JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

3 Copy
52

NATIONAL ACADEMY OF SCIENCES
LIBRARY
APR 3 1951
NATIONAL RESEARCH COUNCIL

IN THIS ISSUE

The Present Concept of the Physical World

Indian Science Congress — 38th Annual Session

International Conference on Elementary Particles

Ionospheric Studies at Calcutta (1944-50)

Fluidization — A New Technique

Field Intensity as a Determinant of Negative Joshi Effect

Studies in Anti-malarials — Synthesis in β-Quinindene Series

Utilization of Tobacco Seed

Varnishes & Paints

Preservation of Citrus Fruit

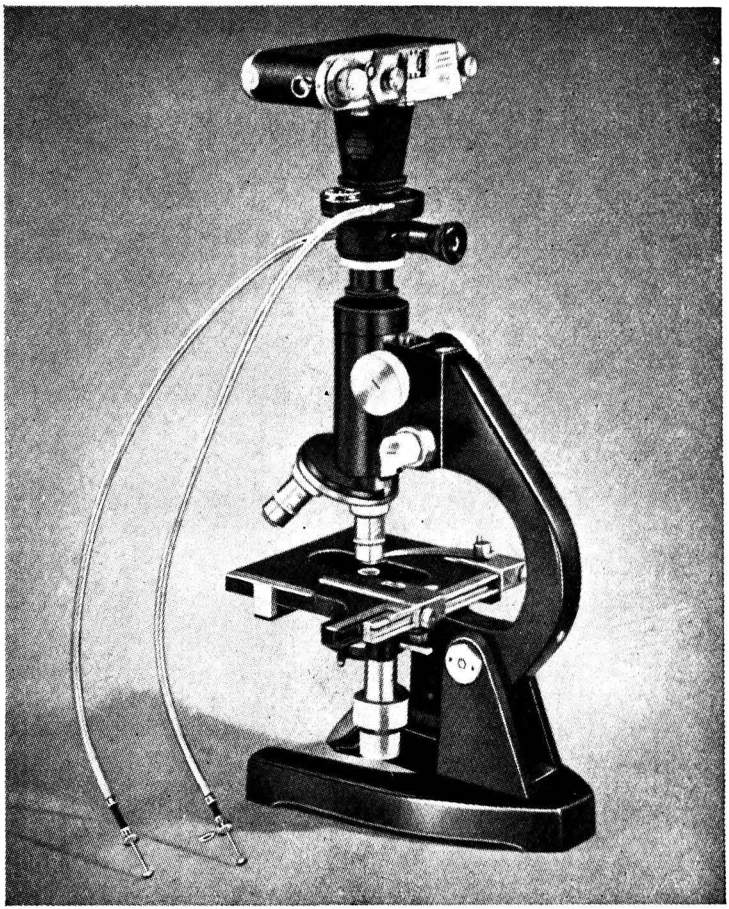
Studies on Indian Bricks

FEBRUARY 1951
Vol. 10
No. 2

PUBLISHED BY THE COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, INDIA

J. sci. industr. Res., V. 10, No. 2, pp. 47-90 ; & V. 10B, No. 2, pp. 27-50, New Delhi. February 1951

PHOTOMICROGRAPHY WITH LEICA



is often a necessity, sometimes an economical convenience, but always a source of pleasure.

SOLE AGENTS

THE SCIENTIFIC INSTRUMENT CO. LTD.

240 HORNBY ROAD
BOMBAY 1

6 TEJ BAHADUR SAPRU ROAD
ALLAHABAD 1

30 MOUNT ROAD
MADRAS 2

29 REGAL BUILDINGS
NEW DELHI 1

11 ESPLANADE EAST
CALCUTTA 1

Journal of

Scientific & Industrial Research

V. 10A, No. 2, FEBRUARY 1951

EDITORIAL BOARD

S. S. BHATNAGAR, O.B.E., F.R.S., D.Sc., F.Inst.P., F.R.I.C., Director, Scientific & Industrial Research (ex officio Chairman)

H. J. BHABHA, Ph.D., D.Sc., F.R.S., Tata Institute of Fundamental Research, Bombay

J. C. GHOSH, D.Sc., F.N.I., Director, Eastern Higher Technical Institute, Calcutta

JIVARAJ N. MEHTA, M.D., M.R.C.P., F.C.P.S., Minister for Public Works, Government of Bombay, Bombay

S. KRISHNA, C.I.E., Ph.D., D.Sc., F.R.I.C., F.N.I., Scientific Liaison Officer, London

K. S. KRISHNAN, D.Sc., F.R.S., National Physical Laboratory, Delhi

MATA PRASAD, D.Sc., F.R.I.C., F.N.I., Royal Institute of Science, Bombay

C. V. RAMAN, F.R.S., N.L., Raman Research Institute, Bangalore

M. N. SAHA, D.Sc., F.R.S., University College of Science, Calcutta

D.N. WADIA, F.G.S.,F.R.G.S.,F.R.A.S.B., Geological Adviser to the Department of Scientific Research, New Delhi

B. N. SASTRI, M.Sc., F.R.I.C., A.I.I.Sc., Editor & ex officio Secretary

A. KRISHNAMURTHI, M.Sc., Assistant Editor

S. B. DESHAPRABHU, Liaison Officer (Production)

CONTENTS

The Present Concept of the Physical World ... 47

Characteristics of the Ionosphere over Calcutta (November 1950) 52
S. S. Baral, R. K. Mitra, D. C. Choudhury, A. P. Mitra, R. B. Banerjee & A. K. Saha

The Indian Science Congress, Bangalore, January 2-8, 1951 54

International Conference on Elementary Particles 58

Ionospheric Studies at Calcutta (1944-50) ... 60
S. S. Baral

Fluidization — A New Technique : Part II ... 65
M. S. Iyengar

Non-Technical Notes
MANUFACTURE OF BENZIDINE, *p*-AMINOPHENOL & 2 : 4-DIAMINOPHENOL 71

Reviews 74

Notes & News 80

Progress Reports 87

Indian Patents 89

For Contents to Section B, *see* page A 21
For Index to Advertisers, *see* page A 17

The JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH *is issued monthly.*

The Council of Scientific & Industrial Research assumes no responsibility for the statements and opinions advanced by contributors.

The Editorial Board in its work of examining papers received for publication is assisted, in an honorary capacity, by a large number of distinguished scientists working in various parts of India.

Communications regarding contributions for publication in the JOURNAL, *books for review, subscriptions and advertisements should be addressed to the Editor,* JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH, *Hillside Road, New Delhi* 5.

ANNUAL SUBSCRIPTION : Rs. 9 (inland) ; 18 sh. (foreign). SINGLE COPY : Re. 1 (inland) : 2 sh. (foreign)

Bengal Chemical & Pharmaceutical Works Ld.

The largest Chemical Works in India

Manufacturers of Pharmaceutical Drugs, Indigenous Medicines, Perfumery, Toilet and Medicinal Soaps, Surgical Dressings, Sera and Vaccines, Disinfectants, Tar Products, Road Dressing Materials, etc.

Ether, Chloroform, Mineral Acids, Ammonia, Alum, Ferro-Alum, Aluminium Sulphate, Sulphate of Magnesium, Ferri Sulph., Potassium Permanganate, Caffeine and various other Pharmaceutical and Research Chemicals.

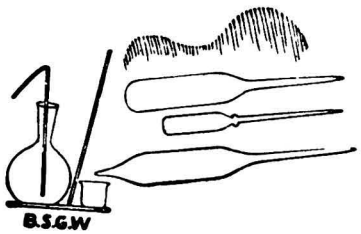
Surgical Sterilizers, Oxygen Apparatus, Distilled Water Stills, Operation Tables, Instrument Cabinets and other Hospital Accessories.

Chemical Balance, Scientific Apparatus for Laboratories and Schools and Colleges, Gas and Water Cocks for Laboratory use, Gas Plants, Laboratory Furniture and Fittings.

Fire Extinguishers, Printing Inks, etc.

Office 94 CHITTARANJAN AVENUE, CALCUTTA

Factories CALCUTTA · BOMBAY · KANPUR



Manufacturers of

SCIENTIFIC APPARATUS,
VIALS, TEST-TUBES,
NEUTRAL GLASS, AMPOULES,
ETC., ETC.

●

For further particulars, write to :

BOMBAY SCIENTIFIC GLASS WORKS

ARAB HOUSE, KHETWADI 13TH LANE
BOMBAY 4

for

HOSPITAL &
LABORATORY
EQUIPMENT

●

LABORATORY
CHEMICALS
FOR SCHOOLS,
COLLEGES &
RESEARCH
INSTITUTIONS

please consult

UNION SCIENTIFIC SYNDICATE

52-58 NEW HANUMAN LANE
BOMBAY 2

Phone : 28465
Grams : "PETROLIUM"

Equipment for work in

ATOMIC ENERGY

RADIOACTIVITY & TRACER MEDICINE

Sealing Instruments & Accessories

Preamplifier & Tube Accessories

Counting Rate & Survey Meters

Geiger-Mueller Tubes

Radioactive Reference Sources

General Equipment & Lead Shields

Film Badge Service

Minometers

Industrial Beta Gauges

Tagged Radiochemicals

Denterated Compounds

Carbon-14 Labelled Compounds

TRACERLAB INC., U.S.A.

Sole Agents for India

RAJ-DER-KAR & CO.

COMMISSARIAT BUILDING, HORNBY ROAD
FORT, BOMBAY

OPIUM ALKALOIDS & THEIR DERIVATIVES

The Government Opium Factory, Ghazipur, manufactures

Morphine	Codeine Sulphate
Morphine Hydrochloride	Ethyl Morphine Hydrochloride (Dionene)
Morphine Sulphate	Narcotine
Morphine Tartrate	Narcotine Hydrochloride
Morphine Acetate	Cotarnine
Codeine	Thebaine
Codeine Phosphate	

Other salts or derivatives of these alkaloids can be manufactured and supplied as required.

The products conform to the standard of purity laid down in the B.P., B.P.C., U.S.P., I.P.L., and other latest recognized authoritative publications.

Most of the drugs are always available for supply in large quantities, packed in bottles containing 1 oz., 2 oz., 4 oz., 8 oz. and 1 lb. as required.

For further particulars, write to :

THE MANAGER
GOVT. OPIUM FACTORY
GHAZIPUR, U.P., INDIA

For

QUALITY & STANDARD

- **Heavy Chemicals** (Mineral acids & salts)
- **Pharmaceuticals** (Tinctures & B.P. products)
- **Printing Inks**
- **Textile Auxiliaries**
- **Disinfectants**
- **Insecticides, &c., &c.**

. . . are manufactured by us under careful control and supervision.

You can buy our products with confidence. Quality is guaranteed.

EASTERN CHEMICAL Co. (INDIA)

DOUGALL ROAD, BALLARD ESTATE
BOMBAY

CHEAPER QUICKER EASIER

with AGRICO SHOVELS

Farmers, miners, railwaymen road-builders—they all prefer Tata Agrico Shovels. Manufactured from special high carbon steel, these shovels last much longer - - - that's why they're cheaper in the end! Superior design makes them easier to handle - - - that's how they save time and labour!

TATA AGRICO IMPLEMENTS

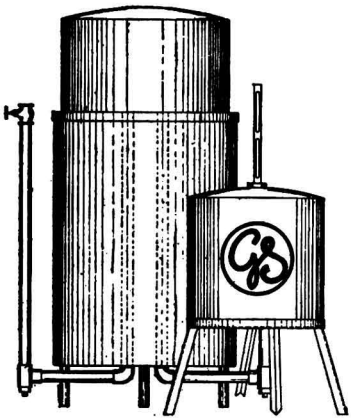
TRADE MARK

Branches at: BOMBAY, MADRAS, KANPUR, JULLUNDHUR, NAGPUR, VIZIANAGRAM SECUNDERABAD.

BUY AGRICO FOR ULTIMATE ECONOMY!

India makes

PETROL GAS PLANTS

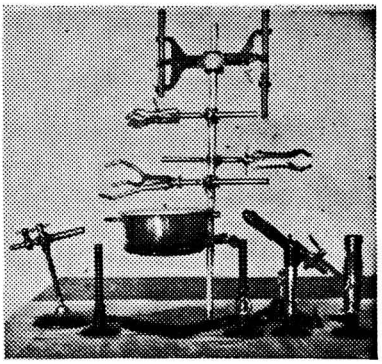


AVAILABLE IN
CAP. 10-250 B.
BURNERS

◆

LATEST INSTALLATION
TWO LARGEST
PLANTS AT
INDIAN INSTITUTE
OF TECHNOLOGY
HIJLI, KHARAGPUR

LAB. HARDWARES



Varied type of fittings

GANSONS Ltd.

Office — DADAR, P.O. B 5576, BOMBAY 14
Works — LALBAUG, BOMBAY

DISCOVERY

THE MAGAZINE OF
SCIENTIFIC PROGRESS

This is Europe's leading popular science magazine. Scientists writing in nontechnical language describe their work in all branches of science.

32 pp. fully illustrated

SINGLE COPIES : 1s 6d YEARLY : 19s POST FREE

Specimen copies sent on request

JARROLD & SONS LTD.

COWGATE, NORWICH
ENGLAND

Our Reliable & Prompt Service

A BOON TO THE INDUSTRIES

DIRECT IMPORTERS & STOCKISTS
OF LABORATORY REQUISITES OF
EVERY DESCRIPTION FROM "A" TO "Z"
INCLUDING CHEMICALS, ETC.

Full particulars from:

UNIQUE TRADING CORPN.

51-53 NEW HANUMAN LANE
BOMBAY 2

"BOROSIL"

AMBER NEUTRAL VACCINE BULBS

ALL CAPACITIES • MACHINE MADE

Can be had from:

BOROSIL GLASS WORKS

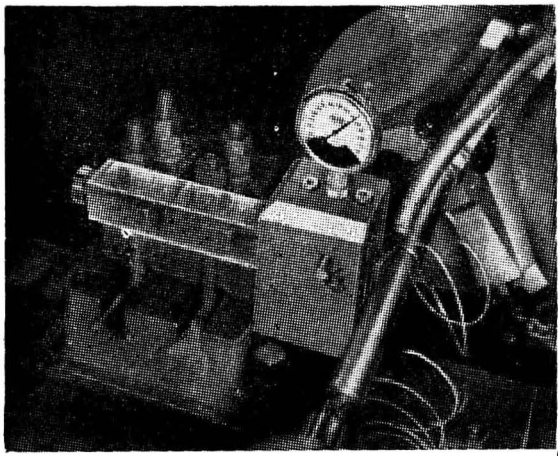
•

PROPRIETORS:

INDUSTRIAL & ENGINEERING APPARATUS Co. Ltd.

CHOTANI ESTATES, PROCTOR ROAD
BOMBAY 7

THE MSE LONDON SCHLESINGER
MACHINABILITY TESTER



A PRACTICAL
WORKSHOP
INSTRUMENT

MEASURES MACHINABILITY

ESTABLISHES A MACHINABILITY
STANDARD OF IMMEDIATE AND
SIMPLE APPLICATION

THE MOST IMPORTANT PRODUCTION
ENGINEERING DEVELOPMENT IN A GENERATION

Branches

Cox Street, COIMBATORE ; 26 Errabalu Chetty Street, G.T., MADRAS;
P.O. Box 168, NEW DELHI

Garlick & Co. Ltd.
ENGINEERS
JACOB CIRCLE, BOMBAY 11

SISTA'S — G. 75.

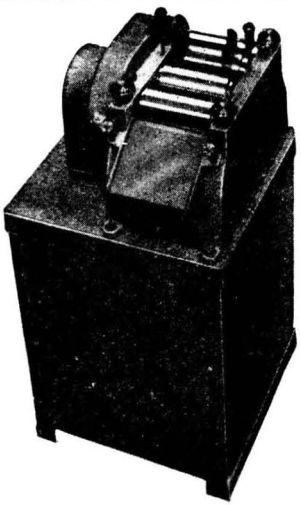
Modern laboratory equipment !

FILTER PAPER — Machery and Nagel, German make
MICROSCOPE — Dr. Heppner System, German make
FH3-modernistic Model, German make
PORCELAIN WARE — 'WETA' Brand, Holland make
MICROSCOPIC SLIDES — Finest Belgian make
LABORATORY GLASSWARE — 'TENAX' Brand, Italian make
AND SEVERAL OTHER LABORATORY EQUIPMENT

Enquire from Sole Representative

ZILCO AGENCIES

128 PRINCESS STREET
BOMBAY 2 (INDIA)



for laboratory and small-scale production

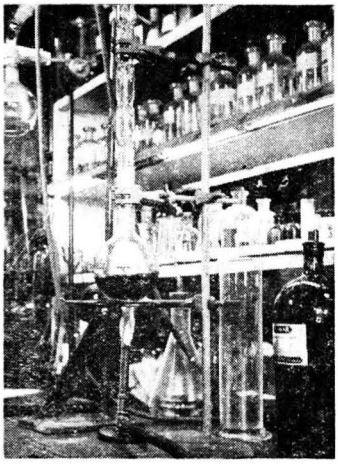
Pascall Roller Mills are ideal. Research chemists find them to be of inestimable value for experimental work, sampling, production testing and small-scale production.

They will refine various materials such as creams, ointments, pastes, paints, printing inks, plastics, etc., and are available with either steel or porcelain rolls.

PASCALL
ROLLER MILL

Sole Agents for
INDIA
BURMA
&
CEYLON

GIDVANI & Co.
PEOPLE'S BUILDING
SIR PHEROZESHAH MEHTA ROAD, FORT, BOMBAY



For responsible analysis...

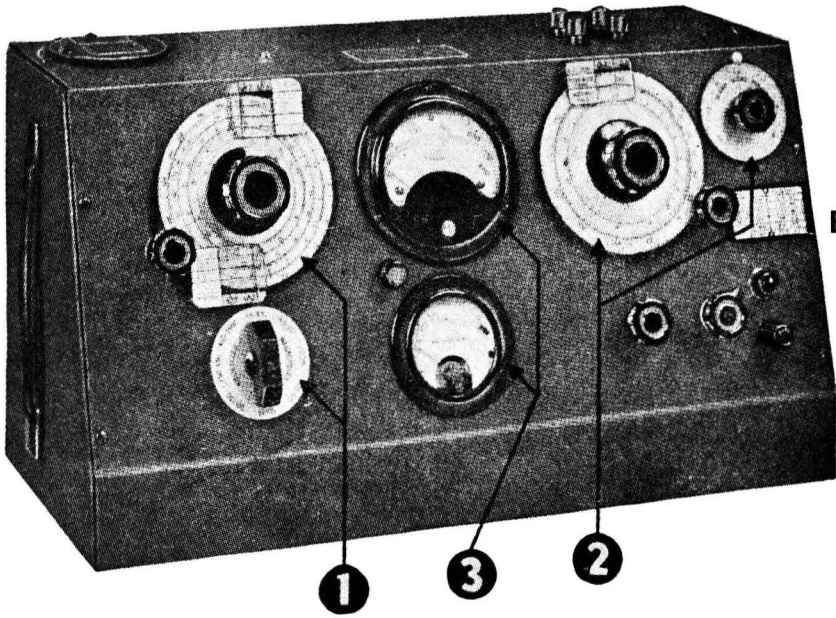
THERE are good reasons for preferring 'AnalaR' reagents. Long specialised experience has devised the best ways to make them, and the best plant to make them in. Analytical laboratories specifically equipped for the work control the raw materials, the processes of manufacture and the finished product. The maker's reputation rests upon them, and guarantees them. For laboratories undertaking important and responsible work the standard analytical materials are

'ANALAR' REAGENTS

Each conforms to published specifications and is labelled to show the maximum limits of impurities.

THE BRITISH DRUG HOUSES LTD. B.D.H. LABORATORY CHEMICALS GROUP **POOLE ENGLAND**

Distributors in India:—
BRITISH DRUG HOUSES (INDIA) LTD. **Post Box 1341** **BOMBAY No. 1**



DIRECT READING

BOONTON'S Q METER

TYPE 160-A 50kc.-75mc.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom-built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* **features which save time and simplify operation.**

SPECIFICATIONS

Oscillator Frequency Range : 50 kc. to 75 mc. in 8 ranges.
Oscillator Frequency Accuracy : ± 1%, 50 kc.— 50 mc.
± 3%, 50 mc.— 75 mc.
Q Measu ement Range : Directly calibrated in Q, 20-250. "Multiply-Q-By" Meter calibrated at intervals from x1 to x2, and also at x2·5, extending Q range to 625.
Q Measurement Accuracy : Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
Capacitance Calibration Range : Main capacitor section 30-450 mmF, accuracy 1% or 1 mmF whichever is greater. Vernier capacitor section +3 mmF, zero, —3 mmF, calibrated in 0·1 mmF steps. Accuracy ±0·1 mmF.

1 OSCILLATOR FREQUENCY DIAL

This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIAL

L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in mmF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 mmF through zero to —3 mmF, accurate to ±0·1 mmF.

3 Q-VOLTMETER AND MULTIPLIER METER

For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1·5 in 0·1 steps, X2, and X2·5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

FACTORY REPRESENTATIVES :

EASTERN ELECTRIC & ENGINEERING Co.

