1956), 1172].

Carbon replica technique

THE ELECTRON MICROSCOPY OF the surface morphology of siliceous materials such as quartz, glass, clays, etc., has been greatly hampered on account of the difficulty in removing the cast silica or plastic replicas from the surface. In a new carbon replica method developed at the Mellon Institute, Pittsburg, U.S.A., a thin layer of amorphous carbon is deposited on the specimen surface by vacuum evaporation. This carbon film reproduces very faithfully the contours and irregularities of the surface. The specimen is then dissolved (in the case of quartz, glass, etc., with hydrofluoric acid), and the thin carbon film is mounted for examination. Since elemental carbon is chemically resistant to a large variety of solvents and acids, the method is very versatile [*Sci. Res. Prog. Mellon Inst.*, (1956), 3].

New method for sectioning soil

A NEW METHOD FOR THE PREPARAtion of soil sections required in soil microbiology is described. It is superior to the methods in use in which the soil is impregnated with balsam, thermolabile plastic material, hardened agar or a marco-resin. In the new method, use is made of 'Bakelite' polymeric resin S.R. 17497 with its associated catalyst and accelerator, as the setting medium. The resin has a low viscosity, good wetting powers and a setting time of 12-24 hr. at room temperature. It sets to a hard solid which permits grinding with carborundum. Setting time can be controlled by varying the amounts of catalyst and accelerator. A piece of air-dry soil, *c.* $2 \times 1{\cdot}5 \times 0{\cdot}5$ cm., is placed in a pool of the resin on a slide. The resin readily fills the soil pores and the soil hardens as the resin sets. Then it can be treated like a rock chip. The upper surface is ground to give the maximum surface area and then polished. The soil is taken off the slide and remounted in the resin, polished side downwards. After setting, the soil is ground, using 'Carborundum' 280-grade, down to a thin film and polished on a No. 200 hone. Sections 50-60 μ thick have been found suitable for the examination of soil fungi. The method has proved useful for the study of movement of fungal hyphae from the humus coating on one sand grain across the soil pore to another sand grain and in the examination of mematodes, mites and thecate amoebae [*Nature*, **177** (1956), 1186].

Technique for enzyme cytochemistry

THE CLASSICAL 'SUPERIMPOSEDsection' cytochemical technique does not have enough resolving power for the accurate localization of an enzyme at the cellular level. This requires a full investigation of the effects of diffusion of enzyme, reagents and reaction products. A technique which enables such diffusion during a cytochemical reaction to be studied is described [*Nature*, **178** (1956), 201].

In this method, the enzyme in small areas inside a cell in a tissue section is inactivated by irradiating a mounted specimen section with long wavelength ultraviolet radiation obtained from a glass-jacketed 250 W. B.T.H. mercury lamp. The section is mounted between two cover slips in water. Ultraviolet light is focussed by an 8 mm. apochromatic objective. By preparing a suitable mask the radiation can be focussed on the sections in patterns of slits or of small holes and areas of a few square microns, e.g. a cell nucleus can be thus inactivated. Heat filters and intensity filters, placed between the mask and the objective, control the irradiation. Between the mask and the objective is a cover slip inclined at 45° to the optical axis. This cover slip serves to reflect light from an auxiliary lamp for taking photographs, at intervals, of the section and the inactivated spots to check on movement of the spots. Cover slips should be firmly mounted to avoid movement of the image of the mask during the irradiation period which may last for 1-2 hr. even in the case of alkaline phosphatase. Several sections besides the inactivated one are mounted on the cover slip to serve as controls. Tolerances for variation in cover slip thickness and the mask-to-condenser distance are very critical.

For studies on alkaline phosphatase, a simple procedure for fixing the section in absolute alcohol and avoiding concentra-

tions of alcohol likely to dissolve alkaline phosphatase subsequently has been evolved. This procedure should be applicable to the study of other enzyme systems.

Using the above techniques, studies with irradiated sections of frozen and dried rat duodenum and later using the Gomori technique for alkaline phosphatase, have been carried out without using a counter-stain. The details in a portion of one villus of the duodenum made to appear by calcium phosphate deposition have been successfully photographed.

Vapour phase reduction of titanium tetrachloride

AN IMPROVED KROLL PROCESS FOR the manufacture of titanium developed by Group Four Metals Ltd., London, consists in the reduction of titanium tetrachloride with magnesium, both reactants being present in the vapour phase. In the usual Kroll process only the halide is present in the form of vapour.

Magnesium vapour is obtained by passing an inert gas (argon) through molten magnesium which also helps to carry the product from the reaction zone into another zone where it is cooled rapidly. The inert gas at the same time takes away some of the heat produced by the exothermic reaction and thus controls the temperature of the reaction. The process permits the reduction of titanium tetrachloride continuously. The temperature of magnesium in the evaporator is maintained at 1083 ± 1°C. throughout the reduction, with the flow of argon through the magnesium controlled at 3·5 cu. ft./min. while the volume of argon circulating in the ring main is 30 cu. ft./min. The temperature of the reactor is maintained at 850°C. The reaction product is a grey, free-flowing powder with a bulk density of about 0·5 g./ml., containing titanium 15-20 per cent, magnesium chloride 75-80 per cent and magnesium 5-15 per cent by weight. The separation is effected by solvent extraction; acetone is used because it dissolves magnesium chloride and is cheaper than other solvents. The removal of magnesium is achieved by bubbling dry hydrogen chloride through a suspension of the titanium containing magnesium in acetone, when magnesium is converted into magnesium chloride which goes into solution, leaving titanium which settles easily and could be recovered from acetone. The final titanium product is washed with pentane and stored under it.

The metal thus produced does not contain more than 97·5 per cent of titanium and the arc melted product showed a hardness of 400 V.P.N. and oxygen content between 0·5 and 1 per cent [*Industr. Chem.*, **32** (1956), 266].

The radio telescope at Dwingelo, Holland

THE INSTALLATION OF THE LARGEST radio telescope in Europe, at Dwingelo, Netherlands, was completed recently. The telescope (Fig. 1) consists of a 'concave reflector' in the form of a paraboloid 25 m. in diameter mounted on a horizontal shaft in a tower 15 m. high, which is equipped with wheels and can move in a circle on rails. The instrument can thus be directed at any point in the sky. The 'reflecting' surface, which has an area of 540 sq. m., consists of metal gauze with a 15×15 mm. mesh. Radio waves with a wavelength of 10 cm. and upwards are reflected perfectly by the gauze. To enable the reflector to retain its paraboloid form in all positions and under all wind pressures, the metal gauze is stretched over a steel frame consisting of a large number of triangles the sides of which are 1 metre long. The weight of the reflector is about 28 tons.

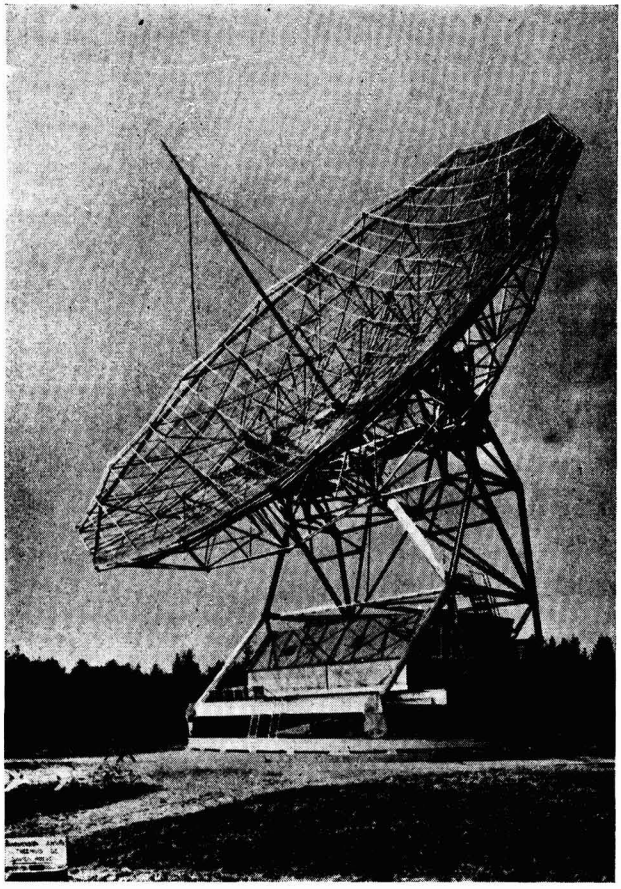


FIG. 1 — THE RADIO TELESCOPE AT DWINGELO

The radio waves which are intercepted and reflected are concentrated at the focus of the reflector — approximately 12 m. above its lowest point — where a small aerial feeds the collected waves to an extremely sensitive receiver in which they are amplified. A recording apparatus, installed in the observation room under the reflector, records the cosmic signals in the form of a curve.

To compensate for the rotation of the earth about its axis a precision instrument, known as the 'pilot', is provided which calculates the required position of the radio reflector and relays the signals to a mechanism which ensures that the telescope continues to follow the object on which it is trained.

The telescope has a resolving power of about 30 minutes of arc, whereby it is possible to separate radio waves emitted by objects situated approximately half a degree apart.

INSDOC 1955-56

THE INDIAN NATIONAL SCIENTIFIC Documentation Centre (INSDOC) received 5559 requests during the year representing an increase of 16 per cent over the requests received during the previous year. The requests were for copies of 4557 papers, translations of 570 scientific articles and compilation of 78 bibliographies. Of the scientific documents, 75·4 per cent were supplied as microfilms, 24·5 per cent as paper and photocopies and 0·1 per cent as original documents; 30·6 per cent of the requests were attended to through the libraries in Delhi, 6·1 per cent through other libraries in India and 63·3 per cent were attended to through agencies abroad. The 456 requests for translation of scientific papers were distributed among different languages as follows: German, 170; French, 99; Russian, 65; Japanese, 53; Italian, 29; Spanish, 23; Dutch, 7; other languages such as Polish, Portuguese, Latin, etc., 10. Besides these, requests were received for copies of translations made earlier.

Some of the subjects covered in the literature search during the year were: Sorel cement and plastic magnesia; preparation of activated carbon from sugarcane bagasse; rice starch, rice bran oil and essential oils; geological occurrence and treatment of ores of tungsten, ilmenite, monazite and zircon; Kurchi (*Holarrhina antidysenterica*) bark; manufacture of metallic soaps of naphthanate acids; hypertension in pregnancy relationships of *Coleoptera*; chemical and mechanical weed control; keratitis, conjuctivitis and other eye diseases of cattle, goats and sheep; phosphate fixation in soil; and artificial suture and anastomosis.

The size of the *INSDOC List* was increased from 24 pages to 32 pages during the year.