ESTABLISHED 1909

127 Mahatma Gandhi Road, Post Box 459, Fort, Bombay 1

Gram : "EASLEKTRIK" **Telephone : 30937 (3 lines)**

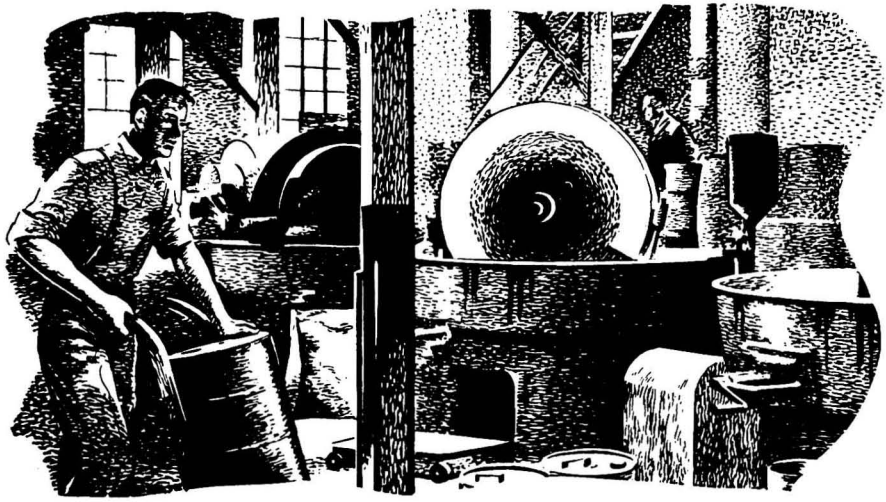
AGENTS :

CHICAGO TELEPHONE & RADIO CO. LTD.

25 Chowringhee Post Box 2589 CALCUTTA Phone : Bank 1953	48 Hazratganj Post Box 46 LUCKNOW Phone : 860	196 Mount Road Post Bag 5238 MADRAS 2 Phone : 84357	68 Queensway Post Box 47 NEW DELHI Phone : 7179

TELEGRAMS : "CHIPHONE" ALL OFFICES

M&B LABORATORY CHEMICALS IN THE SERVICE OF INDUSTRY



Behind the manufacture of paints, dyestuffs and many other industrial products lies a continuous campaign, conducted in the laboratories of the industries concerned, to control, develop and perfect.

May & Baker offer a range of some five hundred laboratory chemicals produced to specifications to meet the requirements of all normal laboratory procedures.

The widespread acceptance of M&B Laboratory Chemicals in every branch of industry bears eloquent testimony to their value.

A complete brochure of specifications will be sent on request.

manufactured by

MAY & BAKER LTD

distributors

MAY & BAKER (INDIA) LTD. BOMBAY • CALCUTTA • NEW DELHI • LUCKNOW • MADRAS

383

IMPERIAL CHEMICAL INDUSTRIES (INDIA) RESEARCH FELLOWSHIPS

Applications are invited for four Imperial Chemical Industries (India) Research Fellowships tenable ordinarily for two years in Physics (including Mathematics), Chemistry or Biology (Botany & Zoology) at any university or institution in India. Monthly stipend Rs. 400. A sum not exceeding Rs. 600 per annum will be made available in each case for special apparatus. Age of applicant not to exceed 35 years. The minimum qualification required is Master's degree followed by research experience. Four copies of application in prescribed form with one copy of each of the original papers (or reviews) published by the candidate, duly forwarded by the Head of the Laboratory in which research is to be undertaken, should reach **the Secretary, National Institute of Sciences, University Buildings, Delhi,** before 3rd March 1951. For copies of the form of application send a large addressed envelope.

For

LAB. HOLLOW & GRADUATED GLASSWARE
HYDROMETERS
CHEMICAL THERMOMETERS
PORCELAINWARE
SILICAWARE
FILTER PAPERS
WET & DRY BULB HYGROMETERS
MAXIMUM & MINIMUM THERMOMETERS
CHEMICAL A.R. & C.P.
STAINS, ETC.

ASK FOR PRICE LIST & ENQUIRE AT

SARAYU SCIENTIFIC Co.
MOOS BUILDING
510 KALBADEVI, BOMBAY 2
Telegraphic Address : **HYDROMETER**

"LONDEX"

TIMERS
RELAYS, CONTACTORS
PHOTOELECTRIC EQUIPMENT
LIQUID LEVEL CONTROL
PRESSURE SWITCHES
ELECTRO-MAGNETIC VALVES

for
LABORATORIES, INDUSTRIES, ETC., ETC.

Sole Agents :

MURRAY & Co.
SWADESHI MILLS ESTATE
NEW QUEENS ROAD
BOMBAY 4

BOOKS & PERIODICALS

PHILIPS TECHNICAL LIBRARY

BOOKS

FUNDAMENTALS OF RADIO-VALVE TECHNIQUE : Book No. 1 in the series of books on Electronic Valves by the Philips Technical Library — deals with the physical principles, the latest constructions and properties of radio receiving and amplifying valves.

Price Rs. 24/- each, post free.

DATA AND CIRCUITS OF RECEIVER AND AMPLIFIER VALVES : Book No. II in the series contains the data of the valves placed on the market during 1933 to 1939. Data are also given of receiving, stabilising and regulating valves, as well as descriptions of measuring instruments for Laboratories and Workshops.

Price Rs. 15/- each, post free.

DATA AND CIRCUITS OF MODERN RECEIVING AND AMPLIFYING VALVES : (first supplement) Book No. III in the above-mentioned series — contains the data and circuits of the valves brought out in the years 1940 and 1941.

Price Rs. 12/- each, post free.

APPLICATION OF THE ELECTRONIC VALVE IN RADIO RECEIVERS AND AMPLIFIERS : Book No. IV in the series aims at being a guide to the set-maker when applying the electronic valve in receivers and amplifiers.

Price Rs. 24/- each, post free.

PHILIPS MANUAL OF RADIO PRACTICE : Compiled by Mr. E. G. Beard, M.I. R.E., of Philips, Australia. Deals with all fundamental and up-to-date information regarding operation and service of radio equipment. Second edition (now in process) containing fuller treatment of frequency modulation, television and servicing will be an excellent book of reference for both amateurs and professionals.

Price Rs. 15/- each, post free.

PHILIPS RESISTANCE WELDING HANDBOOK, by PHILIPS — LONDON : Compiled to meet the need which undoubtedly exixts for a practical manual on resistance welding.

Price Rs. 7/8 each, post free.

PHYSICAL ASPECTS OF COLOUR : by Dr. P. J. Bouma, Philips expert in illumination engineering : an introduction to the scientific study of colour stimuli and colour sensations.

Price Rs. 15/- each, post free.

PERIODICALS

PHILIPS TECHNICAL REVIEW : A Monthly publication on Lighting, Electronics, X-ray and other technical subjects.

Annual Subscription (12 issues)—Rs. 14/-

PHILIPS RESEARCH REPORTS : A two-monthly scientific journal of theoretical and experimental research in physics, chemistry and allied fields.

Annual Subscription (6 issues)—Rs. 17/-

COMMUNICATION NEWS : A quarterly journal containing articles relating not only to transmitting but also to the entire field of P.T.T.

Annual Subscription (4 issues)—Rs. 10/-

INTERNATIONAL LIGHTING REVIEW— A two-monthly journal dealing with the application and development of artificial light.

Annual Subscription (6 issues) Rs. 15/-

For further particulars please write to :

PHILIPS ELECTRICAL CO. (INDIA) LTD.
TECHNICAL & SCIENTIFIC LITERATURE DEPT.
"PHILIPS HOUSE" • HEYSHAM ROAD • CALCUTTA-20

HOSPITAL EQUIPMENT & SUPPLIES
ELECTRO-MEDICAL APPARATUS

LABORATORY EQUIPMENT

METEOROLOGICAL MICROSCOPES
PETROLOGICAL MICROSCOPES
PHOTO-MICROGRAPHIC EQUIPMENT
ANALYTICAL BALANCES
HIGH PRESSURE STEAM STERILIZERS
DISTILLED WATER UNITS
HOT AIR OVENS
*p*H METERS & COLORIMETERS
DIAGNOSTIC & SURGICAL INSTRUMENTS

SUPPLIES

LABORATORY GLASSWARES
PORCELAIN WARES
SILICA WARES
FILTER PAPERS
EXTRACTION THIMBLES
CHEMICALS, STAINS & REAGENTS

MODERN TRADERS

HOSPITAL & LABORATORY FURNISHERS

DWARAKDAS MANSION, SANDHURST ROAD

BOMBAY 4

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Applications are invited for the post of Director, Central Electro-chemical Research Institute, Karaikudi (South India), in the scale of Rs. 2,000-100-2,500. Higher initial salary can be given to exceptionally qualified scientist.

QUALIFICATIONS

(a) High academic qualifications and wide experience of research in Electro-chemistry.

(b) Candidates must also have some experience in organization and administration and should be able to initiate and direct research, and to co-ordinate research work in different branches of Electro-chemistry.

Selected person will be eligible to the Provident Fund of the Council of Scientific & Industrial Research and will have to contribute 6¼ per cent of his salary, an equal amount being contributed by the Council. Appointment shall be made on a contract basis for three or five years.

Applications with copies of testimonials and published papers should reach the **Secretary, Council of Scientific & Industrial Research, P Block, Raisina Road, New Delhi,** by 31st March 1951.

INDEX TO ADVERTISERS

	PAGE
Associated Instrument Manufacturers (India) Ltd., Calcutta	A 22
Bengal Chemical & Pharmaceutical Works Ltd., Calcutta	A 4
Bombay Scientific Glass Works, Bombay	A 4
British Drug Houses (India) Ltd., Bombay	A 11
Council of Scientific & Industrial Research, New Delhi	A 17
Dictionary of Economic Products and Industrial Resources of India	A 19
Discovery, Empire Press, Norwich, England	A 8
Eastern Chemical Co. (India), Bombay	A 6
Eastern Electric & Engineering Co., Bombay	A 12
Gansons Ltd., Bombay	A 8
Garlick & Co. Ltd., Bombay	A 10
General Electric Co. Ltd., Bombay	A 23
Gidvani & Co., Bombay	A 11
Government Opium Factory, Ghazipur	A 6
Griffin & Tatlock (India) Ltd., Calcutta	A 18
Industrial & Engineering Apparatus Co. Ltd., Bombay...	A 9
Martin & Harris Ltd., Bombay	A 24
May & Baker (India) Ltd., Bombay	A 13
Modern Traders, Bombay	A 16
Murray & Co., Bombay	A 14
National Institute of Sciences of India, Delhi	A 14
Philips Electrical Co. (India) Ltd., Calcutta	A 15
Raj-Der-Kar & Co., Bombay	A 5
Sarayu Scientific Co., Bombay	A 14
Tata Iron & Steel Co. Ltd., Calcutta	A 7
The Scientific Instrument Co. Ltd., Calcutta	A 2
Toshniwal Bros. Ltd., Bombay	A 20
Union Scientific Syndicate, Bombay	A 4
Unique Trading Corporation, Bombay	A 9
Zilco Agencies, Bombay	A 10

CAMBRIDGE *p*H-METERS

CAMBRIDGE BENCH PATTERN *p*H-METER

Battery operated, with Morton Electrode System

CAMBRIDGE PORTABLE *p*H-METER

with Self-contained Battery and Electrode System

CAMBRIDGE *p*H-METER, ALL MAINS

Complete with Electrode Assembly

SEALED GLASS ALKALI & CALOMEL ELECTRODES

Available ex-stock

GRIFFIN & TATLOCK (India) Ltd.

B-5 Clive Buildings
P.O. Box 2136
CALCUTTA

274 Hornby Road
P.O. Box 119
BOMBAY

74 Queensway
NEW DELHI

The Present Concept of the Physical World*

IT had already been established by the end of the last century that the multitude of substances in nature are made up by the chemical combinations of a certain number of basic substances called the chemical elements. The smallest unit of a given chemical element was called an atom. The combination of these atoms, either of the same element or of different elements, gives rise to chemical compounds, which compose the body of all the substances that we meet in nature.

Investigation on the conduction of electricity through gases led Thomson towards the end of the last century to the discovery of the fact that this conduction could be attributed to a particle of negative charge having always the same ratio of charge to mass irrespective of the substance under investigation. Moreover, this mass was some thousand times smaller than that of a positive ion. Subsequent researches have established the fact that there is a smallest unit of negative electricity, smaller subdivisions of it not being found in nature, and that all negative electricity appears in integral multiples of this smallest unit, which is now denoted by e. Thus it came to be established that there was a type of particle, called an electron, which always possessed the same negative charge e and the same mass m, which was somehow contained in atoms, and whose behaviour was responsible for the phenomenon of electricity.

Since an atom is an electrically neutral body, it follows that if electrons are contained in it, then it must also contain an equal amount of positive charge. It was not clear at the time how the electrons and the positive charges of electricity were distributed in an atom. For example, were the electrons embedded in a uniform medium of positive electricity, rather like plums in a cake? Or were they like planets revolving round a sun of positive charge? The answer to this important question was furnished by Rutherford in 1911. He showed by a study of the scattering of α particles that the true picture of the atom was to consider it like a solar system in which the electrons move like planets round a heavy centre called the nucleus in which all the positive charge and most of the mass of the atom is concentrated. Since the negative charge inside the atom depended on the number of electrons in it and was an integral multiple of e, the positive charge on the nucleus had likewise to be an integral multiple of e. It was soon established that the number of units of positive charge on the nucleus determined the chemical properties of the atom, and that there were 92 such chemical elements ranging from the lightest hydrogen to the heaviest uranium, with 1 to 92 positive units of charge on the nucleus respectively.

The mass of the nucleus of the lightest element, hydrogen, containing just one unit of positive electricity, was found to be always precisely the same, and some 1,840 times the mass of the electron. Since this nucleus of hydrogen never broke up into smaller fragments, it became convenient to regard it as a new type of fundamental entity, a new elementary particle, called a proton.

Further researches showed that the mass of any atom was always almost precisely an integral multiple of the mass of the proton, while its charge was a smaller integral

* From the Presidential Address of Dr. H. J. Bhabha, 38th session of the Indian Science Congress, Bangalore (January 2, 1951).

multiple of the charge of the proton. These facts led one at the time to accept a picture of the nucleus which made it appear to be made up of protons and electrons only. The number of protons was sufficient to make up the mass of the nucleus, while a certain number of electrons were added inside the nucleus to neutralize the charge of some of the protons and make the total positive charge equal to the actual charge of the particular nucleus. Thus, round about 1930, our picture of the physical world appeared to be remarkably simple. The whole material world was thought of as made up of just two types of elementary particles, protons and electrons. By suitable arrangements of these, one built up the atoms of the chemical elements, and from suitable arrangements of the latter every other material thing that was found in nature. Light, or in more general terms, electromagnetic radiation or photons, and gravitation were the only two other physical entities found in nature.

A scientist at that time could have thought, as many did think, that when one knew the mathematical laws governing the behaviour of these four elementary types of physical entities, the protons, electrons, photons and gravitation, one would know everything of a fundamental nature that there was to know of the physical world, and physics in principle would be a subject which had reached its destination. The subsequent development of the last twenty years shows us how far this belief was from the truth. It shows in a striking manner that however great the successes of a theory, unless this success is complete and total, it is always possible that something very important may have slipped through the net. The apparently small but persistent difficulties or inconsistencies in a theory, or small discrepancies between theory and observation, may be essentially unbridgeable within the framework of the basic concepts of that theory and yield the clue to new ideas.

What were these difficulties of which I have spoken? In order to make a body spin about itself like a top we have to impart to it energy and something called angular momentum. It is found that like electricity, which occurs in nature only in integral multiples of the basic unit e, angular momentum also occurs only in integral multiples of a basic unit which is just Planck's constant divided by 4π, that is $h/4\pi$. Spectroscopic analysis has shown that the two elementary particles, the proton and the electron, each possesses an intrinsic angular momentum or spin of one unit which arises, so to speak, from its spinning about itself like a top. On the other hand, angular momentum which arises from one body moving bodily round another is always an even integral multiple of the basic unit, that is either zero or two or four, etc., times $h/4\pi$. Spectroscopic analysis shows that the spin of a nucleus containing an odd number of heavy particles, that is an odd number of protons in our picture, is always an odd multiple of the basic unit much as if the electrons in the nucleus did not contribute to the spin at all, unlike the electrons outside the nucleus each of which must contribute an odd number of units due to its intrinsic spin and its bodily motion. Secondly, both protons and electrons satisfy a law which the theoretical physicist calls Fermi Dirac statistics. It can be shown then that a nucleus containing an odd number of protons plus electrons must also satisfy the same statistics so that in a molecule composed of two such atoms only certain spectral lines must appear and not others. Experiment again shows that the statistics of such nuclei appear to depend only on the number of heavy particles in the nucleus and not on the total number of protons plus electrons in our picture. In fact all the nuclei seem to behave as if the electrons which were supposed to be in them only manifested their electric charge but neither their spin nor their statistics. A bold attempt to face this difficulty would soon have led one to the view that nuclei were not composed of protons and electrons but rather of protons and some hitherto unknown particle having to a very high degree the same mass as the proton, the same spin and satisfying the same statistics. A particle of this description was discovered by Chadwick in 1931 and was called a neutron. It had to be accepted as a new elementary particle and not a composite structure made up of a proton and an electron for the same reason that prevented us from thinking consistently of the nucleus as being made up of protons and electrons. It immediately led to the acceptance of the picture that all nuclei are composed of only two types of particles, protons and neutrons. The number of types of elementary particles was thus increased by one.

The acceptance of the neutron as an elementary particle, however, introduced a new feature into our concept of the elementary particles. For it had been known for a long time that certain nuclei, as for example those of the radioactive elements, emit electrons every now and then. One can only fit this fact into the picture by assuming that when such an electron is emitted from the nucleus it is in fact newly created in the process and that simultaneously a neutron in the nucleus changes into a proton. Thus we have to admit the possibility that while the elementary particles are not composite, and that as long as they exist they are immutable with absolutely constant properties, nevertheless there are occasions when one or more such particles can disappear altogether with the simultaneous creation of another set. For example, a neutron may disappear and give place to a proton and an electron. Since the neutron, proton and electron all have a spin $h/4\pi$ and the bodily motion of these particles can only contribute an even multiple of $h/4\pi$, the conservation of angular momentum and statistical properties compels us to postulate that there must be yet another elementary particle, called neutrino by Pauli, which possesses no charge, a mass negligible compared with that of the electron and a spin of one unit ($h/4\pi$).

In 1931, Anderson reported a photograph which seemed to be that of a particle of the same mass as an electron and having one unit of positive instead of negative electric charge. The experimental advance of making the cosmic rays themselves take their own photographs instead of taking photographs at random in a Wilson chamber then enabled Blackett and Occhialini soon afterwards to discover a new phenomenon called cosmic ray showers. Although cosmic rays are relatively rare, Blackett and Occhialini showed that very frequently many such rays occurred in a shower and subsequent work has demonstrated that such showers of particles are produced by cosmic rays when they pass through matter, as for example sheets of lead placed in the Wilson chamber. Blackett and Occhialini showed that their showers contained not only the usual electrons but a comparable number of electrons with the opposite charge. With this, the existence of the positron, as this new particle was called, was established.

The existence of the positron could be understood immediately in terms of an equation for the electron which Dirac had put forward in 1928 and which combined in it for the first time the ideas underlying the theories of relativity and quantum mechanics. Dirac had already shown that certain apparent difficulties in his theory could be understood as expressing on the one hand the existence of a particle of equal but opposite charge to that of the electron and, on the other, the possibility of a pair of such positive and negative particles being created by the materialization of energy or of their annihilation with the transformation of their mass energy into radiation. Subsequent experiments have fully confirmed the correctness of these basic processes predicted by the theory. Nevertheless, a consequence of this theory was that no electron or photon of even the highest energy could penetrate large amounts of matter, while a growing body of evidence from cosmic ray experiments indicated that particles which looked like electrons did in fact penetrate great thicknesses of matter. Thus, there seemed to be evidence that quantum theory failed for very high energy electrons, while at the same time there was no theory to explain the phenomenon of the cosmic ray showers. It was only when the Cascade Theory put forward by Heitler and the present author showed that the existence of cosmic ray showers and the behaviour of the soft component of cosmic rays in the atmosphere and in dense substances could be explained on the basis of quantum theory, was it possible to conclude that the electron-like tracks of particles which did not behave completely like electrons nor like protons must be due to a new type of particle having an intermediate mass. Thus, the existence of a new particle called the meson, with a mass some 204 times that of the electron, came to be established in 1938.

A particle with a mass of this order of magnitude had already been envisaged by Yukawa in 1935 in an attempt to explain the short-range nature of nuclear forces, that is the forces between two particles in the nucleus of an atom, as for example, a proton and a neutron. The observed mesons, therefore, came to be regarded as the agency responsible for nuclear forces and, in accordance with this picture, the beta decay was then considered as due to the decay of virtual mesons emitted by nuclei. Research carried out since the end of the war has demonstrated that the picture was again not as simple as

it was then supposed to be. Firstly, although the decay of mesons into electrons has been confirmed by experiment, more accurate experiments have shown that the electrons are emitted with a continuous distribution of energies and not with a sharply defined energy as originally supposed. This inevitably leads to the conclusion that in the process of the decay of a meson into an electron not one but two neutral particles must be emitted.

Secondly, the identification of the observed cosmic ray mesons with the particles responsible for nuclear forces inevitably requires them to have a strong interaction with nuclei, whereas the mesons observed in cosmic rays were seen to penetrate large amount of matter with but a very weak interaction with nuclei. A serious attempt to face this difficulty might easily have led one to the conclusion that the particles responsible for nuclear forces were not in fact the observed mesons. This conclusion was, however, not accepted until the studies by Powell and his group on the tracks of cosmic ray particles in special photographic plates had shown that there are in fact two types of mesons with two different masses, and that the one type decays into the other with a period of about one hundred millionth part of a second. The two types of mesons are now known as *pi* and *mu* mesons respectively. The meson generally seen in cloud chamber photographs are the *mu* mesons whereas the *pi* mesons are the ones which are now identified as being responsible for nuclear forces. In accordance with this picture one would have to attribute an even integral spin (in units of $h/4\pi$) to *pi* mesons. The mass of *pi* mesons, or *pions* as they are called in short, as determined from a study of the density of the tracks they produce in special photographic plates, appears to be in the neighbourhood of 286 times that of the electron.