International Cloud Atlas

THE WORLD METEOROLOGICAL Organization has completed the work of preparing an International Cloud Atlas in two volumes. The atlas will shortly be at the disposal of weather experts and students of meteorology. The first volume consists of about 200 pages of text. The second volume comprises 247 photographs with captions. An abridged version with 100 pages of text and 72 photographs will also be brought out [*Unesco Features*, No. 201 (1956), 6].

Announcements

■ *Dr. C. Nanjundayya*, Director, Technological Laboratory of the Indian Central Cotton Committee, Bombay, has been appointed Joint Director of the Bombay Textile Research Institute. Sponsored by the Millowners' Association, Bombay, the Institute which will be built up and equipped at a cost of about Rs. 1 crore will undertake both fundamental and applied research in the mechanical and chemical processing of cotton fibres. Provision has been made for research on blends of cotton with man-made fibres. Operational research, including statistical quality control and industrial psychology will also form a part of the Institute's activity.

■ *A symposium on the Role of History of Science*, organized by the Indian Society for the History of Science, will be held during the Forty-fourth Session of the Indian Science Congress at Calcutta during January 1957. Some of the papers to be read at the symposium are: *Value of History of Science in General Education* by Dr. D. S. Kothari; *Role of the History of Science in the Study of Ancient Culture* by Prof. R. C. Mazumdar; *Teaching of Chemistry on the Historical Background* by Prof. P. Ray; and *Role of the History of Science in the Teaching of History* by Prof. S. N. Hasan.

Those desirous of participating in the symposium should communicate the title of their paper and a brief abstract, not exceeding 400 words, to the Secretary: Mr. A. Rahman, Regional Research Laboratory, Hyderabad (Deccan).

■ *Palaeobotanical Society* — The Ninth Annual Scientific Meeting of the Palaebotanical Society will be held at the Birbal Sahni Institute of Palaeobotany, Lucknow, on 21 and 22 January 1957. The programme of the meeting includes lectures, reading of papers and discussions.

■ *Award of Doctorate degrees* — The following persons have been awarded Ph.D. degree by the University of Poona: Bhausaheb Bapusaheb Ghatgey (*Studies in essential oils*); Krityunjai Prasad Sinha (*The theory and mechanism of solid-solid reactions*); and Shrikrishna Atmaram Joshi (*The Chemistry of 'White Compound'*).

Kumari A. A. Aleykutty has been awarded the Ph.D. degree of the Annamalai University for her Thesis entitled "*Preparation of sulphones by the Fries and Friedel-Crafts reactions and a spectroscopic study of the internal hydrogen bond in o-hydroxy sulphones*".

■ *The Corday-Morgan Commonwealth Fellowship* of the value of £700 per annum is open to citizens of Commonwealth countries for post-doctorate study in chemistry in a university or research institution, other than the one in which he has studied, in any Commonwealth country approved by the Corday-Morgan Memorial Fund Executive. Application forms, obtainable from the Secretary, Corday-Morgan Memorial Fund Executive, Burlington House, London, W. 1, must be returned not later than 1 March 1957. The appointment will date from 1 October 1957 and shall be announced by 10 May 1957.

■ *Science Research Scholarships* — The Ministry of Education, New Delhi, has invited applications for Research Scholarship (£500 p.a.) of Royal Exhibition 1851 and Rutherford Scholarship (£600-800 p.a.) for the year 1957. The Science Research Scholarship is

for research in pure or applied science for two years and the Rutherford Scholarship is for experimental research preferably in experimental physics and is tenable for three years. Candidates should possess a first class Master's degree with two years research experience and should be under 26 years on 1 May 1957. The last date for receipt of applications is 31 December 1956.

■ *The Royal Institute of Chemistry* — The following have been elected office-bearers of the North Indian Section of the Royal Institute of Chemistry, for 1956-57: *President* — Dr. B. Vishwanath (New Delhi), *Hony. Secretary* — Dr. G. S. Saharia (Delhi), and *Auditor* — Mr. B. N. Sastri (New Delhi).

INSTRUMENTS AND APPLIANCES

Nylon Centrifuge Tubes

The Measuring and Scientific Equipment Ltd., Essex, have manufactured the MSE superspeed "20" refrigerated centrifuge which employs tubes made of nylon. The nylon tubes, supported in close fitting pockets, can be spun on an angle rotor at a speed of 20,000 r.p.m. as against cellulose acetate and glass tubes which distort or shatter above 6000 r.p.m. This centrifuge will make the separation of fine colloidal solutions possible and should be useful not only in industry but also in medical and research laboratories [*Chem. Prod.*, **19** (1956), 332].

Plastic Powder Diffraction Tubes

The preparation of thin-walled plastic Debye-Scherrer specimen tubes needed for powder diffractometry involves considerable difficulties while removing the tubes from the metal wires on which they are formed. A new technique evolved at the Mellon Institute, Pittsburg, U.S.A., overcomes these difficulties. The technique involves ready freezing of the tube upon a thin surface layer of cuprous oxide formed on the wire during the annealing treatment which is carried out in Linde water-pumped nitrogen. Any adhering cuprous oxide is finally removed from the tubes by rinsing in 6N hydrochloric acid, washing and drying [*Sci. Res. Mellon Res. Inst.*, (1955-56), 5].

Chromatogram Drying Oven

Laboratory Equipment Ltd., London, are marketing an electrical oven for drying chromatograms. The oven is thermostatically controlled with a maximum temperature of 100°C. and incorporates a special airflow system which provides horizontal airflow through every part of the working space (25 × 25 × 25 in.). The oven consists of an angle iron frame covered with asbestos board and has an aluminium interior. There is arrangement to drive off the solvent vapours and a pull-out rack for holding filter papers [*Export Rev., Lond.*, **17** (1956), 59].