More recent experiments with the large cyclotron at Berkeley and elsewhere have led to the discovery of yet a new elementary particle, a neutral *pion*, that is a *pion* with practically the same mass as the charged *pion* but with no electric charge. Although such a neutral *pion* interacts strongly with nuclei, nevertheless it cannot be observed directly on a photographic plate or in a cloud chamber due to the fact that it does not possess an electric charge and, therefore, does not ionize. Despite this, however, it has been possible to ascertain its mass with very great accuracy. The reason is that a neutral *pion* decays spontaneously in a time of the order of a hundred million millionth part of a second into two gamma rays. Experiments at Berkeley have shown that when a negative *pion* hits a proton the latter is transformed into a neutron with the emission of a quantum of radiation carrying away the entire mass energy of the *pion*, that is some 140 million electron volts. But there is another alternative which can result from this collision, namely the conversion of the proton into neutron with the emission of a neutral *pion*. The neutral *pion* then decays immediately into two photons with roughly half the energy of the original *pion*, namely seventy million electron volts. However, the neutral *pion* that is emitted decays while in motion, thus resulting in a certain spread in the energy of the two gamma rays. From this spread one can calculate the kinetic energy of the emitted neutral *pion* and from this again the difference in mass between the neutral and the negative *pion*. In this way one finds that the mass of a neutral *pion* is only a few electron masses less than that of a charged *pion*.

Rossi has shown that in cosmic rays some two-thirds of the total energy is converted into charged penetrating particles while one-third disappears into neutral charged particles. Since charged *pions* can have a positive or a negative charge, it follows from this that the interactions of a positive, a negative or a neutral *pion* with a nucleon are roughly of the same magnitude.

I now come to particles whose existence is highly probable though not absolutely certain. In 1947 Rochester and Butler in Blackett's laboratory reported certain unusual events which they had observed in a Wilson chamber. They occasionally saw the tracks of charged particles which seemed to show an abrupt change in their direction in the gas of the chamber. They showed that it was difficult to interpret these tracks as due to scattering in the gas for two reasons. Firstly, no recoil nucleus in the gas was visible. Secondly, it would be difficult to understand why a particle should have such a great likelihood of collision while passing through the rarified medium of a gas and yet pass through dense matter like a lead plate without suffering any collision at all. They put forward the explanation that these

forks were due to the spontaneous decay of a charged particle into another charged particle and a neutral one. Experiments at present being carried out at Pic-du-Midi and Jungfraujoch are rapidly producing further evidence that this interpretation is correct. It would be consistent with the present evidence to interpret the charged particle resulting from the decay as a *pion*. Whether all the original particles are of the same type is not a question that can be answered at present. Most of the particles appear to have a mass in the neighbourhood of 800 times the electron mass. But there is some indication that there may also be particles of this type with masses more than a thousand times that of the electron. Rochester and Butler and more recently Butler and his collaborators have also produced evidence to show that neutral particles of corresponding mass exist which seem to decay into two charged particles in the same way.

Lastly, one should mention the case of a particle observed by Powell and his group and called by him a *tau* meson, which came to the end of its range and emitted three mesons of which one is certainly a *pion*.

We see now that at least nine different types of elementary physical entities exist in nature, while the existence of two more is almost certain. While experiments may give us information about the masses of these particles, their mutual interactions and the processes in which they take part, it seems inconceivable that an experiment would enable us to deduce directly the mathematical equation describing the behaviour of any such particle. We can only hope to set up the mathematical equations governing the behaviour of these particles by taking as our guides certain well-known principles, as for example, the principle of relativity and the ideas underlying quantum mechanics. Even such a clearly defined property as the spin of an elementary particle is not something we can hope to measure directly in the case of particles like the meson but must infer it from considerations of the processes in which they take part by comparing the behaviour of particles of different spins as predicted by theory with the experimental observations.

The circumstance that there are a dozen different types of elementary particles in nature would lead us to expect that there may be many more, and indeed, with our present knowledge we cannot exclude the possibility that there may be an infinite number of them. This does not mean, however, that we shall never be able to obtain a complete description of them all. There are, for example, an infinity of lines in the spectrum of hydrogen and yet we possess today not only a formula which in one neat expression contains the energies of all these lines but also a mathematical theory which allows us to calculate all the stable states of the hydrogen atom, other properties such as the scattering of electrons by atoms, their creation by photons, and even more complicated properties like the nature of the chemical bond between two hydrogen atoms. It is, therefore, quite possible that with increasing knowledge we may be able to find the formula which gives us the masses of all the elementary particles and the general principles which will allow us to deduce the equation satisfied by a particle of any particular mass.

Lorentz at the beginning of this century regarded the charge of an electron as a property of the electron and tried to explain its mass as due to the energy of the electromagnetic field associated with that charge. The idea that the mass of the elementary particle is wholly of field origin has had to be abandoned today because we know a number of elementary particles all having the same electrical charge but different masses. On the other hand, one is faced with the fact that whenever the electromagnetic field interacts with any other type of physical entity, be it an electron, a meson or a proton, then the measure of this interaction, namely the charge of the particle, is always the same. From a phenomenological point of view, therefore, we would be more justified today in considering the electric charge e of an elementary particle as a property of the electromagnetic field rather than of the particle, while considering the mass of the particle as an intrinsic property of the particle, unconnected with its interaction with the electromagnetic field. Our approach to this problem today should, therefore, be just the opposite of that of Lorentz. If the electric charge e is to be considered as a property of the electromagnetic field, as I have suggested, then since the only unit associated with field in which it could be measured is the square root of Planck's constant multiplied by the

velocity of light, we should consider this ratio, or its square e^2/hc, to be an intrinsic property of the electromagnetic field. The dimensionless constant e^2/hc would then appear to be a number associated with the electromagnetic field and not a universal constant of nature, of the same status as Planck's constant h or the velocity of light c which enter into the description of other elementary particles.

It is clear that we are now penetrating into a new level of nature which was practically unknown some twenty years ago. I have pointed out earlier that although there may be an infinite number of types of elementary particles, nevertheless, this fact in itself does not necessarily force the conclusion that we will never be able to describe nature fully or to explain the physical world exhaustively. On the other hand, we cannot be certain with our present knowledge that a complete mathematical theory of the physical world can be based upon a finite number of postulates, and if this were not so we would be faced with a situation in which we could never hope to give an exhaustive description of everything there is in nature, but only to extend with the flow of time the region which we had explored and understood.

Characteristics of the Ionosphere over Calcutta (November 1950)

S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY, A. P. MITRA, R. B. BANERJEE & A. K. SAHA

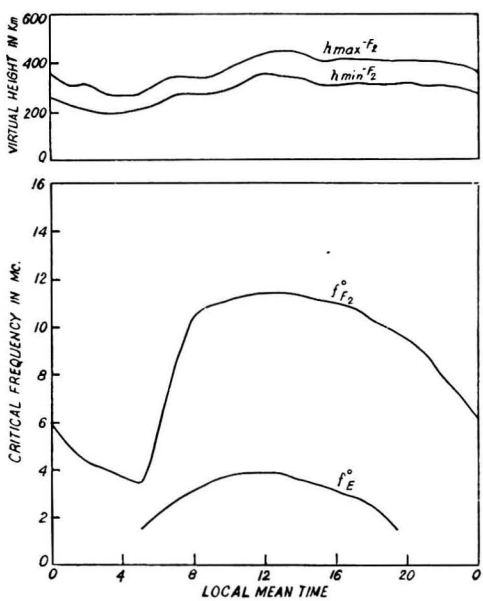
Institute of Radio Physics & Electronics, Ionosphere Laboratory, University College of Science, Calcutta

THE present note records the average ionospheric characteristics observed at Calcutta during November 1950.

Fig. 1 gives in graphical form the mean diurnal variation of (i) the critical penetration frequencies of the E and F_2 regions and (ii) the heights of maximum and minimum ion densities of the F_2 region.

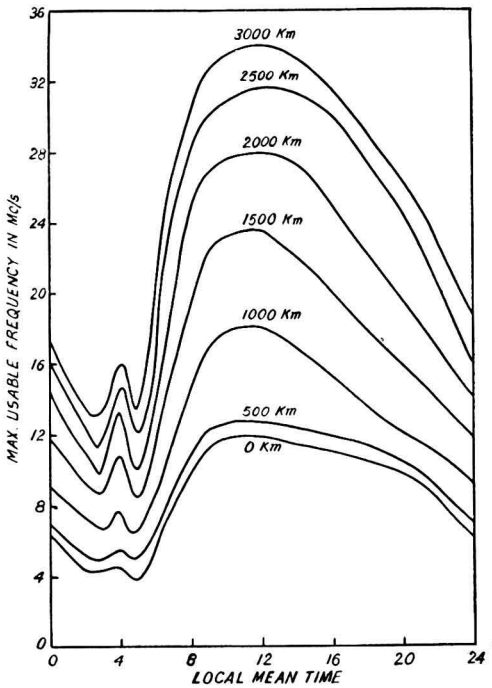
Fig. 2 gives in graphical form the predicted values of maximum usable frequencies for different distances of transmission by reflection at the F_2 region over Calcutta for the month of February 1951. Table I gives the different occasions during routine observations when sporadic E was observed and the values of the corresponding penetration frequencies and heights.

The waves reflected from both regions E and F_2 suffered markedly less absorption throughout the 24 hours in the present month. Strong sporadic E reflections occurred during the afternoon and the early morning hours. The intensity and frequency of occurrence of Es have been markedly greater in the present month than in October.



5 HR. 54 MIN. AHEAD OF G.M.T.

FIG. 1 — NOVEMBER 1950.



AT POINT OF REFLECTION.

FIG. 2 — PREDICTED M.U.F. VIA F_2 LAYER DURING THE MONTH OF FEBRUARY 1951.

TABLE I

MONTH & YEAR	DATE	HOURS	$f°E_s$	$h E_s$
			Mc.	Km.
November 1950	1	00.00	2·60	90
	8	06.00	2·50	90
	10	18.00	2·25	105
	13	10.00	3·50	120
	15	00.00	2·25	90
	16	22.00	3·10	105
	17	04.00	3·00	120
	24	19.00	4·25	120
		20.00	5·00	135
		22.00	3·50	105
		23.00	4·00	120
	25	01.00	3·25	105
		02.00	3·20	105
		03.00	4·00	120
		04.00	4·00	105
	28	19.00	3·95	120
	29	17.00	4·00	120
		18.00	4·00	120
		19.00	4·00	120
		21.00	3·70	90

Indian Scientific Liaison Office, London

THE FUNCTIONS OF THE INDIAN SCIENTIFIC Liaison Office, London, are: (i) To facilitate the movement of scientists within the Commonwealth and to provide adequate facilities for them and their work and to arrange contacts for them; (ii) to keep abreast of the latest improvements in techniques and scientific technical developments and make this information available in India; (iii) to facilitate exchange of scientific information and experimental material such as plants, animals, micro-organisms, etc.; (iv) to help, wherever required, in the placing of research workers in British and American laboratories for research or training.

The Indian Scientific Liaison Officer attends scientific and technical conferences in the United Kingdom and other countries to which delegations are not sent from India. He visits laboratories, research institutes, research departments of universities and industrial research organizations in the United Kingdom and other countries to obtain information regarding scientific and technical developments and will try to arrange, where necessary, for the exchange of technicians and scientists from the various parts of the Commonwealth and the U.S.A.

Members of scientific and educational institutions and trade organizations visiting U.K., who are desirous of visiting laboratories, technical institutions and industrial establishments, are advised to contact the Liaison Office instead of making a direct approach to the institutions concerned. In permitting visitors from India to see the institutions, the advice of the Liaison Officer is invariably sought by the Directors concerned and it would be desirable for the visitors to approach the parties through the Liaison Office to avoid delay and inconvenience in obtaining necessary facilities.

The Indian Science Congress, Bangalore, January 2-8, 1951

THE thirty-eighth session of the Indian Science Congress was held at Bangalore under the presidentship of Dr. H. J. Bhabha, F.R.S. The Pan Indian Ocean Science Congress also held its first session at Bangalore during the first week of January. Mr. Jawaharlal Nehru inaugurated both the congresses. Over 1,500 delegates including scientists from Australia, Madagascar, Malaya, Mexico, New Zealand, Pakistan, Russia, Sweden, U.K. and U.S.A. participated in the deliberations of the congresses.

Scientists & World Peace

Inaugurating the Indian Science Congress, Mr. Nehru appealed to scientists to strive for understanding human needs in addition to understanding the physical world. He exhorted them to cultivate the human approach to problems confronting the world, and to remember that means are as important as ends. He said : " I have the greatest admiration for pure research which was essential and out of which might come out many practical applications ultimately.... The scientist, as a scientist, pursues truth regardless of where he might reach, regardless of every humanitarian consideration. And that is right because it is no good trying to become sentimental at the cost of truth. But the fact remains, if human society is to survive, we have to look at it as a human society and not as an abstraction."

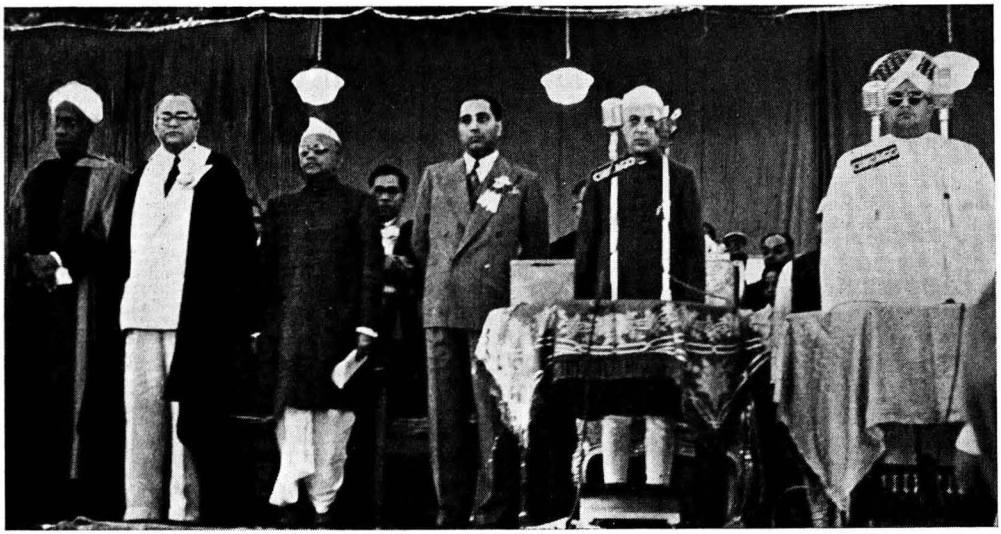
Continuing, the Prime Minister said : " All the world, today, knows what science can do. Nevertheless, it is astonishing how far from what might be called scientific outlook we are, all of us, wherever we might be, although we might profit by the latest advances of science.... There is a kind of a race between the good effects of science which are obvious, and the evil effects of scientific development — not of science, but of its application. One does not know which will win in the end.... While you scientists are rightly concerned with the concept of the physical world and all kinds of basic things which are highly important and which ultimately affect human thinking and human philosophy, nevertheless, it becomes important that we should understand a little more of the mind of the human being, of the individual and the mass, and try in some slight degree to control the minds of the politicians and statesmen, because it may happen that all our work and all you may do may suffer irretrievable damage because of things going wrong.

" The temper of the western countries before the First World War was governed by a belief in progress, step by step, going to higher stages not only in physical betterment, but also in mental and spiritual betterment. It is obvious that the idea of progress, which filled peoples' mind right through the nineteenth century and the early years of the twentieth century, does not fill their minds today. Highly educated people somehow miss something that might be called the concept of good life : the concept of an integrated, poised life. They do not know how to lead their lives in a poised and integrated way. That applies to the individual as to the group and the nation. Now, how are we to find that poise and integration in life, in a nation and as between nations ? Because, if we do not, we do not remain where we are. The choice becomes one of really recovering some balance in national and international relations, or cracking up completely.

" I should like you, gentlemen, to think of these problems which are not new problems before the world. There have been problems ever since philosophers started philosophizing, and the old scientists also thought of science in terms of human philosophy. A measure of human approach to human problems is not only desirable but essential today for scientists as for others."

Presidential Address

In his presidential address, Dr. H. J. Bhabha surveyed the developments leading to the present concept of the physical world.



MR. JAWAHARLAL NEHRU INAUGURATING THE 38TH SESSION OF THE INDIAN SCIENCE CONGRESS.

The early civilizations, he pointed out, depended on a considerable body of practical knowledge acquired empirically, and on some highly developed arts and crafts, to provide themselves with shelter or margin of safety against more hostile acts of nature. But with a few notable exceptions, scientific activity in the modern sense did not begin till the Italian renaissance. Leonardo da Vinci wrote : " There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are based on the mathematical sciences." As long as an observation of a natural phenomena remained, it would not be definite enough to build on, and only by introducing accurate measurement and qualitative relations into it could one be certain that it was right or wrong within the limits of accuracy of the measurements. Some four centuries later Lord Kelvin said : " When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." Once this general approach received fairly wide acceptance, the development of science in the modern sense was inevitable.

It was found quite soon that certain properties, which could be stated in terms of exact measurement, were common to many objects. In certain cases, therefore, it became possible to state a general property without specifying the particular object to which it belonged. Such general properties could then be regarded as laws of regularities of nature which all objects of a certain type satisfy. These laws or regularities of nature are merely empirical statements of properties observed to be common to a large number of objects. They are all unconnected with each other. In order to connect up such regularities with each other, it may be necessary to formulate certain more abstract principles or postulates from which the various observed regularities can be deduced. Newton's fundamental laws of motion exemplify this new approach.

The great importance of the contribution of Newton to the development of physics is that it introduced a new approach to science. It led to the acceptance of the position that the ideas which are to be regarded as fundamental for the understanding of nature are certain abstract concepts or postulates which can be proved directly. This position was accepted because it allows one to order different empirically found regularities of

nature into a unified logical scheme which would not otherwise be possible.

A consequence of this approach is that any newly discovered fact of nature which does not fit into the existing scheme of physics may necessitate a complete change of the fundamental postulates. Although every new discovery which does not fit into the old scheme necessitates a complete change of fundamental postulates, the change is always from a certain set of concepts to a set of more general concepts. As one goes deeper and deeper into the understanding of nature by co-ordinating all the known facts into one scheme by the use of wider concepts as the basic postulates, the old fundamental postulates become, in a sense, a part of the superstructure, taking a place in between the new fundamental concepts and the directly observed regularities of nature. When a science reaches an advanced stage, as physics undoubtedly has today, the facts which can be discovered by direct observation become more and more meagre.

"The aim of theoretical physics", Dr. Bhabha said, "must be to find a complete set of mutually consistent mathematical postulates or axioms from which the properties of nature can be deduced in the form of a series of theorems. It is, however, necessary, in order to achieve the last step of comparing the mathematical statements of the theorems with the results of observation, that the basic mathematical postulates must be supplemented by a set of prescriptions about the interpretation of the mathematical formalism. It is clearly not sufficient that the postulates should be consistent and their correctness from the point of view of physics can be only demonstrated by an agreement between the deductions and the results of experiment."

Dr. Bhabha then reviewed the developments leading to the present concept of the physical world resulting from recent discoveries.

Sectional Addresses

The addresses of the sectional presidents covered a wide range of subjects. They included: *Topological Methods in Analysis* (Dr. C. Racine); *Statistical Opportunities & Responsibilities* (Prof. A. R. Sinha); *The Doppler Effect in Light Scattering* (Prof. C. S. Venkateswaran); *Nature of Double Bonds in Aromatic Ring Systems* (Dr. R. C. Shah); *The Bearing of Geology in Multi-purpose Projects* (Dr. J. B. Auden); *Studies in Systematic Mycology in India* (Dr. B. B. Mundkur); *The Role of Salienta in Human & Mammalian Pregnancy Test* (Dr. J. L. Bhaduri); *The Place of Human Biology in Anthropology & Its Utility in the Service of the Nation* (Dr. S. S. Sarkar); *The Place of Synthetic Food in Our Programme of Self-sufficiency* (Dr. G. Sankaran); *Soil Conservation — a Vital Need of the Nation* (Dr. J. K. Basu); *Physiology of the Kidneys* (Prof. S. M. Banerji); *Man & His Work* (Prof. S. K. Bose); *Sources of Energy for the Development of Agricultural & Industrial Resources of the Country* (Prof. M. S. Thacker).

Symposia, Discussions & Lectures

A symposium on Manures and Crop Production was held under the auspices of the National Institute of Sciences. Prof. N. R. Dhar, who initiated the discussion, observed that food shortage in India exceeded 3 million tons, and crop yields could be raised and deficit in production could be wiped off by making use of both natural and artificial manures. Several visiting scientists took part in the discussion.

The symposium on the Design and Manufacture of Scientific Instruments was opened by Dr. S. V. Venkiteswaran (Poona), who traced the developments leading to the production of meteorological instruments required for meteorological observations in the workshops of the India Meteorological Department. Dr. I. Ramakrishna Rao gave an account of his work on the design and fabrication of precision research equipment in the *Andhra Scientific Instruments Co.* Dr. H. Parameswaran appealed to scientists to co-operate with manufacturers in the designing of scientific equipment required both for teaching and research. A well-organized scientific instruments industry is of immense national importance and it behoves the scientists to help in its development. Dr. C. S. Venkateswaran pointed out that while it was necessary to give every encouragement to the indigenous industry, the manufacturer should bear in mind the special requirements of the research worker and both finish and precision are important.

A discussion on crystal physics was initiated by Dr. C. V. Raman who dealt with the dynamics of crystal lattices.

Among other symposia and subjects discussed, mention may be made of the following: Recent Developments in Topological Algebra; Algebra of Elementary Particles; Line Algebra, Mathematical Teaching & Research in India; High Frequency Radiations Emitted by the Sun & Other Astronomical Bodies; Rôle of Science in Indian Railways; Synthetic Petrol; Mineral Dressing & Its Possibilities in India; Insecticides, Fungicides & Weedicides; Present State of Antibiotics in Therapy.

Among popular lectures delivered during the session, mention may be made of the following: Colouration in Rocks & Minerals by Dr. C. V. Raman; Soil Micro-organisms & Plant Food by Sir John Russel; New Drugs by Prof. Fieser; and "On Time & Space" by Prof. A. D. Ross.

Exhibition of Instruments & Publications

The scientific instruments and technical publications displayed in the exhibition halls attracted much attention. A complete range of instruments required for teaching is now manufactured in India. A large variety of precision instruments required for research is also available. The publications of the Council of Scientific & Industrial Research, including *The Wealth of India*, the *Journal of Scientific & Industrial Research*, *The National Register of Scientific & Technical Personnel*, and others evoked much interest.

UNESCO Programme on Natural Sciences

A meeting of the Science Sub-committee of the Indian National Commission for UNESCO was held on January 5 to consider steps for implementing the UNESCO Programme on Natural Sciences. The Committee recommended that national scientific bodies should be made members of International Scientific Unions or Councils with a view to promote international co-operation. With regard to the teaching and popularization of science, the Committee recommended that science clubs should be started in universities and other educational institutions, and popular scientific articles should be prepared and widely circulated among the lay public.

Ministry of Natural Resources & Scientific Research

THE CONSTITUTION OF THE MINISTRY OF Natural Resources and Scientific Research is announced by the Government of India. The Hon'ble Mr. Sri Prakasa will be the minister incharge of this portfolio. The announcement follows the reorganization of certain departments of the Central Secretariat with a view to securing greater administrative efficiency and economy.

The following subjects have been allocated to the Ministry: (1) The subjects at present dealt with in the Department of Scientific Research, viz. Board of Atomic Energy, co-ordination of scientific activities of the various ministries and scientific advice to Government and other departments, *ad hoc* scientific research in universities and research institutions, research scholarships in applied scientific subjects, Scientific Liaison Offices and Scientific Consultative Committee and such other subjects as may be transferred to it; (2) Mines; (3) Geological Survey; (4) Power (including Central Electricity Board) and (5) Irrigation (including Central Waterpower, Irrigation & Navigation Commission).

International Conference on Elementary Particles

THE International Conference on Elementary Particles organized by the Tata Institute of Fundamental Research, Bombay (December 14-22, 1950), was the first of its kind in India. One hundred and fifty delegates from U.S.A., England, Switzerland, Denmark, Italy, Ceylon and India met together to discuss the theoretical and experimental aspects of fundamental particles and cosmic rays. Messages of good wishes for the success of the Conference were received from scientific bodies all over the world including the Soviet Academy of Sciences. Mr. J. R. D. Tata, Chairman of the Tata Institute of Fundamental Research Council, inaugurated the Conference. Dr. H. J. Bhabha, presiding over the opening session of the Conference, welcomed the scientists who had travelled long distances to assemble at Bombay to take part in the Conference.

The papers and discussions presented to the Conference covered a wide range of the theoretical and experimental aspects of elementary particles. The presentation of the principal papers was followed by discussions, and many fruitful conclusions were arrived at. Sessions on purely theoretical problems and those on experimental aspects were held alternately.

Theoretical Aspects

Prof. Rosenfeld delivered an address on the Modern Quantum Theory on behalf of Dr. Niels Bohr who could not attend the Conference. He then delivered his address on Measurability.

Dr. Bhabha gave a lucid exposition of the relativistic theory of elementary particles developed by him and communicated new results he had obtained, which threw further light on the subject. Prof. Peierls of Birmingham University dealt with commutation laws and other aspects of relativistic quantum theory. This was followed by another discussion on geometry of spinors by Prof. F. Perrin.

Prof. E. J. Eliezer of Colombo University gave an account of some new work he had done on the equation of the electron. Theoretical considerations in regard to certain nuclear reactions involving mesons were dealt with by Prof. G. Wentzel of the University of Chicago. These interactions were observed in the Berkeley cyclotron. He also referred to other problems which are related to the modern meson theory.

Recent work in non-localized quantum field theories was described by Prof. Möller, University of Copenhagen. A paper by Prof. Heitler of Zürich dealing with his recent theoretical work on the plural production of mesons in nuclei was communicated by Dr. Eliezer.

Prof. M. N. Saha gave a talk on "The Origin of Cosmic Rays" wherein he summarized three existing theories on the subject. After discussing the merits of and objections to each theory, he concluded that the present evidence indicated that cosmic rays were probably of galactic origin. Prof. P. M. S. Blackett pointed out that the processes which gave rise to cosmic rays need not necessarily be nuclear reactions. A mechanism analogous to the one which causes thunderstorms on the earth could well be responsible for the production of these high energies, in line with Fermi's recent theory.

Experimental Aspects

Discussions on experimental aspects centred round techniques employed in the measurement of cosmic ray intensities, recent work on nuclear transmutations and physical observations in the upper atmosphere. Papers on nuclear studies at Harwell, Chatillan (France), Bristol, Rome, New York, Manchester and India were presented.

Prof. Leprince-Ringuet of the Ecole Polytechnique, Paris, delivered an address on "Some Aspects of the Interaction of Cosmic Rays with Atomic Nuclei". He described the results of his experiments on the decay of mesons in a cloud chamber and

the results of bombardment by cosmic ray particles on atomic nuclei.

Speaking on the scattering of fast mesons by nucleons, Prof. Amaldi of Universita Degli Studi, Rome, observed that the work on the subject led to two broad conclusions :

(1) That the interaction of μ-mesons with atomic nuclei seems to be due to the electromagnetic field ; and

(2) that the electromagnetic scattering of fast μ-mesons can be considered and explained theoretically so long as their energy does not exceed a certain value.

He also compared his results with those calculated using the meson field theory. Prof. B. Peters of Rochester University, U.S.A., who is at present working at the Tata Institute of Fundamental Research, Bombay, gave an account of the recent progress in the study of primary cosmic radiation. The experimental work on the measurements of the radiations recorded on special photographic plates which were sent up to altitudes above 80,000′ were described. Mr. A. S. Rao of the Tata Institute of Fundamental Research described the results of recent experiments of balloon flights by Messrs Gokhale, Pereira and Rao to measure the intensity of penetrating cosmic rays at altitudes above 70,000′. It was pointed out that India was very favourably situated for measurements of this type because of the proximity of the magnetic equator. The experiments under discussion were carried out at Bangalore in 1950 and yielded valuable results which were presented before the Conference. A paper describing the apparatus and methods employed in these experimental flights have been published in the columns of this Journal.*

Describing his recent work on new type of elementary particles, which he calls V-particles and which exist in nature, Prof. P. M. S. Blackett referred to the important work that was being carried out by his collaborators at the high altitude laboratories at Pic-du-Midi and at Jungfraujoch. Dr. Sahiar, a member of the staff at the Tata Institute of Fundamental Research, is also participating in this work at the latter station.

Prof. N. Feather of the Department of Natural Philosophy, Edinburgh, described his experiments on the attempts to detect the negative proton and the di-neutron. Prof. Peierls read out a paper communicated by Sir John Cockcroft, giving an account of work done recently at the Atomic Energy Establishment, Harwell, England. He described a few nuclear reactions which have been studied using neutrons generated in the Harwell cyclotron.

Studies carried out at Colombo University on latitude effect of penetrating showers were described by Prof. Mailvaganam of Colombo University. Dr. V. Sarabhai reported the results of recent work carried out at Ahmedabad on the correlation of the intensity of cosmic rays at lower latitudes with meteorological factors such as temperature, pressure, etc.

Dr. P. Fowler, a collaborator of Prof. Powell at the University of Bristol, spoke on the recent work on high energy nuclear disintegrations and especially on the nature of cosmic ray showers observed on photographic emulsions. Prof. Leprince-Ringuet also gave a short account of the work now being conducted in his laboratory on the nature of cosmic ray showers as observed on photographic emulsions.

Prof. Amaldi gave an account of the recent work of his group in detecting the difference in time in the arrival of cosmic ray particles in showers. He hoped that the workers at the Tata Institute of Fundamental Research would work on the theory of the subject.

A proposal to establish a high altitude cosmic ray research station on the Himalayas was discussed. Concrete proposals to be placed before the next General Assembly of the International Union of Physics and the UNESCO were formulated. The Cosmic Ray Commission decided to recommend assistance to scientists in different parts of the world to carry out field work.

Concluding the deliberations, Dr. Bhabha expressed his appreciation for the financial assistance given by UNESCO through the International Union of Pure and Applied Physics and the International Council of Scientific Unions to meet the travelling expenses of foreign scientists from Europe and America to attend the Conference. Dr. Bhabha thanked Prof. Fleury, Secretary-General of the International Union of Pure and Applied Physics, and other organizations in Britain, France, Denmark and Italy who had co-operated in making the Conference a success.

* R. P. Thatte : *J. sci. industr. Res.*, 1949, **8**, 259.

Prof. Wentzel of Chicago University and Prof. Rosenfeld of the University of Manchester are extending their stay at the Institute to give a course of lectures. The lectures would be open to scientific workers from all parts of India.

Dr. Bhabha hopes to convene annual meetings in India of Indian workers on nuclear physics and triennial meetings of international atomic scientists. The first National Nuclear Conference would be convened in December 1951 in Bombay.

Ionospheric Studies at Calcutta (1944-50)

S. S. BARAL

Institute of Radio Physics & Electronics, University of Calcutta, Calcutta

IONOSPHERE study was first started in 1930 at the University College of Science, Calcutta, by Prof. S. K. Mitra. The laboratory participated in the polar year observations of 1932-33 when regular records of the E and F-layer virtual heights were kept. Records were again kept more or less regularly during the period 1934-38. With the declaration of war in 1939, the transmitting licence was withdrawn and the equipment was dismantled. The observations had, therefore, to be stopped for sometime. However, as the ionospheric records of Calcutta were of considerable importance for the prediction of transmission conditions in the south-east Asian theatre of war, the licence was restored as a special case in December 1943. It took some time to set up the apparatus again and regular observations were started anew from August 1944.

Since 1944 observations are being carried on under the auspices of the Council of Scientific & Industrial Research as part of the programme of the Radio Research Committee and the data commencing from September 1944 are being regularly issued in pamphlet form under the title " Ionospheric Data" for exchange with similar publications of other ionospheric stations. Monthly average values of the data are also being regularly published in the *Journal of Scientific & Industrial Research*[1].

In the present note, the results of study and analysis of the recorded data up to June 1950 are summarized. These consist of :

1. Determination of the rates of electron production and the effective recombination coefficients in the E and F_2 regions ; the value of the terrestrial magnetic field and the effects of lunar and solar tides in the F_2 region.
2. Comparative study of the ionospheric records of stations in different parts of the world (including those of Calcutta) which showed the existence of certain anomalies in the distribution of ionization with latitude and longitude.
3. Study of the associations between ionospheric changes and certain terrestrial and cosmic phenomena, e.g. thunderstorm, solar eclipse, meteoric showers and solar activity.
4. Statistical analysis of the F_2-region disturbance records which revealed a 27-day recurrence tendency.

Fuller accounts of the results with technical details are being published elsewhere.

Determination of Ionospheric Parameters

Rate of Electron Production — The rate of electron production (q) and its variation throughout the whole day for the E and F_2 regions have been determined by the method of Seaton[2]. It is found that the diurnal variation of q does not follow the $\cos \chi$ law (χ, zenith angle of the sun).

For region E, q was found to vary from 30 per cm.^{3} per sec. in winter months (during the period of low solar activity) to 50 per cm.^{3} per sec. in summer months (during the period of high solar activity). For region

F_2, q was greatest in the period of high solar activity during summer, being 400 per cm.^{3} per sec. at that time.

Temperature — Temperatures in the E and F_2 regions have been determined from the relation

$$H = \frac{kT}{mg_{h_M}}$$

(considering a parabolic distribution of ionization with height) where

H = the scale height and is equal to half the semi-thickness of the layer;
m = molecular mass of the active constituent (gas ionized);
k = Boltzman constant;
T = absolute temperature;
g_{h_M} = acceleration due to gravity at the height h_M of the layer.

At the E-region heights, the winter and summer temperatures are 190°K. and 220°K. respectively on the assumption of atomic oxygen as the active gas, and 380°K. and 450°K. on the assumption of molecular oxygen as the active gas. Of these, the latter values are in agreement with the temperature at the height of 120 km. measured by V-2 rocket experiments[3].

At the F_2-region heights, the temperature was found to vary from 700°K. in winter to 1,200°K. in summer (for the period of high solar activity) and from 500°K. in winter to 900°K. in summer (for the period of low solar activity). The summer value of temperature was thus 40 per cent higher than the winter value.

Effective Coefficient of Recombination — The effective coefficient of recombination (α) has been determined for both day and night time conditions for region E for the period 1947-48, and for region F_2 for the period 1945-48. The data for ionospherically quiet days only were used. The average values are 10^{-9} cm.^{3} per sec. for region E and 10^{-11} cm.^{3} per sec. for region F_2. The values are variable and the results obtained are presented in Fig. 1.

An inspection of the curves for region E shows that the value of α for this region is sufficiently variable, though over a small range. It is, in general, smaller at day-time than at night-time. Further, for a chosen hour, the summer values are, in general, smaller than the winter values.

The curves for region F_2 show that α for this region undergoes similar diurnal and seasonal variation, but with much larger amplitudes.

Intensity of the Earth's Magnetic Field—The intensity of the earth's magnetic field (H)

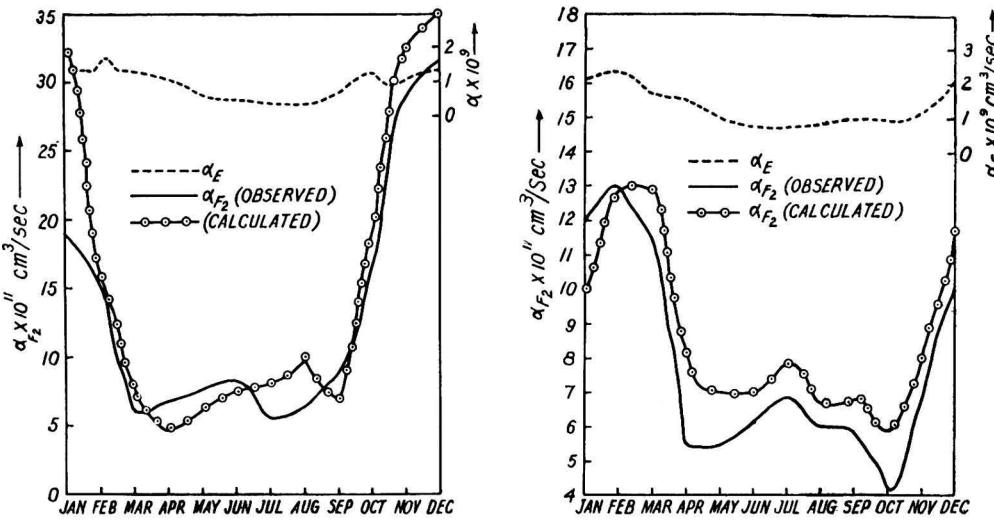


FIG. 1 — SEASONAL VARIATION OF THE EFFECTIVE COEFFICIENT OF RECOMBINATION FOR THE E AND F REGIONS OVER CALCUTTA. THE CURVE ON THE LEFT IS FOR THE PERIOD OF LOW SOLAR ACTIVITY; THAT ON THE RIGHT IS FOR THE PERIOD OF HIGH SOLAR ACTIVITY.

over Calcutta at the height of the F_2 regions has been determined with the help of the equation

$$\mathbf{H} = \frac{2\pi mc}{e} \cdot \frac{f_x^2 - f_o^2}{f_x}$$

where f_o is the ordinary-wave critical frequency and f_x the extraordinary-wave critical frequency.

The observed values of **H** are plotted in Fig. 2 in such a manner that the points representing the same value of the magnetic field are distributed uniformly along a horizontal line. It will be seen that most of the values lie around the theoretical value 0·36 Gauss as calculated according to the inverse d^3 law. It may be noted that the values of **H** obtained showed a seasonal variation of about 10 per cent.

Ionospheric Tides — The results of analysis for the determination of tidal effects are shown in the following tables. For analysis of solar tidal effects, results of observations of two stations other than those of Calcutta, namely Delhi and Chungking, had also been used. Table I gives the semi-diurnal harmonic of the lunar tidal oscillations in the F_2 region at Calcutta and at Delhi. Table II gives the semi-diurnal harmonic of the solar tidal oscillations in the F_2 region at Calcutta, Delhi and Chungking.

TABLE I — LUNAR IONOSPHERIC TIDE — REGION F_2

Station	Variation of H_{max}		Variation of $f°F_2$	
	Amplitude (km.)	Phase of maximum (lunar hr.)	Amplitude %	Phase of maximum (lunar hr.)
Calcutta (22°N. 88°E.)	2·0	4·0	0·5	6·0
Delhi (28°N. 77°E.)	3·0	5·2	1·25	7·5

TABLE II — SOLAR IONOSPHERIC TIDE — REGION F_2

Station	Variation of H_{max}		Variation of $f°F_2$	
	Amplitude (km.)	Phase of maximum (hr. after local lower transit)	Amplitude (Mc./s.) (mean)	Phase of maximum (hr. after the lower transit) (mean)
Calcutta (22°N. 88°E.)	10·6	12·5	1·06	11·8
Delhi (28°N. 77°E.)	13·4	13·0	0·60	...
Chungking (29°N. 107°E.)	23·5	13·0	0·60	...

Comparative Study of Ionospheric Data

A comparison of the ionospheric characteristics over Calcutta with those at other places shows[4] the following latitude and longitude effects:

1. The monthly average mid-day values of ionization for both E and F regions, for stations situated at different latitudes, do not exactly follow the $\sqrt{\cos \chi}$ law. The region E character figure $(f°E)^4/\cos \chi$ decreases from equator to pole.

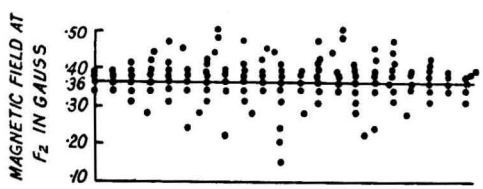


FIG. 2 — VALUES OF THE EARTH'S MAGNETIC FIELD NEAR THE HEIGHT OF THE F_2 REGION AS DEDUCED FROM OBSERVATIONS ON MAGNETIC DOUBLE REFRACTION OF RADIO WAVES REFLECTED FROM THE IONOSPHERE.

2. Stations equally distant north and south of the equator do not possess identical ionospheric characteristics. For such stations the E ionization is consistently greater for the northern hemisphere than for the southern hemisphere.

3. The ionospheric characteristics at Calcutta correspond more to those at Madras than to those at Delhi, although the difference in latitude is 10° for Madras and only 6° for Delhi. This is because the geomagnetic latitude of Calcutta is closer to Madras than to Delhi[5].

Association of Ionospheric Changes with Some Terrestrial & Cosmic Phenomena

Thunderstorm — Strong association of E-region abnormality (occurrence of sporadic E) has been found with the occurrence of thunderstorms (March-July). This is particularly noticeable during the months of April and May when there are frequent nor'-westers towards the afternoon. The thunderstorm data were kindly supplied by the India Meteorological Department.

Solar Eclipse — Variations of E and F_2 ionizations during two solar eclipses (July 20, 1944 and May 9, 1948) have been studied[6]. The E-region ionization was found to decrease as expected. No clearly noticeable change in the F_2 ionization could be found.

From the measurements during the eclipse of July 20, 1944, the value of the effective coefficient of recombination in the E-region heights has been determined[6]. Curves in Fig. 3 show the change of ionization during

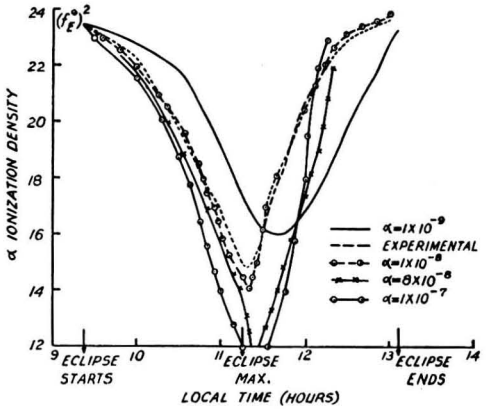


FIG. 3 — VARIATION OF THE MAXIMUM IONIZATION DENSITY OF THE E LAYER DURING SOLAR ECLIPSE OF JULY 20, 1944. THE EXPERIMENTALLY OBSERVED CURVE IS COMPARED WITH THEORETICAL CURVES DRAWN WITH DIFFERENT ASSUMED VALUES OF THE EFFECTIVE RECOMBINATION COEFFICIENT α. FROM THE THEORETICAL CURVE WHICH AGREES BEST WITH THE OBSERVED CURVE, THE VALUE OF α IS ESTIMATED.

the eclipse for four assumed values of α, viz. 1×10^{-9}, 1×10^{-8}, 5×10^{-8} and 1×10^{-7} cm.^{3} per sec. The observed change in ionization density during the eclipse is also plotted on the same graph. It is seen that the observed curve closely fits the theoretical curve for the value of $\alpha=1\times10^{-8}$ cm.^{3} per sec.