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Progress Reports

INDIAN CENTRAL COTTON COMMITTEE: ANNUAL REPORT 1954-55

DURING THE YEAR ENDING AUGUST 1955 THE AREA under cotton (18·3 million acres) and its production (42·98 lakh bales) reached the highest level since the partition of India. The corresponding figures for the previous year were: acreage, 17·2 million acres; and production, 39·65 lakh bales. The figures for the year under report mark the achievement of targets fixed under the First Five-Year Plan period one year in advance. A noteworthy trend in the cultivation of cotton has been the marked and sustained improvement in the quality and yield of cotton. Long staple cotton formed 37 per cent of the total in 1954-55 against 23 per cent in 1950-51. The yield per acre has gone up from 93 lb. in the quinquennium 1947-52 to 116 lb. in 1954-55.

During the period under review 18 seed distribution and extension schemes were in operation and out of the total area of 99,26,660 acres proposed to be ultimately covered by improved varieties of cotton in different cotton-growing tracts an area of 69,24,000 acres (69·7 per cent) had been covered during the year. The additional income to the growers of improved varieties during 1954-55 has been estimated at Rs. 12·5 crores.

A brief account of the researches carried out during the year under the auspices of the Committee is given below:

A number of improved varieties with higher yields, longer fibre and better spinning qualities were evolved for different regions. Improved strains 170-Co. 2 and 68 × 22 with staple length $1\frac{1}{16}$-$1\frac{1}{8}$ in. gave 18 and 25 per cent higher yields than the improved *Surti* strain 2087 commonly cultivated in the Gujarat and Ahmednagar areas.

Work on the production of hybrids yielding extra-long, fine and silky lint has resulted in the evolution of two promising hybrids, viz. B.C. 33 × Moco and B.C. 68 × Sea Island which are superior to Co. 2 × S.I. in respect of vigour and growth, better boll opening and lesser number of moles in the produce. Four improved strains LL 43, 53, 54 and 60 with fibre length 1·04-1·09 compared to 0·92 in. of the control have been evolved for the Punjab region. Another strain LL 56 gave the count strength products of 2002 at 40's spinning count. It has been found suitable for spinning 56's counts, as compared to 38's of 320 F control.

A new strain 9030 yielding 51 lb. cotton and 41 lb. lint per acre more than the control, MCU-1 and with ginning percentage 38·3 and fibre length 0·99 in. as against 36·5 and 0·96 in. of the control has been evolved for the Madras State. An improved long staple strain LO313 evolved for the same state possesses mean fibre length 1·08 in., fibre weight $1{\cdot}36 \times 10^{-6}$ g /cm. and 64 per cent mature fibres as compared to 1·0 in., $1{\cdot}26 \times 10^{-6}$ g./cm. and 54 per cent of the control.

Physiology — From studies carried out to investigate the effects of application of trace elements on the growth and yield of cotton and on the rotational crops, it was found that while the application of fairly large doses of chromium, manganese, zinc, copper and boron produced small increases in yield, small doses were ineffective. The residual effect of one application of any one of these elements lasts for two seasons. Application of 16 oz./acre of manganese sulphate gave an increase of 210 lb./acre over control while 24 oz./acre borax gave an increase of 103 lb. of seed cotton.

The application of 10 or 20 p.p.m. of a naphthalene acetic acid spray has been found to increase the yield of cotton by about 50 per cent in the case of *desi* variety.

Studies on the stability of nitrogenous fertilizers in Indian soils have shown that there is considerable loss (20-70 per cent) of nitrogen in the form of ammonia from nitrogenous fertilizers like ammonium sulphate, farmyard manure, groundnut cake, added to alkaline cotton soils. The *p*H of the soil has been found to be the major factor governing the loss of ammonia; soil with higher *p*H lost more nitrogen than soil with a lower *p*H value. Lighter soils lost more ammonia than heavy soils probably due to the adsorption capacity of mineral colloids for ammonia. Soils with low C/N ratio lost more ammonia than soils with high C/N ratio. The addition of organic matter (containing carbohydrates) like straw, molasses, plant refuse, etc., has been found to help in minimizing the loss of ammonia by 50-80 per cent while the addition of acidifying chemicals like potassium hydrogen sulphate, boric acid, ferrous sulphate, sulphuric acid and gypsum was ineffective.

Agronomy — Of the different fertilizers ammonium sulphate proved to be the most economical source of nitrogen. Its application, half at sowing time and half at flowering, gave the highest yields.

In rotation experiments, it was found that cotton sown after leguminous crops gave higher yields than when sown after wheat.

Technological research — A new dyeing technique, based on a quantitative relationship between dye absorption by cotton and its swelling has been developed for measuring the maturity of cotton fibre.

In an investigation on the neppiness due to different types of cotton, it was found that the hand-ginned lint possessed the least number of neps, the saw ginned lint gave the highest number of neps while the roller ginned lint had intermediate number of neps. An apparatus for easy examination of neps in cotton lint, yarn, etc., has been designed and fabricated.

COLONIAL RESEARCH COUNCIL

THE ANNUAL REPORT OF THE COLONIAL RESEARCH Council, U.K., for the year 1954-55 presents the research activities of the Colonial Products Council, Colonial Social Science Research Council, Colonial

Medical Committee, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonian Insecticides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Anti-Locust Research Centre and some Special Advisory Bodies. Fifty-two new schemes and 48 supplementary schemes were sanctioned during the year involving grants totalling £533,548.