Meteoric Shower — Results of earlier observations made in this laboratory[7] that E-region ionization is abnormally increased during periods of meteoric shower have been confirmed. The increase of ionization as produced during a number of showers has been determined. Assuming that each meteor produces 10^{10} ions per cm.^{3} of the track (as calculated by Pierce[8]), the number of meteors on August 11, 1947 was calculated from the recorded data. It was found that about 3,000 meteors fell over an area of 100 metre radius during the maximum of the shower.

Solar Activity — Over the period of our observations, good correlation between the monthly average mid-day f°E and Zürich sunspot numbers was obtained. This is evident from the contour diagram in Fig. 4.

In Fig. 5 average monthly values of f°E for mid-day and f°F_2 for mid-day and midnight are plotted for the period of observation. It will be noticed that the summer noon value of f°E has increased from 4·4 Mc./s. in the sunspot minimum year (1945) to 5·5 Mc./s. in the sunspot maximum year (1947). The noon ionization density thus increased by 50 per cent for region E. The corresponding increase for region F_2 is found to be 80 per cent. It may, therefore, be concluded that the ionizing radiations responsible for producing the E and F_2 regions also increased by 150 per cent and 230 per cent respectively from the sunspot minimum year (1945) to the sunspot maximum year (1947).

The relationship between the variations of f°F_2 and sunspot numbers is approximately linear. Hence the variation of the yearly average value of f°F_2 for each hour of the day, with the variation of the sunspot number, may be represented in the form of a nomogram (FIG. 6). This may be used as follows: Suppose we want to know the yearly average mid-day f°F_2 for the epoch at which sunspot number is 100. We place a

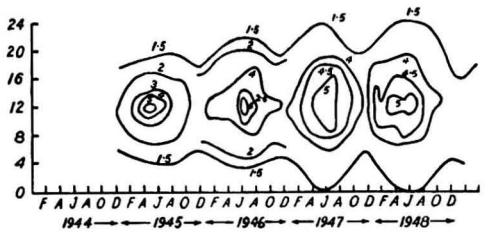


FIG. 4 — CONTOUR DIAGRAMS OF MONTHLY f°E FOR THE PERIOD OF OBSERVATION (1944-48). EACH LINE IS DRAWN THROUGH POINTS REPRESENTING THE SAME VALUE OF THE PENETRATION FREQUENCY. A POINT ON ANY OF THESE LINES GIVES THE PENETRATION FREQUENCY FOR THE HOUR OF THE DAY, AS SHOWN BY THE ORDINATE, AND IN THE MONTH OF THE YEAR AS SHOWN BY THE ABSCISSA. IT WILL BE SEEN THAT THE AREA ENCLOSED BY EACH LINE EXPANDS WITH THE RISE OF SOLAR ACTIVITY.

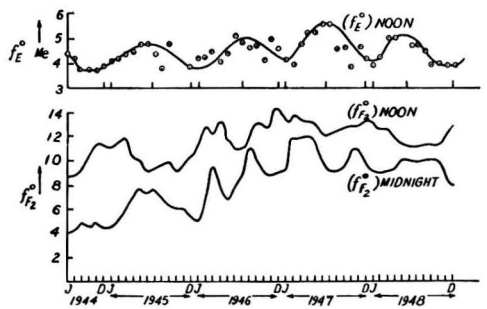


FIG. 5 — VARIATION OF THE MONTHLY AVERAGE VALUES OF ORDINARY-RAY CRITICAL FREQUENCIES FOR E (f°E NOON) AND F_2 (f°F_2 NOON AND f°F_2 MIDNIGHT) REGIONS THROUGHOUT THE PERIOD OF OBSERVATION.

straight edge passing through 100 on the ordinate on the right and the mark 12 on the nomogram. The edge passes through 11·5 on the ordinate on the left. This gives the yearly average sought.

It is to be noted that the nomogram is characteristic of the geographic location of the place of observation (Calcutta).

Ionospheric Disturbance — 27-day Recurrence

Search has been made for any 27-day recurrence tendency of ionospheric disturbances in the F_2 region. This, if established, would correlate F_2-region abnormalities with solar disturbances.

For this purpose the method adopted by Chree[9] to find out the 27-day recurrence period in magnetic disturbances has been followed. The daily mean values of the region F_2 ionization have been calculated for each day of every month for the 3 years, 1947-49, and the following procedure has been adopted : Five days for each month on which the ionosphere appeared to be most abnormal are chosen. The daily mean of the data for each of these five days are arranged in a horizontal column along with the data of five days before that date and

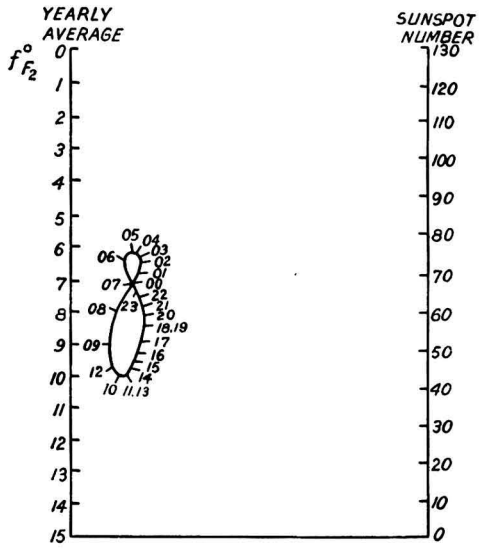


FIG. 6 — NOMOGRAM FOR OBTAINING YEARLY AVERAGE VALUES OF $f^{\circ}F_2$ FOR VARIOUS HOURS OF THE DAY FOR DIFFERENT VALUES OF ZÜRICH SUNSPOT NUMBERS.

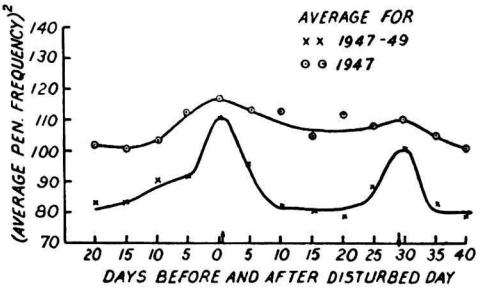


FIG. 7 — ILLUSTRATING 27-DAY RECURRENCE TENDENCY IN IONOSPHERIC ABNORMALITIES.

35 days after, at five days' interval. The data for the different disturbed days are tabulated one below the other. This is continued till all the daily average data are exhausted. From the table so formed we are able to pick up each ionospheric disturbance and look for any periodic repetition of the same disturbance. Fig. 7 shows the graphs obtained from the average of data for (i) one year only (1947) and (ii) three years (1947-49). From the graphs it can easily be seen that there exists a 27-day recurrence period in the repetition of ionospheric abnormality.

A knowledge of the repetition tendency as found above is useful in the prediction of maximum usable frequency for long distance radio transmission.

Acknowledgement

The above work forms part of the programme of the Radio Research Committee of the Council of Scientific & Industrial Research, Government of India. The author is indebted to Prof. S. K. Mitra for his kind help and guidance throughout the progress of the work.

REFERENCES

1. BARAL, S. S. *et al.* : *J. sci. industr. Res.*, 1948, **7**, 59, 392 ; 1949, **8A**, 6, 43, 73, 117, 165, 215, 257, 307, 352, 395, 432, 463 ; 1950, **9A**, 6, 47, 82, 114, 147, 195, 231, 274, 309, 352.
2. SEATON, S. L. : *Phys. Rev.*, 1947, **71**, 712.
3. BEST, N., HAVENS, R. & DURAND, E. : ibid., 1947, **71**, 915.
4. *Series-F Publications of the Central Radio Propagation Laboratory, Washington D.C.*
5. BARAL, S. S., GHOSH, S. N. & DEBRAY, M. : *Nature*, 1948, **159**, 117.
6. BARAL, S. S. & MITRA, S. N. : *Sci. & Cult.*, 1944, **10**, 175.
7. BHAR, J. N. : *Nature*, 1937, **139**, 470.
8. PIERCE, J. A. : *Proc. I.R.E.*, 1938, **26**, 892.
9. CHREE, C. : *Phil. Trans. Lond.*, 1923, **213A**, 245.

Fluidization—A New Technique: Part II

M. S. IYENGAR

Central Laboratories for Scientific & Industrial Research, Hyderabad (Deccan)

AMONG the many types of industrial processes that involve the interaction of solid particles with steam, gas or liquid streams, are gasification of coal, catalytic synthesis of liquid hydrocarbons, catalytic cracking of petroleum, adsorption operations, drying, dissolving, etc. In most cases the bed of solid is " fixed " or confined in an immobile state within a particular apparatus. In an increasing number of cases, the solids are not held immobile by mechanical restraint but are free to move if the forces caused by a flowing stream within the bed so dictate. A bed of solids utilized in this unrestrained condition is properly called a fluidized bed, inasmuch as the solid phase behaves as a pseudo-liquid and solids may be withdrawn from and added to the main body of the fluidized mass through pipes and valves much in the manner of a true liquid.

In a previous paper[1], the advantages of a fluidized bed and the application of fluidization technique to various industrial processes were described. In the present paper an attempt is made to correlate the data available to date on the fundamentals of fluidization.

When a fine granular material is dumped into a vessel, the resulting bed will have a definite bulk density. This density will depend on the shape and size of the particles. If during dumping the sides of the vessel are tapped gently, the particles will pack more densely than under quieter conditions. Let us assume that in Fig. 1 (A) represents a closely packed bed, and when a fluid is admitted to the bottom of the vessel at a low velocity (G_1), a pressure differential Δp_1 will be registered in the manometer. On gradually increasing the velocity of the fluid, the pressure differential will increase until a point of equilibrium is reached when the weight of the bed in the fluid stream equals the fluid pressure differential multiplied by the cross-sectional area of the vessel. Mathematically, it may be expressed as :

$$\Delta p = \frac{V_T}{A_T}(1-\varepsilon)(\rho_s - \rho_f) \quad \ldots\ldots \quad (1)$$

The symbols are defined in Table I.

As the rate of fluid flow increases, the bed begins to expand and this increases the percentage of voids in the bed sufficiently to keep the pressure differential constant, despite the accelerated flow rate. At a certain fluid velocity (G_2), the bed will have expanded to such a density that the individual particles will become disengaged sufficiently from each other to permit internal movement of the particles in the bed. This internal movement is induced by the fluid moving through the interstices of the bed and indicates the start of fluidization. This condition is illustrated by sketch (B, FIG. 1). Like the bulk density which results from dumping the material into the vessel, this limiting bed density, at which fluidization begins, depends also on the size and shape of the particles of the bed and has been termed

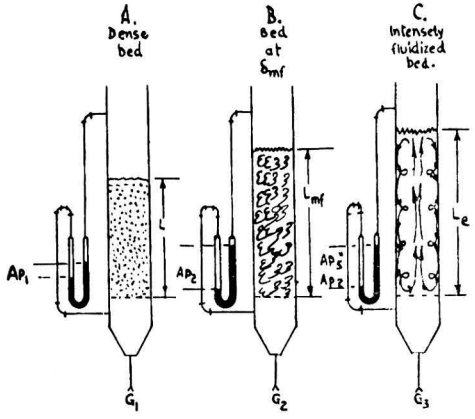


FIG. 1 — OPERATING STAGES OF FLUIDIZED BEDS.

" maximum fluid density ". The fractional voids associated with this condition are termed " minimum fluid voidage ". The concept of minimum fluid voidage is important in predicting the onset of fluidization.

An additional increase in fluid rate (G_3) expands the bed further and intensifies the motion of the particles. The particle movement is, however, not an entirely random one. In fact the fluidized bed resembles somewhat a column of liquid which is heated from the bottom, with the result that co-ordinated convection currents are generated throughout the fluid body. Illustration (C) in Fig. 1 shows schematically these convection currents, which were usually observed to progress downward on the wall of the vessel. For much higher rates of fluid flow, the state of agitation increases still further and the bed resembles a boiling liquid. The fluidization associated with this condition is termed *batch* (*static or non-circulating*) *fluidization.* For still higher flow rates of the fluid, the particles flow out of the vessel co-current to the fluid. The co-current solid fluid flow is termed as *continuous* (*or circulating*) *fluidization.* These basic observations have been reported by Leva and his co-workers[2], Wilhelm and Kwauk[3], as well as Parent, Yagol and Steiner[4].

Recent studies of Valentine[5] on circulating system of large particles in an air stream

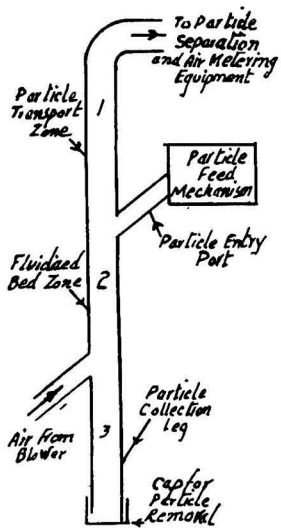


FIG. 2 — APPARATUS FOR STUDYING PNEUMATIC TRANSPORT/FLUIDIZED BED RELATIONSHIPS.

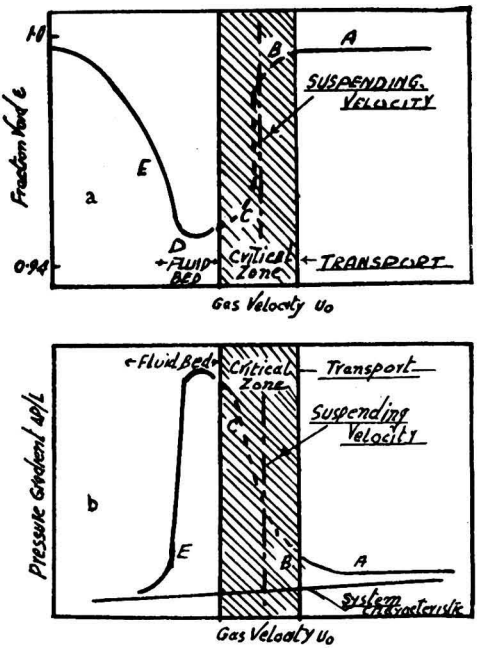


FIG. 3 — INTERDEPENDENCY OF FRACTION VOID, PRESSURE DIFFERENTIAL AND GAS VELOCITY AT A SINGLE SOLID FEED RATE.

establish interesting relationship between pneumatic transport and fluid bed formation. Essentials of the apparatus are illustrated in Fig. 2. It comprises a 4″ glass tube fitted with side ports to permit introduction of a stream of particles and of air. Clay spheres, three sizes within the range 0·24″ to 0·36″ dia., were used. Interdependency of fraction void, pressure differential and gas velocity at a single solid feed rate is illustrated in Fig. 3. Gas velocity varied between 0 and 90 ft./sec.

At high air velocities, A, all particles are transported upward and out of the equipment. Particle concentration in section 1 is sparse and does not vary greatly with fluid velocity changes. There is co-current flow of gas and particles. As air velocity is decreased to condition B, an increase in particle concentration takes place in section 1, solid and air continue to flow through the section. There is a tendency for the particles to collect and fall abruptly as an accumulated group from upper section 1 of the apparatus to lower section 2. Thereafter, at lower velocities than this critical

value, the movement of particles is downward in counter-current flow to the air. A relatively high particle density is immediately formed in section 2, Fig. 2, at condition C in Fig. 3. In the critical zone, the change from co-current to counter-current flow occurs rapidly and cannot be measured properly. In Fig. 3 the zone is hence demarcated. A minimum in bed voidage is measured at D, at a velocity less than the suspending velocity for individual particles. As velocity is decreased further towards E, the particle concentration of the bed decreases markedly as shown by the rising fraction void curve. The entire sequence of events is reversible. Thus, on the basis of these observations, one can conclude that fluidized bed is formed as a transition state between co-current upward pneumatic transport and counter-current downward fall of particles.

Batch (or Non-circulating) Fluidization

Papers by Max Leva and his co-workers[2,6-8] Wilhelm and Kwauk[3,9], Morse[10] and Matheson, Herbst and Holt[11] provide the most satisfactory theory and criteria for batch fluidization presented to date.

Fluidization is characterized by counter-gravity flow of fluids through beds of fine, solid particles. In an analysis of pressure drop-fluid velocity relations of such a system, it has been observed by a number of workers that the bed begins to expand at a definite fluid velocity. Although the pressure drop increases steadily with the fluid velocity for flow through unexpanded bed, it remains essentially constant. The equation (1) holds good in this system also.

The validity of equation (1) was tested by many investigators[2-4,12] and found to be independent of such system properties as material density, shape and size of particles, weight-size distribution of the charge, geometry of the vessel, fluid density and viscosity. Particle size ranges supporting equation (1) extend from 600-mesh or more[4] through fine-grained sands and iron Fischer-Tropsch catalysts[2,5,6] up to particles 0·25″ in dia.[3]. Various gases as well as water were used as vehicles, and vessel diameters varied between 1″ to 6″.

Leva and his co-workers used 2·5″ and 4″ columns and worked with round and sharp sand particles in the range of 0·002″ to 0·015″ dia. and with anthracite coal, using air, carbon dioxide and helium as fluidizing gases.

The correlation developed by Leva and his co-workers is based on Carman's equation for laminar flow in a fixed bed[13], modified by assuming a constant pressure drop for the fluidized bed. Carman's equation for streamline flow region is :

$$G=\frac{\rho_f \varepsilon^3 \Phi_s^2 D_p^2 \Delta p g_c}{180\,(1-\varepsilon)^2 \mu L} \quad \ldots\ldots\ldots \quad (2)$$

Replacing L by L_f for the fluidized bed and rearranging the above equation in the following steps :

$$G \times \frac{\mu L_f}{\rho_f} = \frac{\varepsilon^3}{(1-\varepsilon)^2} \times \frac{\Delta p g_c \Phi_s^2 D_p^2}{180} \quad \ldots\ldots \quad (3)$$

$$G \times \frac{\mu}{\rho_f} \times LN_v = \frac{\varepsilon^3}{(1-\varepsilon)^2} \times \frac{\Delta p g_c \Phi_s^2 D_p^2}{180} \quad \ldots \quad (4)$$

$$G \times \frac{\mu}{\rho_f} \times \frac{1-\varepsilon_o}{1-\varepsilon} = \frac{\varepsilon^3}{(1-\varepsilon)^2} \times \frac{\Delta p g_c \Phi_s^2 D_p^2}{180\,L} \quad \ldots \quad (5)$$

$$\text{or} \quad G \times \frac{\mu}{\rho_f} N_v = K \left(\frac{\varepsilon^3}{(1-\varepsilon)^2} \right)^m \quad \ldots\ldots \quad (6)$$

As all the other terms on the right-hand side are assumed to be constant, m = 1·0, if the fluidized bed follows Carman's equation. Use of this analysis indicated that particles of comparatively larger diameter obeyed equation (2) ; whereas, with smaller materials, deviations were observed that became progressively more significant as the particle diameter decreased. From these observations Leva and his co-workers concluded that smaller particles require an extra amount of energy for fluidization. The ratio of this " extra energy " to the total energy supplied was called " fluidization efficiency ". They correlated the fluidization efficiency to particle size and finally obtained the following expression :

$$\eta = (G_f - G_e)/G_f \quad \ldots\ldots\ldots \quad (7)$$

Wilhelm and Kwauk have studied the fluidization characteristics of sand, glass beads, lead shots, crushed stones and Sconony catalyst beads in water and air. Particle size range was from 0·11″ to 0·21″. The apparatus used consisted of a glass tube provided with a metal screen to support the bed of particles. The essentials of the apparatus are shown in Fig. 4. Columns of 3″ and 6″ dia. were used. The general procedure has been to correlate the pressure gradient, fluid velocity and fraction voids

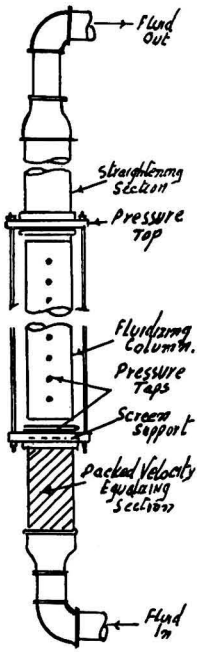


FIG. 4 — APPARATUS FOR FLUIDIZATION STUDIES.

by means of dimensionless groups, as shown by the following equations :

$$N_{Re,W}=\frac{D_pG}{\mu}=N_{Re,C}(1-\varepsilon)/\Phi_s \quad \ldots\ (8)$$

$$\varepsilon=\frac{L_f-L_a}{L_f} \quad \ldots\ (9)$$

$$K\Delta p=\frac{\Delta pD_pg_c\rho_f}{L_a.2G^2}\left(\frac{D_pG}{\mu}\right)^2=\frac{\Delta pD_p^3\rho_fg_c}{L_a.2\mu^2} \quad (10)$$

$$K_{\Delta p}=\frac{(\rho_s-\rho_f)D_pg\rho_f}{2G^2}\left(\frac{D_pG}{\mu}\right)^2=\frac{(\rho_s-\rho_f)D_p^3\rho_fg}{2\mu^2} \quad \ldots\ (11)$$

The correlations derived are based on the assumption that a granular bed is equivalent to parallel channels. They employed $K_{\Delta p}$ which is essentially the product of a friction factor and the square of a Reynolds number, and Reynold number as prime variables for correlating data and introduced fraction voids as parametric curves.