The important research activities of the different units are summarized below:

Colonial products — Studies on cane juice from sugarcane grown under different conditions have shown that the bad clarification of juice from cane grown under drought conditions is due to increase in the concentration of organic non-sugar compounds, chief among them being phenols and nitrogenous compounds including amino acids. It has been found possible to produce juice of desirable settling quality simply by controlling water supply to the cane. Among the chemical aids for clarification, formalin gave best performance. Provided the phosphate content of juice was satisfactory, the addition of 0·5 to 1·0 ml. of 35 per cent formalin per litre gave larger flocs settling at a satisfactory rate and to a reasonable mud volume.

Conditions have been worked out for the production of laevulinic acid, in high yields from molasses. Ammoniated molasses has been found to be a good cattle feed. It has been shown that it is only the reducing sugars in molasses that react with ammonia and therefore prior inversion of molasses allows for the fixation of greater percentage of nitrogen.

The use of 0·3 per cent acetic acid has been found to check the development of off-flavours during parboiling of rice; it has almost no effect on the vitamin B_1 content of rice.

Medical research — The nature and antibiotic action of the antifungal antibiotic comirin, isolated at the Colonial Microbiological Research Institute, Trinidad, against fungi and yeast have been studied. Against *Aspergillus flavus* it behaved like other antibiotics in that increase in inoculum size and agar concentration reduces the zone size which is probably due to adsorption effects. Concentrations of comirin greatly in excess of the lethal concentration are ineffective against fungus on agar plates if the fungus has reached the stage of producing aerial mycelia before the antibiotic is added. In liquid culture comirin is strongly absorbed by both susceptible and non-susceptible cells. Comirin is extremely resistant to microbial degradation; none of the organisms tested so far has been found to produce a comirinase.

From balance experiments involving measurement of intake and output of nitrogen, sulphur, phosphorus, calcium, potassium and calories in human subjects it has been concluded that positive nitrogen balance is accompanied by positive sulphur and phosphorus balance, but not by positive potassium balance. Ninety per cent of the calories taken are absorbed. Sulphur and phosphorus are retained along with nitrogen.

A hitherto unknown variant of haemoglobin, haemoglobin G has been discovered in the blood of an individual in Gold Coast. It differs from all other known variants of human haemoglobin in its mobility on paper electrophoresis at *p*H 8·6 and in its mode of migration at *p*H 6·5 and 8·6 in free boundary electrophoresis. It seems to be inherited according to Mendelian principles and a homozygote which is not anaemic has been discovered. There is no difference between the spectrum of haemoglobin G and normal haemoglobin.

A simple and reliable method has been developed for estimating foetal haemoglobin. It is based on partial denaturation of the haemoglobin and then estimating it spectrophotometrically in the ultraviolet region.

Agriculture — Studies on the germination of oil palm seed have shown that the embryo is non-dormant even at ambient temperatures of 25°-30°C. The delay in the germination of the seed is due mainly to restricted respiratory interchanges resulting from low permeability of the kernel integument and the shell, the permeability of the latter being influenced by its moisture content. While germination of the nut is dependent on a reaction favoured by temperatures of 35°-40°C. it has been shown that once this temperature requirement has been satisfied, germination is favoured by lower temperatures of the order of 25°-30°C.

Work on fixed ammonia in tropical soils has shown that soils naturally containing a high content of fixed ammonia fix negligible quantities when further treated with ammonium salts.

Application of 200 lb./acre phosphate fertilizer was found to increase the yield of maize from 1060 to 2892 lb./acre in Basutoland. This response to phosphate was not affected by the presence or absence of nitrogen or potash. In sandy loam soils, application of 2 tons of lime per acre raised the *p*H of the soil from 5·1 to 6·5 in a single reason and increased the yield of maize from 1900 to 2600 lb./acre.

The insecticides Tensol and OBD 5 were found to afford good protection to Banak (*Virola koschuvi*) logs against pineworm (*Ambrosia*).

Manurial trials at Central Agricultural Station, Kumasi, Gold Coast showed triple and single superphosphates to be more promising as fertilizers for groundnuts than ammonium sulphate. Trials on rice at Hong Kong showed that the percentages of phosphate and potash in NPK mixture can be reduced without affecting yields. Best yields were obtained from two applications of NPK fertilizer of ratio 40: 30: 15 at the rate of 280 lb./acre. For leafy vegetables, root crops, pulses and flowers, the optimum N: P: K ratios have been found to be 8: 5: 5, 8: 6: 6, 3: 8: 5 and 5: 10: 5 respectively.

Insecticides — Fundamental studies on the penetration of the insect integument by DDT solutions carried out at the Imperial College Field Station, England, have yielded some interesting results. Lanoline solutions of DDT were applied topically to *Protophormia terraenovae* and it was found that a fraction of the absorbed insecticide is taken up directly by the tissues, the quantity depending on the concentration of the insecticide. The remainder of the absorbed insecticide (*c.* 50 per cent) is taken up in solution in micelles of the absorbed oily carrier and depends partly on the degree of absorption of the oily carrier itself and varies at different parts of the integument.

A new method has been evolved for comparing the stimulating effect of different stimulants for tsetse fly. The method is based on determination

(*Continued on page* 538)

INDIAN PATENTS

[A few of the Patent Applications notified as accepted in the *Gazette of India*, Part III, Section 2, 25 August to 22 September 1956, are listed below.]