Wilhelm and Kwauk[3] noted an important difference between fluidization with water and fluidization with air. In the former case, the bed is made of well-dispersed particles, and the water rises between the individual particles. In the latter case, however, the particles are not well dispersed, but tend to agglomerate into clumps or aggregates, which tend to move to one side and allow the gas to pass as a " bubble " or else are carried upwards as slugs by the gas. The first case is termed as particulate fluidization and the second, aggregative. The difference between the two cases is one of difference in the degree of segregation. Morse[10] and Matheson, Herbst and Holt[11] have treated the degree of segregation as a result of a dynamic balance between (i) the segregation tendency, or rate of separation of fluid from particles and (ii) the remixing tendency, or rate of gravity flow of particles into fluid pockets. Morse treated the segregation tendency as a fluid flow problem by applying the Carman equation for flow through fixed packed beds to adjacent zones in a fluidized bed and obtained the following equation :

$$u_o=\frac{L_f(\rho_s-\rho_f)(\varepsilon_2-\varepsilon_1)g_c\varepsilon_3^2}{\mu a^2.5L_1} \quad \ldots\ (12)$$

The equation indicates that segregation is self accelerating and is greater in deeper beds. Segregation is favoured also by large particle size and density, by large difference in density between particles and fluid, and by small fluid viscosity.

Matheson, Herbst and Holt[11] measured relative viscosities of cracking catalysts, sand and metal oxides in a Stormer rotating viscometer and found that for narrow size cuts viscosity decreased with particle size. Viscosity was theoretically found to be a function of the volume within which a particle can move freely in the more dense part of the fluidized bed.

Continuous (or Circulating) Fluidization

Data on continuous fluidization are scarce and the papers dealing with this are by Lewis, Gilliland and Bauer[14] and Satyanarayan and Iyengar[15,16].

The test apparatus used by Lewis and his co-workers consisted of 10′ of 1¼″ internal dia. brass tubing. Glass beads were introduced in the bottom of the section together with the fluidizing air. A cyclone separator at the top permitted return of entrained disperse phase to solid feed standpipe. They determined the average solid density (solid

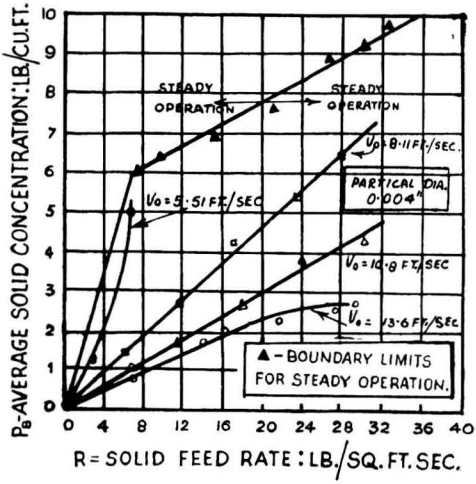


FIG. 5 — DETERMINATION OF AVERAGE SOLID DENSITY (SOLID CONCENTRATION) FOR DIFFERENT SOLID FEED RATES.

concentration) for different solid feed rates and obtained graphs similar to that shown in Fig. 5. The graph also indicates the boundary of steady and unsteady operation regions. In the steady region, the experimental conditions could be maintained for a longer duration without any significant variations. In all cases, the solid concentrations obtained for a given solid were lower than those for batch fluidization.

Satyanarayan and Iyengar[15,16] have measured solid concentrations in a circulating system at different air velocities. The test section of their apparatus consisted of 4′ height of nearly 1″ dia. pyrex glass tubing. Singareni coal was introduced in the bottom of the section through a screw conveyer run by a geared electric motor. The coal particles were fluidized by the upward flow of air. The essentials of their apparatus are shown in Fig. 6. The coal particle sizes used ranged from 0·0038″ to 0·0071″. The graph obtained by them showing the effects of particle size and of air velocity is indicated in Fig. 7. They found that the solid concentration is maximum at low air velocities and decreases as the flow of air is increased. The data also showed that the bed density (solid concentration) increases with increasing particle size.

Basing their interpretation on the postulated balance between (i) the segregation tendency and (ii) the mixing tendency in fluidization as put forward by Wilhelm, Morse, Matheson and others, Satyanarayan and Iyengar explained their above observations as follows: With increase in air velocity,

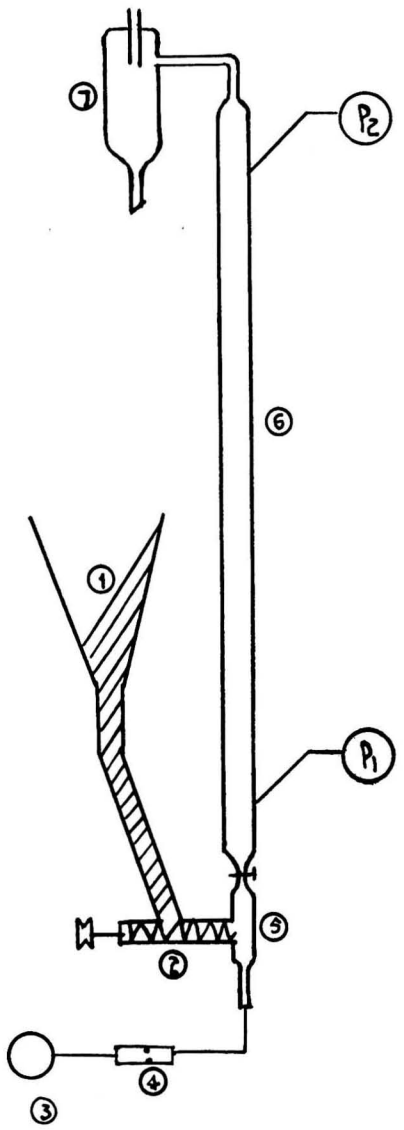


FIG. 6 — APPARATUS FOR CONTINUOUS FLUIDIZATION : (1) FEED BUNKER ; (2) SCREW CONVEYER ; (3) COMPRESSOR ; (4) ORIFICE FLOW METER ; (5) MIXER CHAMBER ; (6) FLUIDIZING COLUMN ; (7) CYCLONE SEPARATOR ; AND (8) P_1, P_2, PRESSURE TAPS.

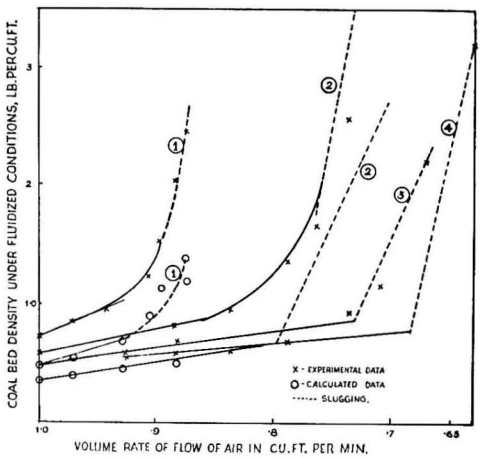


FIG. 7 — FLUIDIZED BED DENSITY VS. AIR FLOW RATES FOR EXPERIMENTAL VALUES OF BED DENSITIES: (1) COAL PARTICLES, 52/60 MESH 52/60 (B.S.S.); (2) COAL PARTICLES, 60/85 MESH; (3) COAL PARTICLES, 85/100 MESH; (4) COAL PARTICLES, 100/150 MESH; COAL FEED RATE, 140 GM. PER MIN. IN ALL CASES.

the tendency for segregation of particles is reduced and the balance between the dispersive forces tilts in favour of particulate fluidization resulting in the decrease of bed density. In the same way with increase in particle size, the tendency for segregation is increased and the balance now tilts in favour of aggregative fluidization resulting in an increase of bed density.

Time of Residence

Parent, Yagol and Steiner[4] derived an expression for calculating the probable time of residence of a particle of fluidized solid within a reactor continuously operated. They considered a system of fluidized solids where fresh material was constantly introduced at a fixed rate, perfect mixing was taking place, and material was continuously withdrawn at such rate as to keep a fixed quantity in the system. The final expression they derived was:

$$X = e^{-\frac{\theta}{\theta_H}} \quad \ldots\ldots\ldots\ldots (13)$$

where X was the fraction of particles originally present and were still present in the reactor after time θ, and θ_H was the average holding time or time required to introduce a fresh charge in the reactor equal to that originally present at a rate equal to the total withdrawal rate.

Head Loss Calculations

Parent, Yagol and Steiner[4] also derived an expression for calculating the head loss in a fluidized bed by assuming that the head loss was due to (i) "hydrostatic" or suspension head of the solid and (ii) the complex motions of the gas and particles.

If V is the volume of the solid particles exclusive of voids, D the inner diameter and m and ρ_s are the mass and true density of the solid respectively, then:

$$V = \frac{\pi}{4} D^2 Z_o = \frac{m}{\rho_s} \quad \ldots\ldots\ldots (14)$$

$$\text{or} \quad Z_o = \frac{4m}{\pi d^2 \rho_s} \quad \ldots\ldots\ldots (15)$$

where Z_o is the hypothetical height of the void-free solid substance in the tube.

To obtain the head loss expression in terms of manometer reading, Z_o is multiplied by the ratio of the densities of the solid and manometer fluid, whence the pressure drop:

$$Z^1 = \frac{4m}{\pi d^2 \rho_f} \quad \ldots\ldots\ldots (16)$$

TABLE I — NOMENCLATURE

A_T	= cross-sectional area of fluidization vessel (sq. ft.)
D_p	= diameter of sphere of the same volume as that of the particle (ft.)
g_c	= conversion factor, 32·17 (ft.) (lb.)/(lb. force) (sec.)^2
g	= local acceleration due to gravity, ft./(sec.)^2
G	= superficial mass velocity (based on gross cross-sectional area of empty tube), lb./(sec.) (sq. ft.)
k	= empirical correlation factor (dimensionless)
$K_{\triangle p}$	= Wilhelm and Kwauk's correlating factor based on friction factor in granular beds (dimensionless)
L	= height of settled bed (or length of pipe), (ft.)
L_f	= height of fluidized bed (ft.)
L_a	= height of hypothetical bed containing no voids (ft.)
L_t	= length of the flow path between segregation zones (ft.)
m	= exponent on $\frac{\epsilon^3}{(1-\epsilon)}$ in Leva's fluidization correlation (dimensionless)
n	= exponent on Reynolds number to correlate with friction factor (dimensionless)
N_V	= expansion ratio = $\frac{\text{expansion bed volume}}{\text{settled bed volume}}$ = $(1-\epsilon_o)/(1-\epsilon)$
$N_{Re,\,C}$	= Reynolds number = $\varphi_s D_p G/\mu (1-\epsilon)$ (dimensionless)
$N_{Re,\,W}$	= Reynolds number = $D_p G/\mu$ (dimensionless)
$\triangle p$	= pressure drop, lb./sq. ft.

TABLE I — NOMENCLATURE (*contd.*)

a	= surface area of particles per unit volume of packed space (sq. ft./cu. ft.)
u_o	= superficial velocity of fluid through the bed (ft./sec.)
ϵ	= fraction of voids in the bed of particles (dimensionless)
ϵ_o	= fraction of voids in the settled bed
ϵ_1, ϵ_2	= average fractions of voidage in columns above two neighbouring zones, 1 and 2
μ	= fluid viscosity, absolute, lb. mass/(ft.) (sec.)
φ_s	= Carman's shape factor for securing the specific surface of non-spherical particles
ρ_f	= fluid density, lb. mass/cu. ft.
ρ_s	= true (not bulk) particle density, lb. mass/cu. ft.
η	= fluidization efficiency (dimensionless)
V_T	= dumped volume of packed material in column (cu. ft.)

Acknowledgements

The author wishes to acknowledge with thanks the help and assistance of Mr. G. Satyanarayan Rao in the preparation of this paper. The author also wants to take this opportunity of thanking Dr. Husain Zaheer for taking a keen interest in this subject and for permitting this paper to be published.

REFERENCES

1. IYENGAR, M. S. : *J. sci. industr. Res.*, 1950, **9A,** 314.
2. LEVA, M., GRUMMER, M., WEINTRAUB, M. & POLLCHIK, M. : *Chem. Eng. Prog.*, 1948, **44** 511, 619.
3. WILHELM, R. H. & KWAUK, M. : ibid., 1948, **44,** 201.
4. PARENT, J. D., YAGOL, N. & STEINER, C. S. : *Chem. Eng. Prog.*, 1947, **43,** 429.
5 VALENTINE : Thesis, School of Engineering, Princeton University, 1949.
6. LEVA, M., GRUMMER, M., WEINTRAUB, M. & STORCH, H. H. : *Chem. Eng. Prog.*, 1948, **44,** 70.
7. LEVA, M., GRUMMER, M. & POLLCHIK, M. : *Ind. Eng. Chem.*, 1949, **41,** 1206.
8. Idem. : *Chem. Eng. Prog.*, 1949, **45,** 563.
9. WILHELM, R. H. : *Research*, 1950, **3,** 159.
10. MORSE, R. D. : *Ind. Eng. Chem.*, 1949, **41,** 1117.
11. MATHESON, G. L., HERBST, W. A. & HOLT, P. A. : ibid., 1949, **41,** 1099.
12. HATCH, L. P. : *Trans. Am. Geophys. Union*, 1943, 536.
13. CARMAN, P. C. : *Trans. Inst. Chem. Eng.* (London), 1937, **15,** Part I, 150.
14. LEWIS, W. K., GILLILAND, E. R. & BAUER, W. C. : *Ind. Eng. Chem.*, 1949, **41,** 1104.
15. SATYANARAYAN RAO, G. & IYENGAR, M. S. : *Proceedings of the All-India Symposium on Fuels*, Hyderabad (Dn.), 1950 (in press).
16. Idem. : Paper communicated to the 38th Indian Science Congress, 1951.

Non-Technical Notes

MANUFACTURE OF BENZIDINE, *p*-AMINOPHENOL & 2 : 4 DIAMINOPHENOL

INDIA IMPORTS EVERY YEAR 12 TO 20 million lb. of various synthetic dyestuffs valued at about 4 crores of rupees in the pre-war years, and rupees 12 crores at the present time. Direct cotton colours, such as congo red, form one-sixth of this quantity.

Benzidine is one of the important intermediates used in the manufacture of direct cotton colours. In the manufacture of congo red, the most extensively used direct cotton dye in India (annual import, one million lb.), benzidine is required to the extent of about 30 per cent by weight of the dye.

Investigations have been carried out under the auspices of the Council of Scientific & Industrial Research to study the possibilities of manufacturing benzidine in the country. The process developed has distinct advantages over the known ones. The use of expensive metals and chemicals for reduction has been eliminated by the adoption of an electro-chemical process. Optimum operating conditions have been worked out to obtain high efficiencies and yields.

The basic raw material used in this process is nitrobenzene, which is now manufactured in India and is available in commercial quantities. Nitrobenzene is electrolysed in the presence of caustic soda and a suitable catalyst. The product obtained, hydrazobenzene, is extracted with a solvent and subsequently converted into benzidine by treatment with acid. Benzidine is separated in the form of the sparingly soluble sulphate

which is reconverted to benzidine by treatment with soda ash solution. The solution is concentrated under vacuum and cooled when benzidine separates out.

Two important products, *p*-aminophenol and 2 : 4-diaminophenol, which are also used as dye intermediates, are manufactured from nitrobenzene, and with the same type of equipment as is used in the manufacture of benzidine. In addition to its use as a dye intermediate, *p*-aminophenol is an important photographic chemical, being used as a developer, either by itself or, after further processing, as Metol. It is also used in the manufacture of a large number of fine chemicals and drugs including phenacetin. 2 : 4-Diaminophenol is also a valuable photographic developer, sold under various trade names, e.g. Amidol and Diamol.

In view of the fact that these two important products are manufactured from the same basic raw material and with the same type of equipment, it would be advantageous to take up the manufacture of these materials along with benzidine in the same establishment so as to reduce overhead charges and production costs. Processes for the manufacture of *p*-aminophenol and 2 : 4-diaminophenol also have been worked out under the auspices of the C.S.I.R., and the new processes are superior to the known manufacturing processes in simplicity of operation, high yields, purity of products and low costs.

p-Aminophenol — For the manufacture of *p*-aminophenol, nitrobenzene is electrolysed in the presence of sulphuric acid and a suitable catalyst. *p*-Aminophenol is the main product obtained ; small quantities of aniline are obtained as a byproduct. Unreacted nitrobenzene, and aniline are separated from *p*-aminophenol by steam distillation in the presence of suitable chemical reagents. The solution is concentrated under vacuum, and cooled, when crystals of *p*-aminophenol separate out.

2 : 4-*Diaminophenol* — 2 : 4-Diaminophenol is obtained as the sulphate by electrolysing *m*-nitraniline in the presence of sulphuric acid and a catalyst, and the solution is concentrated under controlled conditions. As the sulphate can be used directly, both in photography and in dyeing, it is not necessary to prepare the free base.

m-Nitraniline required for this purpose is prepared by the usual chemical process (nitrobenzene → *m*-dinitrobenzene → *m*-nitraniline).

Capital Expenditure

A factory with a daily production capacity of 120 lb. of benzidine, 66 lb. of *p*-aminophenol and 72 lb. of 2 : 4-diaminophenol is considered to be an economical unit for the manufacture of these products.

The building and certain items of plant equipment are common to all the three products, and the estimated costs of these items are as follows :

	Rs.
1. Building with a floor space of 6,000 sq. ft.	72,000
2. Motor generator set to supply direct current to the electrolytic cells	30,000
3. Boiler to supply process steam	15,000
4. Vacuum shelf-drier for drying the solid products	9.000
Total	1,26,000

The main items of equipment required for the individual processes are :

BENZIDINE

	Rs.
Electrolytic cells, 6 (5 in operation and 1 stand-by)	4,800
Auxiliary electrical equipment (power cables, bus bars, switchgear, etc.)	5,000
Steam-jacketed, lead-lined, C.I. digestor	2,000
Centrifuge (18″ stoneware, basket), complete with motor drive	10,000
Vacuum evaporation equipment	12,000
Solvent recovery equipment	8,000
Settling tanks, neutralizers, crystallizers, etc.	6,000
General services : water and steam mains, lighting, etc.	10,000
Erection expenses and contingencies	10,000
	67,800

p-AMINOPHENOL

	Rs.
Electrolytic cells, 4 (3 in operation and 1 stand-by)	3,200
Auxiliary electrical equipment	3,000
Steam distillation equipment	8,000
Vacuum evaporation equipment	9,000
Settling tanks, neutralizing tanks, crystallizers, etc.	6,800
General services	5,000
Erection expenses and contingencies	8,000
	43,000

2 : 4-DIAMINOPHENOL

	Rs.
Nitration equipment	15,000
Reduction units	3,000
Electrolytic cells, 3	2,400
Auxiliary electrical equipment	2,000
Steam distillation equipment	8,000
Vacuum evaporation equipment	9,000
Filter press	6,000
Miscellaneous equipment (acid-proof settling tanks, neutralizers, crystallizers, etc.)	12,000
General services	10,000
Erection expenses and contingencies	15,000
	82,400

TOTAL CAPITAL INVESTMENT

	Rs.
Building (excluding site)	72,000
Common plant equipment (M.G. set, boiler, etc.)	54,000
Individual plant equipment :	
Benzidine	67,800
p-Aminophenol	43,000
2 : 4-Diaminophenol	82,400
Working capital to cover operating expenses for two months	90,000
	4,09,200

Working Costs

BENZIDINE

(120 lb. per day basis)

Material	*Qty. reqd.*	*Rate,* Rs.	*Cost,* Rs. a. p.
Nitrobenzene	200 lb.	96/- per cwt.	171 6 0
Caustic soda	240 ,,	26/- per cwt.	55 12 0
Hydrochloric acid	200 ,,	20/- per cwt.	35 12 0
Sulphuric acid	60 ,,	11/- per cwt.	5 14 0
Xylene	45·4 gal.	6/4 per gal.	283 12 0
Lead oxide	20 lb.	-/15/- per lb.	18 12 0
Soda ash	72 ,,	16/- per cwt.	12 14 0
			584 2 0
Rebate for the recovery of 95% caustic soda, xylene and lead oxide			340 6 0
			243 12 0
Electrical energy, 750 kWh. @ -/1/- per unit			46 14 0
Steam, water, etc.			50 0 0
			340 10 0
Labour and supervision			60 0 0
Depreciation on plant equipment (15% on Rs. 92,800 for 300 days)			46 6 0
Depreciation on building (5% on Rs. 24,000 for 300 days)			4 0 0
Interest on investment (5% on Rs. 1,46,800 for 300 days)			24 10 0
Overheads			50 0 0
			525 10 0

Cost of production, Rs. 4-6-0 per lb. (naked)

p-AMINOPHENOL

(66 lb. per day basis)

Material	*Qty. reqd.,* lb.	*Rate,* Rs.	*Cost,* Rs. a. p.
Nitrobenzene	122	96/- per cwt.	112 0 0
Sulphuric acid	171	11/- per cwt.	16 13 0
Soda ash	147	16/- per cwt.	21 0 0
Copper sulphate	0·6	-/7/- per lb.	0 4 0
			150 1 0
Credit for aniline, 18 lb. @ Re. 1/- per lb.			18 0 0
			132 1 0
Electrical energy, 450 kWh. @ -/1/- per unit			28 2 0
Steam, water, etc.			40 0 0
			200 3 0
Labour and supervision			50 0 0
Depreciation on plant equipment (15% on Rs. 61,000 for 300 days)			30 8 0
Depreciation on building (5% on Rs. 12,000 for 300 days)			2 0 0
Interest on investment (5% on Rs. 93,000 for 300 days)			15 8 0
Overheads			20 0 0
			318 3 0

Cost of production, Rs. 4-13-0 per lb. (naked)

2 : 4-DIAMINOPHENOL

(72 lb. of sulphate per day)

Material	*Qty. reqd.,* lb.	*Rate,* Rs.	*Cost,* Rs. a. p.
Nitrobenzene	100	96/- per cwt.	85 11 0
Nitric acid	98	60/- per cwt.	52 8 0
Sulphuric acid	1,040	11/- per cwt.	102 2 0
Hydrochloric acid	161	20/- per cwt.	28 12 0
Sodium sulphide	124	32/- per cwt.	35 7 0
Sodium bicarbonate	124	30/- per cwt.	33 4 0
Soda ash	247	16/- per cwt.	35 4 0
Copper sulphate	2·7	-/7/- per lb.	1 3 0
			374 3 0
Electrical energy, 272 kWh. @ -/1/- per unit			17 0 0
Steam, water, etc.			60 0 0
			451 3 0
Labour and supervision			80 0 0
Depreciation on plant (15% on Rs. 90,400 for 300 days)			45 3 0
Depreciation on building (5% on Rs. 36,000 for 300 days)			6 0 0
Interest on investment (5% on Rs. 1,69,000 for 300 days)			28 2 0
Overheads			60 0 0
			670 8 0

Cost of production, Rs. 9-5-0 per lb. (naked)

REVIEWS

PIEZOELECTRIC CRYSTALS AND THEIR APPLICATION TO ULTRASONICS, by Warren P. Mason (Macmillan & Co. Ltd., London & D. Van Nostrand Co. Inc., New York), 1950, pp. xi + 508. Price 56*s*. & $ 7.50

This is a recent addition to the Bell Laboratories' Series and, like its predecessors, makes a valuable contribution to the scientific literature. The work is not intended to be a comprehensive treatise either on the subject of piezoelectricity or on ultrasonics, but aims at presenting, in a consolidated form, advances made in the field during the last decade with particular reference to the development of new synthetic crystals and the theory of ferroelectricity.