Chemicals, plastics, rubber, paints and allied products

43295. Deserpidic acid lactone and salts thereof, and process for their preparation: *Heating with a lactonizing agent a compound of the formula* $\diagup OH$ *Des* $\diagdown COR$ *to obtain the corresponding lactone* — CIBA LTD.

54921. Process for preparing crystal violet lactone: 2-[4, 4'-*bis* (*dimethylamino*) *benzohydrol*]-5-*dimethyl aminobenzoic acid is oxidized with an aqueous oxidizing medium containing a monocyclic aromatic hydrocarbon and the lactone is separated from the hydrocarbon* — STERLING DRUG INC.

55034. Production of rubber-like products from paraffins: *Subjecting saturated aliphatic hydrocarbons to chlorination and thereafter dehydrochlorinating the chlorination products* — RUHRCHEMIE AKTIENGESELLSCHAFT

55078. Method for preparing 2-acylamino-1, 3, 4-thiadiazole-5-sulphonamides: 2-*amino*-1, 3, 4-*thiadiazole*-5-*sulphonamide is reacted with an acid anhydride* — AMERICAN CYANAMID CO.

55117. Organic esters: *A* 2-*halomethyl*-3, 4, 5, 6-*tetrahydro-pyrimidine or a* 2-*halomethyl imidazoline is reacted with an acid* $R'—\underset{\displaystyle R''}{\overset{\displaystyle R}{\overset{|}{C}}}—\overset{\displaystyle O}{\overset{\|}{C}}—OH$, R *being an aryl radical, R' an aryl, alkyl, cycloalkyl or S-heterocarbocyclic radical, R" a hydroxy or hydrogen and n being* 2 *or* 3 — CHAS, PFIZER & CO. INC.

55403. Manufacture of monoazo-dyestuffs insoluble in water: *A substituted aminophenyl tetrazole is diazotized and coupled with an aromatic or heterocyclic orthohydroxy carboxylic acid arylide or an acylacetic arylide, the coupling component being free from groups imparting solubility in water* — FARBWERKE HOECHST AKTIENGESELLSCHAFT VORMALS MEISTER LUCIUS & BRUNING

56279. Production of androstene-3 β-17 β-diol esters: *Dehydro-epi-androsterone esters are treated in suspension with a borohydride of an alkali, or alkaline earth metal and the desired epi-androsterone-ester is separated* — ORGANON LABORATORIES LTD.

56821. Production of crystalline polystyrene: *Carrying out the polymerization in presence of a solvent for low molecular weight styrene polymers and using a catalyst obtained by reacting a compound of a metal of sub-groups of* 4*th to* 6*th groups and a metal, metal alloy, metal hydride or organo metallic compound of* 1*st to* 3*rd groups of periodic system* — MONTECATINI SOCIETA GENERALE PER L'INDUSTRIA MINERARIA E CHIMICA & K. ZIEGLER

53974. Reaction products of polymers with polyisocyanates or polyisothiocyanates: *Comprises a reaction product of a polymer with a polyisocyanate or polyisothiocyanate in admixture with an organic chloride* — DUNLOP RUBBER CO. LTD.

54977. New phenothiazine derivatives and process for their manufacture: *Reacting a phenothiazine with a* 2-(*N-methyl-piperidyl-*2')-1-*halogen-ethane*—SANDOZ A. G.

56096. Amphotericins, their salts and method of manufacture: *A strain of Streptomyces sp* 3684 *is cultivated in an aqueous nutrient medium under submerged aerobic conditions until substantial anti-fungal activity is imparted to the medium* — OLIN MATHIESON CHEMICAL CORP.

53678. Phenthiazine derivatives and processes for their preparation: 10-*piperazinyl alkyl phenthiazines are prepared by methods known per se starting from a substituted piperazine, a diphenyl sulphide or a substituted diethylamino alkyl phenothiazine* — SOCIETE DES USINES CHIMIQUES RHONE-POULENC

54525. Piperazine compounds and method of preparation of piperazine adipate: *Treating piperazine containing fraction with lower aliphatic alcohol* — THE BRITISH DRUG HOUSES LTD.

54872. Substituted 1·10-diaza-anthracenes: 2-*alkoxy*-6: 9-*dihalogeno*-1: 10-*diaza-anthracene is reacted with an hydroxy amine having a mono or dihydroxy alkyl group in the molecule* — WARD BLENKINSOP & CO. LTD.

55079. Preparation of codeinone and neopine: *Treating* 14-*bromocodeinone with hydrogen in the presence of a hydrogenation catalyst* — MERCK & CO. INC.

55080. Preparation of 14-bromocodeinone: *Reacting theoaine with a N-bromo-amide or N-bromo-amide or N-bromoimide* — MERCK & CO. INC.

55157. Alkaline earth metal salts of cycloserine and process of producing the same: *Treating water slurry of silver salt of cycloserine with water soluble alkaline earth metal salt having anion to form water-insoluble silver salt* — COMMERCIAL SOLVENTS CORP.

55181. Manufacture of fertilizer from magnetic apatite rock: *By smelting in an electric furnace phosphate rich non-magnetic portion of apatite rock mixed with silicious rock, manganese and copper ores and coke breeze and skimming the top slag layer for use as fertilizer* — THE TATA IRON & STEEL CO. LTD.