The subject-matter of the book has not been introduced from the historical point of view but by way of introduction to the subject; the first three chapters deal with crystallographic systems and crystal constants. Four of the subsequent chapters deal in greater details with properties and uses of quartz, Rochelle salt, ammonium dihydrogen phosphate (ADP), potassium dihydrogen phosphate (KDP), ethylene diamine tartarate (EDT) and dipotassium tartarate (DKT). The subject is dealt with from the theoretical and experimental points of view. Theory of ferroelectricity in Rochelle salt, barium titanite and dihydrogen phosphate developed by the author is dealt with at length.

After discussing the theory in detail, the last three chapters of the book are devoted to describing methods of producing and measuring ultrasonics in liquids and solids and to the knowledge obtained from such measurements. An appendix dealing with the application of tensors to the equations of liquids, gases and solids is an important feature of the work.

The book presents for the first time in a consolidated form the results of researches in the above field carried out during recent years. It fulfils a keenly felt want for such a book and will be greatly appreciated by those working on the subject.

S.P.

SOILS — THEIR PHYSICS AND CHEMISTRY, by A. N. Puri (Reinhold Publishing Corpn., New York), 1949, pp. 550, Figs. 61. Price $ 7.00

This book is mainly a record of the author's researches in soil during the past 25 years. It is divided into three parts: chemistry of soil, mechanical analysis of soils, and soil moisture. There are altogether 58 chapters. The author conceives of the soil, freed from all extraneous matter, as mixture of simple ferroaluminosilicic acids, in which the hydrogen atoms are held by primary valences. With this concept he has tried to interpret the vast data he has collected on the physico-chemical properties of soils. It is disappointing to find very few references to the work of other investigators on these lines, but this omission, the author explains, is " to avoid controversial topics ".

The book, on the whole, is very well written and the excellent mode of presentation will certainly be appreciated by the students of soil science for whom it is meant. There are, however, some irregularities in a few instances which might have been avoided. For example, in the measurement of soil acidity by hydrogen electrode against a calomel half cell, *p*H has been given straightaway as observed

$$\frac{\text{E.M.F.} - 0{\cdot}246}{{\cdot}0591}$$

No mention has been made that the value, specially the denominator, is dependent on temperature. Again, a statement like " a colloidal solution should not be regarded as a heterogenous system, but as a homogeneous, molecular solution of its surface molecules " (p. 61) may be confusing to a student.

The printing, binding and general production are up to the publisher's usual high standards.

The book should find a place in the library of all agricultural colleges and institutions and should prove valuable to every student and worker in soil science.

S. P. RAYCHAUDHURI

STRUCTURAL CHEMISTRY OF INORGANIC COMPOUNDS, Vol. I, by Walter Hückel, Translated from German by L. H. Long (Elsevier Publishing Co. Inc., New York & London), 1950, pp. xii + 437. Price $ 9.00

This volume is a translation of Books I and II of the treatise *Anorganische Strukturchemie* by the well-known author of *Theoretische Grundlagen der organischen Chemie.* Book I, starting with a short introduction to stoichiometry and chemical affinity, gives a masterly presentation of the principles of Werner's co-ordination theory, including sections on mono and multi-nuclear co-ordination complexes, polyhalides, metaphosphates, iso and hetero-poly acids. Book II begins with a 66-page chapter on the periodic system and atomic structure, followed by a succinct review of the theories and applications of major physical methods for the study of the structure of inorganic compounds. The book closes with a short chapter on the chemical bond outlining the Hund-Mülliken concept of molecular orbitals and a brief critical discussion on Pauling's concept of quantum-mechanical resonance.

One can easily differentiate between the scope and object of this treatise and of its well-known English counterpart, viz. *Structural Inorganic Chemistry* by A. F. Wells (Clarendon Press, 1945), by the much greater emphasis laid here on the chemical constitution, derivable wherever possible by chemical means, than on the "crystallographic" structure obtained by purely physical methods. He rightly suggests that the inorganic chemist should enter the wonder world of crystal chemistry *not* by the way of the crystallographers and mineralogists, but by a planned extension of Werner's theory of co-ordination, thereby maintaining a point of contact with his past observations and elaborating into the new field of activity as a logical necessity. The present treatise, according to him, "attempts to furnish inorganic chemistry with a structural and constitutional theory in one embracing representation, — a system founded upon properties that are governed by constitutional peculiarities". He explains why the periodic system alone does not serve one to find one's way through the maze of facts in inorganic chemistry because it is essentially a systematization of the elements and *not* of compounds, where many close relationships of chemical behaviour, e.g. between Al^{+++} and Fe^{+++}, Mg^{++} and Fe^{++}, have been ignored unavoidably.

The reviewer was struck by the exactitude of the author in the collection and presentation of useful data on the multifarious topics discussed in the book and their cautious and critical appraisal. In going through the book, which was a rare pleasure, he was reminded of Werner's classic work *Neure Anschauungen,* and felt what has been so ably put by the publishers — that there are not many people alive who could have written a book of this calibre.

Small misprints are noticeable on pages 145, 155, 160, 176, 221, etc. A brief discussion on ultra-violet absorption spectra might possibly have been included in the chapter on physical methods for investigating chemical bonding. A treatment of the Pauling-Slater bond of localized electron pairs in the closing chapter was desirable.

J. GUPTA

THE FUNDAMENTALS OF ELECTROMAGNETISM, Second Edition, by E. G. Cullwick (Macmillan & Co. Ltd., London), 1949, pp. xxvi + 327. Price 18*s*.

This is the second edition of the book first published in 1939 and the subject-matter with few exceptions remains practically unaltered. The book has been written specially for the benefit of the young engineering students and lays emphasis on the essential unity of the phenomenon of electricity and magnetism. The author appears to feel that this point of view has unfortunately been lacking in the training of the electrical engineering students with the result that the latter's knowledge is often disjointed and confused. This is a view which is shared by many and the author, therefore, deserves our thanks for having satisfied this need so ably and so well. For practical reasons the author does not propose any drastic changes in the present-day methods of undergraduate teaching in engineering colleges, but he would like the fundamental point of view to be increasingly emphasized.

Chapter I starts with a brief outline of the theory on atomicity of matter and describes the properties of electrostatic field based on the laws of Coulomb and Gauss. The basic

ideas of Maxwell on displacement currents and polarization may appear a little abstract to students starting on the subject for the first time but the author has spared no pains to present them in a clear and attractive manner.

Chapter II is devoted to the discoveries of Oersted and Faraday on magnetic fields and electromagnetic induction. Physical processes occurring in generators, electric motors and transformers are discussed. The discussion of the magnetic field produced by a moving charge is continued in chapter III. The usual relations are obtained and the chapter ends with the derivation of the fundamental relations on inductances. Chapter IV is entitled " Ferromagnetism " and describes the principles of electromagnet, hysteresis loss in ferromagnetic substances, magnetomotive force and the theory of permanent magnets. Illustrative examples, which are fully worked out, will be specially appreciated by the engineering student. The author is a strong supporter of the M.K.S. systems, and while recognizing that a complete change-over, however desirable, to the system can be brought about only gradually, he has, wherever possible, used it in solved examples. The last chapter discusses the theory of electromagnetic waves and the Vector potential of the electric current. This chapter, though necessarily short for a subject of such immense importance, will be found most illuminating by the reader who wishes to get a deeper understanding into the phenomena of electricity and magnetism. For those who propose to follow the subject further, references are given as footnotes.

The book, though primarily written for the engineering student, will also be found useful by students of pure physics as it lays stress on the fundamental rather than on engineering applications. However, as the descriptive portions of instruments have been left out, it will not completely serve the purpose of a text-book for undergraduates in physics. The author, however, cannot be blamed for this as he never had this class of students in mind. On the other hand, it will, in many ways, satisfy the need of the student of applied mathematics and will be specially appreciated by those who have read the books of Jeans and Ramsey on electricity and magnetism.

P.K.K.

THE IDENTIFICATION OF MOLECULAR SPECTRA, by R. W. B. Pearse & A. G. Gaydon (Chapman & Hall Ltd., London), First Edition, 1941, revised 1950, pp. xxi + 276. Price 50*s*. net

The Identification of Molecular Spectra, by R. W. B. Pearse and A. G. Gaydon, hardly needs any introduction, particularly as it has proved indispensable to pure spectroscopists as well as chemists and astrophysicists ever since its first appearance ten year ago. As interest in investigations in molecular spectra has increased in extent and importance in recent years, it is very appropriate that the authors should have thought of bringing out this revised volume. In so doing they have endeavoured to incorporate data that accumulated till November 1949, though they originally planned to collect information only up to 1947. In the new edition no major alterations are made in the arrangement of the material. As before, it mainly consists of a table of persistent band heads, information about the occurrence, appearance and transition of the individual band systems and reproductions of some band spectra of general interest. As the authors point out, it is important to remember that references to the various investigations are not exhaustive as they are intended to cover only those that would assist in the identification of molecular spectra. This book along with *The Structure of Diatomic Molecules*, by G. Herzbery, which also has been recently revised with many significant additions, especially with regard to molecular constants, should prove invaluable to any research worker interested in molecular spectroscopy either directly or indirectly.

Four new plates containing 26 enlargements have been added. They show the spectra of various systems of O_2, hydrides (NaH, MgH, MgH^+, ZnH^+, PH, MnH and NiH) and NO_2, SiF, TiO, CO^+ and CH_2O.

K.N.R.

PLASTICIZERS, by D. N. Buttrey (Cleaver-Hume Press Ltd., London), 1950, pp. viii + 175. Price 18*s*. net

Plasticizer is a substance which transforms a rigid and brittle resin into a flexible and tough plastic. But to define it in a simple and unequivocal manner is as difficult as it is to define a plastic. It is, therefore, not surprising that the definition of a plasticizer, adopted in the book under review, " as a

substance which is added to a polymeric material in order to modify its elastic and viscous properties without changing the chemical nature of the material" is not altogether exact ; it can as well apply to the filler added to a polymeric material. However, the plastics technician, for whom the definition is meant, will not mistake a filler for a plasticizer, for he knows from experience what a plasticizer is and what it can do. The book is written, in fact, primarily for the technician in plastics and allied industries and essentially from a technical viewpoint, as a practical guide for him in the choice of a new plasticizer.

It is this practical consideration which has prompted the author to select, from the thousands of plasticizers found in scientific and patent literature, about four hundred of them, of actual and potential commercial application, for detailed study. They are described in 10 chapters under the headings : phthalate esters, phosphoric acid derivatives, glycerol and glycol derivatives and miscellaneous esters, esters of adipic and sebacic acids, fatty acid esters, esters of abietic and ricinoleic acids, toluenesulphonic acid derivatives, diphenyl derivatives, miscellaneous plasticizers (camphor, aceto- and benzophenone, dibenzyl ether, etc.), and hydrocarbon and aromatic extenders. Under each plasticizer are listed its chemical and physical characteristics, solubility in common solvents and compatibility with other plasticizers and with various polymeric materials. Since the ultimate criterion of a plasticizer is the performance of the plasticized product, quantitative data covering the mechanical, electrical and other properties of typical plasticized sample are presented in tabular and graphical form. References to literature and to industrial concerns which supplied a good deal of the technical information are given at the end of each chapter.

It may be regretted that the theory of plasticizer action is only briefly dealt with in the final chapter XI. But one easily understands the author's explanation that, since the emphasis in this book is on technical aspects of plasticizers, and the scientific knowledge of plasticizer action is still in the process of investigation, he prefers to postpone to a later edition a full and comprehensive treatment of the subject. He succeeds, however, within the space of a short chapter, in giving a clear idea of the effect of a plasticizer, of the solvent and non-solvent type, on polymeric material in terms of chemical structure and with the help of experimental data from tensile creep tests and deformation-time curves. The compatibility of plasticizer with polymer is examined from structural viewpoint and from the more recent and still-to-be-developed thermodynamic approach.

The book is unique in presenting a wealth of physical and chemical data on a comprehensive list of plasticizers and should be most welcome to technologists and research chemists in the field of high polymers.

L.M.Y.

TESTING RADIO SETS, by J. H. Reyner (Chapman & Hall Ltd., London), 1950, pp. 215. Price 22/6*s*.

This is the fifth edition of a well-known and useful book by Reyner. Its popularity with radio engineers, servicemen and laboratory workers may be gauged by the fact that it has run into five editions. The book has not lost any of its usefulness as the author, very wisely, has endeavoured to keep it abreast of the fast-developing technique of radio receiver design by revising it periodically and issuing new editions. The testing of receivers has become highly specialized and to do it effectively, it is very necessary that the fundamental principle of set-testing must be accompanied by design information to assist in understanding the principles involved and to help the person in the exercise of deductive reasoning, which is the basis of servicing. The author has combined both judiciously.

The fourth edition was published in 1944. The revised edition reviewed here is practically the same except for certain minor changes in some paras and the substitution of more scientific terms like " capacitance ", " power pack ", or " supplies ". The plates illustrating test instruments have been rearranged to advantage.

In chapter I, the para on current tests has been rewritten to accord with modern methods and the description of a " split-anode " adapter has been deleted as that method is obsolete. A para on valve voltmeters has been added. In chapter III on generators and indicators, the third para under *Drift* has been rewritten describing a modern beat frequency oscillator whose drift is only 5 cycles per hour as against 25

cycles per hour of the older type. On page 47, an additional para has been added, mentioning the facility provided in modern diode voltmeters of measuring D.C. potentials with accuracy. At the end of the same chapter, a brief mention is made of combination instruments made by Messrs Taylor Electrical Instruments and Automatic Coil Winder & Equipment Co. In Chapter IV, on page 63, the word " matter " has to be substituted by " manner ". This error was noticed in the earlier edition but obviously has been overlooked when revising. On page 74, the more specific abbreviation R.F. has been used in place of the more general H.F. in the subheading " Distortion Due to H.F. Currents ". On page 83, under diode faults, an additional para has been inserted drawing attention to the poor quality in reproduction caused by a broken or disconnected diode load. On page 88, under the subheading " Common Impedance Coupling ", the first three paras have been revised taking into account the more general and prevalent H.T. supply in place of " battery supply ".

There are hardly any changes in chapters V, VI and VII, except that the plates facing page 112 have been rearranged and the sub-paras on detector bias and R.F. chokes have been interchanged. These chapters deal with the old and conventional method of testing and tracing faults in R.F. circuits and superhets. It is a pity the author does not refer to the modern method of tracing the signal from aerial to the loudspeaker by means of suitable valve voltmeters and R.F. and A.F. amplifiers. This method has been found to reduce considerably the time taken for locating a fault. Special test equipment incorporating the above principle having the rather colourful name of " Chanalysts " are marketed in America.

The chapter on mains apparatus is the same except that the word " eliminator " has been rightly dropped in preference to " power packs " or " supplies ". The former word is a symbol of the not-too-distant past when " battery eliminators " were in vogue. The para under " A.C. Receivers " has been rewritten to include modern indirectly heated valves with coated cathodes.

The chapters on receiver tests and component testing have not been altered. It is felt that in conformity with the modern accepted expression, the para on " condenser testing " might have been headed as " capacitor testing ".

There is no change in the chapters on " Cathode Ray Oscillograph ", " Some Curious Faults " and the three appendices.

This edition can be recommended to those who are new to the art as a very useful book and as a practical guide to receiver testing. To those who already are in possession of the fourth edition, it may not, perhaps, be worth while to invest on the revised edition.

T. V. RAMAMURTI

MAN IS A MICROCOSM, by J. A. V. Butler (Macmillan & Co. Ltd., London), 1950, pp. xiii + 152 + 8 plates. Price 10*s.* 6*d.* net

Those halcyon days when Francis Bacon could declare proudly that he took all knowledge for his province are no more. In these days of great specialization it is not possible for the man in the street to cope with the vast amount of accumulated knowledge in different fields of science. He has neither the leisure to go through nor the equipment to understand learned treatises on different subjects. He has, therefore, to depend on popular accounts of important topics, written in an easy and understandable style. Dr. Butler's book, written in a simple and popular style, is, therefore, a welcome publication. It is a broad survey and interpretation of present knowledge of the nature and basis of life. The author discusses in clear, lucid style the place of life in the universe, how it originated and what we know of the nature of living things.

In the introductory chapter the author indicates the scope of the work as a whole. In the succeeding chapter he gives a brilliant exposition of what he calls the building stones of the fabric of life. But these building stones, the simplest molecules of life, are common to the living and the non-living. He goes on, therefore, to point out the links between the animate and the inanimate parts of the universe. There seems to be a gradual loss of energy and waste of power in the inanimate world. A greater part of solar energy, for example, is merely lost in space; only a small part of it is utilized. But this extravagant waste is balanced by the growth, development and evolution in the animate world. The author then takes the reader on to the more complicated pro-

cesses of the growth of life and the part played in this growth by proteins, enzymes, vitamins and genes. Then in a brief chapter he discusses the origin of life itself. In the final section he points out the steps by which man has gradually attained mastery over the whole world.

Dr. Butler traces four great landmarks in what may be called the ascent of life. The first stage, the complete elaboration of the basic chemistry of life, is already achieved in the simple free-living cells. The elaboration of such cells from simple molecules is, therefore, the first rung in this ascent. The next stage consists in the grouping of these cells into large organisms. The process involves differentiation, specialization, growth and the uniting of vast numbers of cells into a single organism. The third stage is the development of such an organism into a mobile animal, with muscles, sense organs and a brain. The final stage is the attainment by man of the ability to use symbols and through symbols to acquire mastery over his environment. In this section, the author deals with the origin of language, the growth of knowledge and the development of science. Dr. Butler must be congratulated on the lucid and clear exposition which he gives of this process of evolution.

The author does not stop with a mere recapitulation of the present-day knowledge on life. He discusses the place of man in this vast universe and disproves some of the popular misconceptions. Is man a mere speck in a very unimportant globe circling round a second-rate star? The human being seems to shrink into utter insignificance as the astronomer unfolds the immensities of heaven. Dr. Butler, however, stoutly refuses to accept any such position for man. The book is an eloquent plea for the view that man is not out of keeping with the splendour of his setting, and that he is a microcosm in the macrocosm of the universe. It is an elaboration of Hamlet's sentiments: "What a piece of work is a man! how noble in reason! how infinite in faculties! in form and moving, how express and admirable! in action, how like an angel! in apprehension, how like a god!"

Another illusion which Dr. Butler helps to dispel is the common man's impression that science has mastered and discovered almost every secret of life. The man in the street reads about wonder drugs, test-tube babies and electronic brains and is impressed; and naturally he comes to the conclusion that there is very little left to be found out. Dr. Butler, in his book, has succeeded brilliantly in putting the scientific discoveries into a reasonable perspective and in showing what has been achieved and what remains to be done.

In conclusion, one cannot help wishing that there were many more of such eminently readable books on other branches of science. Dr. Butler must be congratulated on his clear, able and masterly analysis of the intricate aspects of the evolution of life.

K. VENKATARAMAN

Publications Received

MODERN GAS TURBINES (2nd Ed., revised), by Arthur W. Judge, Chapman & Hall Ltd., 32*s*.

THEORY OF FLOW AND FRACTURE OF SOLIDS, by A. L. Nadia, McGraw-Hill Book Co. Inc., $10.00

APPLICATION OF THE ELECTRONIC VALVE IN RADIO RECEIVERS AND AMPLIFIERS, Book No. 4, by B. G. Dammers Ing, Philips Electrical Co. (India), Rs. 24

CAROTENOIDS, by Paul Karrer, Cleaver-Hume Press Ltd., $8.50

THE PHYSICAL CHEMISTRY OF DYEING, by Thomas Vickerstaff, Oliver & Boyd Ltd., 42*s*.

AMINOPLASTICS, by C. P. Vale, Cleaver-Hume Press Ltd., 12*s*. 6*d*.

PHYSICS IN CHEMICAL INDUSTRY, by R. C. L. Bosworth, Macmillan & Co. Ltd., £ 3 10*s*.

CHEMICAL AGE (Series Two), by T. P. De Sousa, Technical Press Publications, Bombay, Rs. 10

ANIMAL NUTRITION, by Cyril Tyler, Chapman & Hall Ltd., 15*s*.

NOTES & NEWS

A New Type of X-ray Scattering

DURING THE COURSE OF STUDY of the soft X-ray emission and absorption spectra of the elements (11 Na-14 Si), a new type of scattering has been observed (*Nature*, 1950, **166**, 563) from the measurements of the K-valence band spectra coupled with K-absorption. Spectra of these elements in different compounds, the energy differences between the valence band and upper allowed but unfilled energy zones have been mapped. These unfilled energy zones are expected to be present in an insulator according to the modern theory of solids.