55185. Liquid hydrocarbon compositions having a reduced tendency to leak through cellulose materials and cellulose material having a reduced permeability to hydrocarbon liquids: *Liquid hydrocarbon has an organic phosphorus*

compound and a hydrocarbyl polysiloxane—N. V. De Bataafsche Petroleum Maatschappij

55625. Pigmented styrene polymers: *Comprising a styrene polymer or a styrene copolymer and a titanium dioxide pigment* — Union Carbide & Carbon Corp.

56165. Manufacture of piperidine derivatives: *Reacting a tetrahydropyridinedione with an organometallic compound such as phenyl lithium or a grignard compound* — F. Hoffmann-La Roche & Co. Aktiengesellschaft

53852. Manufacture of dehydro-compounds of the steroid series: *Steroid compounds saturated in* 1: 2 *position and/or in* 4: 5 *position are subjected to the aerobic action of anzymes, e.g. of Didymella lycopersici, Colonectria decora* — Ciba Ltd.

54707. Rubber compositions: *Masticating crude rubber in the presence of a liquid softener* — Dunlop Rubber Co. Ltd.

55092. Manufacture of glutarimide: *Converting into amino group, a substituent in the phenyl radical of an α-phenyl-α-alkyl-glytarimide* — Ciba Ltd.

56042. Manufacture of anthraquinone vat dyestuffs: *Treating a product obtained by reacting* 1-*amino-anthraquinone with heavy metal oxide, with carbazolizing agent* — Ciba Ltd.

57725. Reaction products of polymers with polyisothiocyanates: *Comprises a reaction product of a polymer with a poly-isocyanate or polyisothiocyanate in admixture with an acylic organic acid chloride* — Dunlop Rubber Co. Ltd.

53347. Production of a new type of fertilizer and soil conditioner: *Reacting humic acid or products containing same with ammoniacal liquor* — Council of Scientific & Industrial Research

53527. Improved process for the production of humic acid from coal or lignite: *By oxidizing coal at* 100°-300°*C. in presence of gaseous or solid catalysts* — Council of Scientific & Industrial Research

53996. Manufacture of polyoxygenated dehydrosteroids: *By subjecting steroids saturated in* 1: 2- *and/or* 4: 5-*position and not oxygenated in at least one of the* 11, 17 *and* 21 *positions to the action of enzymes from aerobic cultures of Calonectria decora and the like enzymes of at least one of a group of three fungus strains which introduce oxygen* — Ciba Ltd.

54395. Manufacture of active manganese dioxide suitable for dry batteries: *Oxidizing by chlorine an ammoniacal suspension of manganese hydroxide* — Council of Scientific & Industrial Research

55115. Butyl rubber compositions: *Having incorporated in the composition an organic substance belonging to the class of highly polymerized hydrocarbons having an aliphatic and/or aromatic and/or naphthenic base* — Pirelli Societe Per Azioni

55141. Process and furnace for the production of calcium carbide: *Wherein the calcium oxide containing material is fed into the reaction zone such that it as well as the carbide forming material do not come into contact with hot gas produced by the combustion of fuel* — Stamicarbon N. V.

55814. Preparation of thermoplastic copolymers: *By heating a mixture comprising a polymerizable composition consisting of arylonitrile styrene and alpha-methyl styrene, and a polymerization modifier and then separating therefrom a copolymeric product having a viscosity of from* 6 *to* 40 *centipoises* — The Dow Chemical Co.

56286. Water insoluble azo dyestuffs: *Coupling diazo compound with coupling compound of phthalocyanine series* — Farbenfabrieken Bayer Aktiengesellschaft

57263. Quaternary ammonium compounds: *One mole of tris-(dimethylaminomethyl)-phenol is reacted with* 1-3 *moles of a quarternizing compound having* 10-21 *carbon atoms and containing a reactive anion* — Rohm & Haas Co.

Chemical processes, engineering and equipment

53889. Cold-gas refrigerating apparatus: *Wherein the portion of the communication channel located between the cold and hot terminal surfaces of the regenerator is connected to an additional space and an additional heat exchanger* — N. V. Philips' Gloeilampenfabrieken

55583. Tube mill: *Plurality of frusto-conical sections, comprising of grinding surfaces of longitudinal ribs, separated and sub-divided by longitudinal and transverse grooves respectively* — Societe Anoyme Usines Emile Henricot

55737. Apparatus for continuous crystallization: *Precrystallizer has a intake for molten liquid and a tube for supply of crystallization* — Aktiebolaget Bofors

57453. Heat exchangers and tubes therefor: *A composite tube comprising an outer tube, an inner tube spaced therefrom and a heat conducting helical wall contacting the two tubes and forming a passage, is characterized in that the wall is metallically bonded both to the inner and outer tubes* — John Thompson Water Tube Boilers Ltd.

57513. A continuous electrochemical process for the deacidification and clarification of the beet and sugarcane juices by electrolysing them to neutrality with direct current and aluminium, iron or steel electrodes and followed by liming and filtering and neutralizing the alkaline filtrate with calcium superphosphate: *By electrolysing the juices to neutrality with direct current and Al, Fe or steel electrodes and followed by liming to about pH* 9 *and neutralizing the filtrate with calcium superphosphate* — Ghosh

54604. Process for the removal of pink colour and offensive smell from solid lake bitterns: *Solid bitterns are carbonized* — Council of Scientific & Industrial Research

54691. Process for bacteriological steeping of cellulose matters: *Soaking the raw material with water to which is added an inoculum of an anaerobic culture of "Glostridium butyricum C8"* — Prevot & Raynaud

54070. Conversion of hydrocarbons: *By carrying out the catalytic cracking at a relatively low conversion to coke gasoline and lighter products below* 50 *per cent, fractionating the cracked products to recover fraction between* 10 *and* 80 *per cent boiling points of the virgin feed and recycling it to cracking step* — Esso Research & Engineering Co.

Physics — general

55464. High-frequency multi channel generator: *In which the final frequency is derived from a final frequency oscillator which by means of*

A.F.C. is stabilized with respect to a crystal controlled coarse step generator, a crystal controlled fine step generator and an interpolation oscillator — N. V. PHILIPS' GLOEILAMPENFABRIEKEN

53867. Electrical telecommunication systems: *Comprises a plurality of apparatus groups, a lesser plurality of registers and a translator* — THE GENERAL ELECTRIC CO. LTD.

53161 and 53915. Process for carrying out nuclear fision reactions: *The design and dimensions of the thermal reactor together with the initial proportion between the qualities of moderator and fissible material are so selected that the susceptibility of the reactivity of the fission reaction to the fluctuation in the proportion between the quantities of moderator and fissile material will be minimal.*

In which the nuclear fuel is applied in the form of a rapidly settling suspension of solid fissible material in a moderating carrier liquid — STRICHTING REACTOR CENTRUM NEDERLAND

54504. Thermionic cathodes: *Cathode supplying electrons from the inside walls of a tubular hole made in a body of electron dispenser material, the depth of said hole being not less than the depth of penetration of electric field into the hole* — STANDARD TELEPHONES & CABLES LTD.

56810. Improvements in or relating to electrolytic capacitors and their manufacture: *Tantalum is electropolished before being anodically formed* — BRITISH DIELECTRIC RESEARCH LTD.

56909. Electrical capacitors: *Comprising one or more layers of flexible plastic film dielectric and paper dielectric metalized on one face* — A. H. HUNT (CAPACITORS) LTD.

Food and kindred products

53319. A process for improving the storage life of cashew kernels: *Cashew kernels are fried in hydrogenated oil containing antioxidant and an acid synergist* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Drugs and pharmaceuticals

53863. Preparation of antibiotics by fermentation with *Streptomyces fuscofaciens*: *Cultivating a strain of Streptomyces fuscofaciens in a nutrient medium* — CHAS, PFIZER & CO. INC.

54876. Insecticidal and acaricidal compositions: *Phosphorous compound with inert carrier as defined in the specification* — CIBA LTD.

55325. Aqueous penicillin suspension comprising inositol phosphoric acids and their salts: *Inositol phosphoric acid or a salt thereof is dissolved in the aqueous phase* — BRISTOL LABORATORIES INC.

56101. Manufacture of vitamin A_2 and esters thereof: *Condensing 4-2′, 6′, 6′-trimethyl-1′, 3′-cyclohexadiene-1′-yl)-2-methyl-2-buten-1-al with 1-hydroxy-3-methyl-2-penten-4-yne* — HOFFMANN-LA ROCHE & CO.

Fuels and lubricants

53133. Manufacture of coal briquettes: *A mass of particles under pressure is caused to undergo angular shear strain of such magnitude and distribution as to produce a briquette of high strength* — COAL INDUSTRY (PATENTS) LTD.

55815. Apparatus for gasifying finely divided fuels which are in suspension: *Gasifying finely divided fuels in suspension with oxygen, a homogeneous mixture of oxygen and fuel being blown into a reaction gasifying chamber characterized in that the fuel is conveyed by means of a conveyor worm in the immediate vicinity of gasifying chamber* — HEINRICH KOPPERS GESELLSCHAFT MIT BESCHRANKTER HAFTUNG

55511 and 55512. Horizontal coke oven batteries: *Comprising a locking device associated with a latch on at least the pusher machine side door of each oven of the battery, an individual control conduit extending from each locking device to the coke side of the battery.*

Comprising a locking device associated with a latch on at least the pusher machine side door of each oven of the battery, the locking device being operable to release its associated latch by the application of low pressure fluid to the device — HEINRICH KOPPERS GESELLSCHAFT MIT BESCHRANKTER HAFTUNG

55410. Process for displacing petroleum from oil-bearing formations: *Wherein the direction of flow of displacing medium and oil through the formation is repeatedly reversed by appropriate control of the pressure* — N. V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ

PROGRESS REPORTS — *continued from page 535*

of frequencies of flights of flies given different concentrations of the stimulants. The activity of the flies was found to vary linearly within a small range of concentrations. Alcohols have been found to be less efficient olfactory stimulants of *Glossina morsitans* than the corresponding carboxylic acids, ethyl esters and acetates all of which have similar stimulating powers, their effective range being 10^{-4}-10^{-7} g. mol./litre.

Studies on the relative toxicity of the different insecticides against larval instars of filarial vector *Culex fatigans* have shown the toxicity to decrease in the order — EPN (ethyl-*p*-nitrophenyl benzenethiophosphonate), dieldrin aldrin and heptachlor.

A pentachlorophenol (P.C.P.)-in-oil preparation has been found satisfactory for controlling miscellaneous weeds in mulched coffee without inducing taint in the crop.

Meteorology—Cetyl alcohol has been found useful in reducing the rate of evaporation from water reservoirs by forming a thin film over the surface. This finding is of great significance for areas depending on water supplies from natural and artificial surface reservoirs, like East Africa where normally the rate of evaporation is 4-8 ft. per year.

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Printed by H. JACQUEMOTTE, S.J., at the Catholic Press, Ranchi, India
Published by the Council of Scientific & Industrial Research, India. Editor: B. N. SASTRI, M.Sc.

Regd. No. P-842