The K-emission spectra of these elements present in insulators are characterized by a long wavelength satellite of the K-valence band spectra, the energy difference between the satellite and its parent line agrees well with the energy gap between the filled valence zone and the empty energy zone of the corresponding compound. The author attributes this to an internal scattering process by means of which an electron from the valence band is raised to the upper empty band and the photon (emitted by the transition to the K-shell) is degraded in energy by a corresponding amount. The confirmation of this result and assumption can also be obtained from previous investigation on diamond. It has been known for a long time that the long wavelength satellite of C-K_α is observed with diamond but is absent in the case of graphite. Also the energy difference between the satellite and the K_α line is 7 *ev* which is exactly the energy difference as theoretically calculated by Kimball. The reason for the absence of the long satellite in the case of graphite lies in the fact that (it being a conductor) filled valence band overlaps to a considerable extent up to the unfilled band and the discrete nature of the upper energy zone is lost. Similarly the appearance of the long wavelength satellites of boron and beryllium in BO_3 and BeO can be explained. The whole may be looked upon as a partial absorption of photon taking place internally within an atom. There is reason to believe that this can be experimentally observed only with low atomic weight elements in compounds having good insulating properties. —A.P.

The Reflecting Microscope

RECENT ADVANCES IN THE DEVelopment of the reflecting microscope in England, Russia and the United States of America are reported (*Science*, 1950, **112**, 381).

The chief advantage with reflecting systems lies in the fact that they extend the range of achromatism of the microscope through the entire spectrum, ultra-violet, visible and infra-red and, secondly, they are ideally suited to infra-red microscopy. Various types of such objective and condenser systems with varying numerical aperture have been developed. With an aspheric mirror pair of Schwarzschild aplanats, spherically corrected and coma free, Burch designed an objective of N.A. 0·65. Objectives with spheric-mirror pairs have been designed by Seeds and Wilkins and by Kavanagh. A solid reflecting objective has been described by Drew.

Amongst the most important uses to which reflection microscopes are put are emission and absorption microspectroscopy, microspectrophotometry, colour translating and photomicrography.

Microspectroscopy is now a very powerful device in examining minutest parts of an object spectroscopically and hence finds a wide application in physics, chemistry, biology and medicine.

The superiority of reflection type microscope in microspectroscopy lies in the wide range of spectrum (2,000 Å to 15μ) from infra-red to the ultra-violet, to which it is suited. Another advantage is, once adjusted for any wavelength it is in good focus for any other, but a serious drawback is that a portion of the cone of light from the specimen is obscured in passing through an on-axis mirror system, so that the cross-section of the light beam is annular. If the linear cross-section ratio of the obscure to the full beam is greater than about 0·3 to 0·4, serious image deterioration may result.

A simple arrangement for ultra-violet or visible absorption spectroscopy of single crystals, thin solid films and minute quantities of solutions consists of the source of light, the reflecting condenser, the specimen and the reflecting type objective projecting the image of the specimen on the slit of the spectrograph. The adjustment of illumination is much more critical than with an ordinary microscope. This method has also been adapted for fluorescence and emission microspectroscopy.

In infra-red microspectroscopic investigation, the reflecting microscope is illuminated by the infra-red source and the image is cast on the entrance slit of a conventional recording infra-red spectrometer of the Perkin-Elmer single beam type. By means of mirrors and apertures, any portion of the image alone may be directed on the spectrometer. Single crystals, fibres, biological tissues and cells, etc., can be investigated by this method. Specimens upward of 20 to 50 dia. are satisfactory; quantity of material may be as small as 10^{-7} gm.

The most popular arrangement is, first the light source, the monochromator, then microscope and finally the radiation detector. The advantage is, since only a fine spectral width of radiation is allowed to fall on the object, photochemical reactions are not induced. A rotating step sector is placed at the image plane for plate calibration in photographic photometry. A photo-multiplier tube is used for photoelectric photometry. Recently Sinshimer has designed a continuous recording ultra-violet and visible microspectrophotometer.

The principle of colour translation has been successfully applied on a similar microscopic set up. Three different ultra-violet wavelengths are used sequentially and their images transformed with three additive visible colours. These are then superimposed over the viewing screen. The hue at any point in the image then corresponds to the absorptions for the three ultra-violet wavelengths at the corresponding object point. The constituents of the instruments are ultra-violet radiation source, Wadsworth type grating monochromator, an auto-

matic exposure control system, a reflecting microscope with optics designed by Gren, a 35 mm. camera, a film-processing station for developing, fixing and drying 3 adjacent frames in 10 to 20 sec. and a triple beam projector with a viewing screen.

The reflecting microscope has a wide field of application in biology and medicine for the observation and for the physical and chemical analysis of tissues and cells. By using reflecting microscope with absorption spectrographic adaptation, fixed and unfixed squamous, parabasal and abnormal cells of the cervical mucosa have been studied from the point of view of cancer detection. — W.M.V.

Velocity of Light

THE FIGURE OF 1,86,282 MILES per second for the velocity of light, obtained by Dr. L. Essen of the National Physical Laboratory, Tedington, in 1947, has now been confirmed by recent investigations carried out in Sweden and U.S.A. This value is 11·1847 miles more than the accepted figure of Michelson.

The method is similar in principle to Michelson's excepting that a very short (7″) tube was used. Radio waves sent down this metal tube and reflected backwards and forwards between the two ends built up an electrical resonance (which can be detected with very high precision), when the time of travel between the ends equals the time interval between successive waves. Dr. Essen used radio waves at a frequency of 10 thousand millions per second and this frequency was measured with an accuracy better than one part in a million.

In radar, the distance to an object is calculated from the time taken by a pulse of radio waves to travel there and back, the velocity of waves being the same as that of light. The new value will, therefore, enable radar to be used more accurately and will be particularly valuable for aerial survey work where the shape of ground is plotted by means of radar. Other significant changes that will be introduced as a result of this new figure will probably be in the field of astronomy, atomic research and electronics.

Synthesis of Higher Fatty Acids

THE SYNTHESIS OF HIGHER MEMbers of the aliphatic carboxylic acid series by the Arndt-Eistert reaction and purification of the crude products are described (*Canad. J. Res.*, 1950, **28**, 556).

Pure stearic acid (Eastman Kodak 402) was recrystallized four times from 80 per cent aqueous ethanol including two treatments with Norit. 60 gm. of the product (m.p. 69·6°C.) and 60 c.c. of thionyl chloride or oxalyl chloride were refluxed for 3 hr. and excess reagent removed under reduced pressure. An ethereal solution of stearyl chloride (1 mole) was added to a cooled ethereal solution of diazomethane (2·5 moles) prepared from N-nitrosomethylurea by the method of Arndt. The solid deposit was separated by cooling to −20°C. after 12 hr. and then dried *in vacuo* over P_2O_5. The crude diazoketone, obtained in quantitative yield as a yellow solid, was used as such for the next higher acid through the corresponding ester. Two methods were found satisfactory: (1) conversion in absolute ethanol using silver oxide as catalyst; (2) conversion in benzyl alcohol at high temperatures without any catalyst. Both of these methods give a yield of 80 per cent crude acid; the latter is more expeditious. *Nonadecanoic acid*: 31 gm. of 1-diazo-2-nonadecanone was dissolved in 310 c.c. of absolute ethanol at 55°-60°C. Silver oxide (8 gm.) was added with mechanical stirring and temperature raised gradually to 65°-70°C. for 36 hr. When a sample of the reaction mixture no longer evolved oxygen on treatment with HCl, the mixture was refluxed for 3 hr., filtered hot, cooled and the yellow solid deposited removed. Acidification of the hydrolysed filtrate and extraction with ether gave the crude acid as a cream-coloured powder, m.p. 65°-66°C., in 83·5 per cent yield. White glistening leaflets, m.p. 68·5°C., were obtained on purification. 1-*Diazo*-2-*eicosanone* was prepared from nonadecanyl chloride as above and gave, on recrystallization from dry ether, lemon leaflets, m.p. 71·2°C.: ultra-violet absorption spectrum of 0·002 per cent isopropanol solution showed maximum at $\lambda = 247 m\mu$ and $e = 10,200$. Benzyl ester of eicosanic acid obtained from benzyl alcohol gave, on hydrolysis and subsequent purification, glistening leaflets of *eicosanic acid*, m.p. 75·2°C. The eicosanyl chloride obtained from the acid with oxalyl chloride was used for preparation of 1-diazo-2-heneicosanone on reaction with diazomethane in ether. Rearrangement in hot benzyl alcohol gave *heneicosanic acid* in white glistening leaflets (on purification), m.p. 72°-73·5°C.

For purification, the acids were recrystallized from 90 per cent ethanol before distillation in high vacua to remove impurities which decompose at the distillation temperature. Distillation is effected in an ordinary vacuum sublimation apparatus with a wide (25 mm. dia.) side tube. The pressure inside the apparatus was 0·5 micron and the bath was maintained at 90°C. for nonadecanoic acid, 110°C. for eicosanic acid, and 130°C. for heneicosanic acid. A final recrystallization from 90 per cent alcohol homogenizes the different distillates. The whole purification process entails only 10 per cent loss.

Galvanizing Baths Containing Aluminium

THE ADDITION OF ALUMINIUM TO galvanizing baths imparts lustre, corrosion resistance and other properties to the galvanized surface. The existing literature on the subject is reviewed and minimum quantities of aluminium needed to obtain the desired results for various steels are described (*J. Iron & Steel Inst.*, 1950, **166**, 77).

The addition of 0·18 per cent of aluminium to the bath produced coatings without the formation of alloy layers. In the presence of appreciable amounts of carbon with or without small amounts of silicon, 0·33 per cent of aluminium can suppress completely the formation of iron-zinc alloys even when the temperature rises to 490°C. and immersion time is limited to 30 sec. Cold-reduced sheet steel samples treated in baths containing 0·10 per cent and 0·05 per cent aluminium at 430°C. gave galvanized sheets free from flaking. Alloy formation was suppressed with 0·10 per cent aluminium. Only a little alloy at surface crevices could be seen after 30 sec. with 0·05 per cent aluminium; the usual alloy layers were formed, though thinner than usual, even after galvanizing for 1 min. These adversely affected the bending properties. The flaking of

the coating on bending is eliminated by a 0·10 per cent aluminium addition. This may also be achieved with 0·05 per cent aluminium if the outer layer of zinc is fairly thin. The results hold good both for cold-reduced sheet or pack-rolled material.

The theory that the alloy- suppressing action of aluminium is due to the presence of a membrane is not substantiated since alloying occurs at higher temperatures and immersion for longer duration in spite of the presence of aluminium. The formation of alloy-free coating caused by a non-adherent alloy is also discounted since a strip of steel immersed in the bath and then vigorously scraped did not produce any local growths of alloy. The aluminium appears to promote the formation of a ternary Fe-Zn-Al alloy by diffusion inwards into the steel base. The formation of the alloy is not apparent until relatively heavy additions of aluminium are made but with the smaller additions enough alloy appears to be formed to obstruct the usual formation of the normal *zeta* and *delta* layers. A detailed study of the surface structure of different steels, upon which depends their behaviour towards galvanizing, is essential to obtain full benefits of aluminium additions to the galvanizing baths without the associated drawbacks which have so far discouraged its use.

Utilization of Oil Mill Refinery Wastes

RECENT WORK ON THE UTILIZATION of oil mill refinery wastes conducted at the Institute Tech. d'Etude et de Recherches des Corps Gras and the Inst. de Recherches pour les Huiles et Oleagineaux in France is described (*Chem. Age*, 1950, **63**, 573).

The recovery of lecithins which are now being increasingly used in food technology is emphasized. Lecithins can be recovered from the mucilaginous matter mainly by centrifuging — after flocculation and removal of aqueous layer — and may be subsequently further treated with acetone for removal of glycerides, fatty acids and possible impurities. Carotenoids, colouring matters in the oils and fats are generally eliminated in the process and bleaching and recovery is not possible except in palm oil. The red palm oil (which is the name given to liquid fraction obtained on neutralizing palm oil) represents about one-third of the original oil and contains unsaturated glycerides and most of the colouring matter. The recovery of carotene from this fraction involves the preparation of methyl esters and subsequent (a) distilling under high vacuum ($\frac{1}{10}$ mm. Hg) at a temperature of 130°-40°C. and recovering the carotenoids by chromatography or (b) saponifying at a temperature of 60°C. or below in a nitrogen atmosphere and treating the resulting dry soap mass with petroleum ether, acetone or a chlorinated solvent. The latter (b) is an improved method and limits the saponification to the coloured liquid part of the oil so that there is economy both of solvent and apparatus. The soap forms a useful byproduct — sodium oleate — with 25-30 per cent palmitate. The carotene extracts should prove valuable in animal nutrition. They are odourless and tasteless and sufficiently stable as they retain all the natural antioxidants of palm oil.

Sterols which form the greater part of the unsaponifiables of oils are a valuable source of sex hormones, vitamin D and other pharmaceutical products. The sterol content varies widely : from 0·3-0·4 per cent in linseed or colza oils to 3·5 per cent in cotton seed oil, and over 7 per cent in some fish liver oils. The odorous substances in oils and fats removed in the superheated steam treatment have a fairly high ketone content, e.g. methyl monylketone. These substances may be of value in perfumery.

The uses of cake proteins in the production of adhesives, plastics, synthetic fibres, in paper and for other miscellaneous purposes are described.

New Resin-sand Moulding Process

A NEW RESIN-SAND PROCESS FOR making foundry moulds and cores, described as " Croning ", " C ", or " Shell " process, developed in Germany during the war is now being tried on a pilot-plant scale in U.S.A. (*C.T.J.*, 1950, **127**, 1012). The process promises large savings and improvements over conventional sand moulding of cast iron and other metals and may become one of the biggest single uses for resins.

A mixture of 100 parts of dry sand and 8 parts of a thermosetting phenolic resin binder is placed on the hot metal pattern previously treated with a silicone resin as in greasing a cake pan. The pattern is built up to a thickness of $\frac{1}{8}$"-1", the excess resin-sand mixture is shaken off and used again. The pattern covered with a thin layer of the resin-sand mixture, about $\frac{1}{16}$" thick, is heated in an oven for 1-4 min. until the resin is set, forming a thin shell over the pattern ; the shell is then removed from the pattern. Cores to fill hollow spaces in the final product are made by blowing the resin-sand mixture with compressed air into a split-heated metal core box. The mould is embedded in a box of steel shot where it can receive the molten metal. The mould surfaces are smooth and require little surface cleaning.

Sections as thin as 0·01" can be poured and tolerances of 0·002"-0·003" for small castings can be achieved with the process. Castings up to 100 lb. have been produced. The method may prove very useful for mass production of identical and relatively small castings for automobiles, tractors and farm machinery. The volume of sand necessary for making moulds can be reduced by 90 per cent ; machining and cleaning costs are cut by 80 per cent ; improved working conditions result from the relative freedom from excessive dust and heat ; more efficient handling of materials and better use of foundry floor space are claimed. Hardened moulds can be made ahead of time and stored until needed.

Velocities of Ultrasonic Waves in Liquids

A NEW METHOD FOR MEASURING velocities of ultrasonic waves in liquids over a wide range of frequencies has been developed at the Geophysics Laboratory of the Andhra University (*Nature*, 1950, **166**, 742). The method is free from the limitations from which other known methods suffer ; it is simple, rapid and accurate and is specially suited to liquids, both opaque and transparent, available in small quantities.

A small cell is constructed by cementing two thin cover-glass slips on either side of an annular brass disk of uniform thickness

(2·48 mm.) and inside dia. 1 cm. A side-hole is provided for introducing liquids in the annular space. Ultrasonic waves generated by a wedge are transmitted through this liquid plate and communicated to water contained in a glass trough which serves as the ultrasonic cell for obtaining the Debye-Sear's diffraction pattern. Resonance frequencies of the liquid plate are determined in the usual manner employing the wedge method. The low order of the fundamental resonance frequency of the liquid plate enables a number of transmission maxima to be obtained at close intervals with a single wedge of frequency range 3-6 Mc./sec. Using this set of transmission frequencies, the fundamental frequency and hence the velocity of sound in the liquid contained in the cell is evaluated. Results obtained with the method for the velocities of sound in some liquids are given in Table I.

TABLE I

	Frequency (Mc./s.)	Velocity calculated in metres per sec. at 30°C.	Velocities obtained by other methods (23°-27°C.)
Glycerine	0·390	1,950	1,986
Water	0·304	1,520	1,500
Mercury	0·285	1,425	1,440
Toluene	0·260	1,300	1,300
Ethyl alcohol	0·231	1,155	1,150
Carbon tetrachloride	0·181	905	930

Identification of Vegetable Oils

A METHOD FOR IDENTIFYING OILS, fatty acids or alkydes of unsaturated fats and fatty acids used in paints and varnishes is described (*Chem. Age*, 1950, **63**, 572). Advantage is taken of the difference in the refractive index of isomers and the solid or liquid state in which they exist. The method also serves to distinguish ricinene oil obtained by dehydrating castor oil (which recently has become a valuable addition to linseed and wood oils in the manufacture of paints, varnishes and alkyd resins) from natural drying oils.

2 gm. of the fatty acids from the oil or alkyd resin to be tested, freed from solid fatty acids (by cooling to −40°C. in methanol) is made up to 20 c.c. with a solution obtained by heating 20 gm. NaOH with 100 c.c. diethylene glycol to about 205°C. The mixture was heated over an oil bath at 200°C. for 20 min. during which hydrogen or nitrogen was passed through it. Splitting the soap in the usual manner and recrystallization of the fatty acids from methanol gave crystals of 10, 12-octadecadienic acid of about 20 per cent yield indicating the presence of dehydrated castor oil in the original material. Tests by this method gave the following results: (1) commercial dehydrated castor oil, including samples obtained catalytically in the laboratory, the liquid fatty acids constituting about 96-98 per cent of total fatty acids, showed an increase in refractive index between 0·0034 and 0·0048 or 18-22 per cent. The m.p. after one recrystallization was between 49° and 53°C. Tests of the mixed m.p. with purified 10, 12-acid were positive in all cases. (2) Oils of high linoleic acid content such as sesame, poppy seed, tobacco seed and liquid fatty acids constituted 55-85 per cent of total acids and showed an increase in refractive index of 0·0053-0·009. No solid isomerization product was obtained on cooling in methanol. (3) Conjugated oils in most cases showed no increase in refractive index but rather a slight decrease. (4) Oils of high linoleic acid content, linseed oil, etc., showed a marked rise in refractive index. A small amount of solid isomer was formed having a higher refractive index of the order of 0·0150 than the solid acids of ricinene oil and could, therefore, be easily identified as pseudoelaeostearic acid. (5) Natural conjugated unsaturated wood oil and one or two others exhibit no rise in refractive index through isomerization. They may be distinguished even in mixtures with other natural oils by the higher refractive index of the solid fatty acids separating out in the first stages (elaeostearic acid). Solid isomers are not formed in the treatment of such oils or their mixtures with other natural oils. (6) Castor oil showed a slight decline in refractive index; tall oil fatty acids showed an increase and no solid isomerization products were formed. (7) Ricinene oil, comprising 25 per cent dehydrated castor oil in linseed oil, yielded a positive result; no detection could be made up to 10 per cent.

In all these cases except the last one, the method furnishes a definite means of identification; a further supplementary test is needed to identify ricinene in oil mixtures.

Analysis of Concretes

THE METHODS EMPLOYED IN THE analysis of hardened concretes, mortars and renderings are described in a bulletin (*National Building Studies, Technical Paper No.* 8, H.M.S.O., Price 9*d.*) published by the *D.S.I.R.*, London.

The majority of concrete types employed in Great Britain contain Portland cement and the methods detailed are based on this assumption; concretes made with cements based on blast furnace slags or with high-alumina cement can be dealt with similarly if the analysis of the cement is known.

The methods involve the separation of (a) a solution containing all the calcium of the cement, (b) clean aggregates in their original grading, (c) clay and silt (if present) together with some silica precipitated by the action of the acid on the set cement. In an aliquot part of (a) the calcium (and sometimes the SiO_2) present is determined, the cement is calculated from this. In another aliquot, the sulphate is determined. The grading of the aggregates is obtained by sifting (b) and weighing the sieve fractions. Sodium carbonate solution is used to remove soluble silica from (c) which is then dried and weighed. The method provides for the determination of the sand or aggregates, and estimation of the clay and silt (material passing No. 200 sieve having an aperture of 0·076 mm.). The assumptions involved in the method and in the subsequent calculations are: (1) The CaO content of the cement is 64·5 per cent (the average figure for Portland cement) or is known (1-a-alternative). The SiO_2 content of the cement is 21·4 per cent, or is known. (2) All the CaO dissolved by the acid is derived from the cement, or the soluble CaO content of the aggre-

gate is known (2-a-alternative). All the SiO_2 originally present in the cement is dissolved by the acid and alkaline solutions employed. (3) The aggregates, including any clay or silt, are entirely insoluble in the acid and alkali used. (4) The loss on ignition and insoluble residue of the cement are 2 per cent and nil respectively, or are known. (5) The aggregates suffer no loss on ignition, or the loss is known. (6) The loss on ignition of any clay and silt present is 10 per cent, or is known. (7) Nothing has been washed or dissolved out of the concrete, for example by acid waters, before sampling.

Where the nature of the aggregate is not known, it is advisable, as a preliminary to chemical work, to cut a section across and determine the character of the particles. Individual particles which are exposed can be broken or drilled out for analysis.

Identification of Minerals

CURRENT METHODS OF IDENTIfying opaque minera s, taking advantages of such properties as colour, hardness, isotropism, anisotropism, reflecting power, electrical conductivity, etching and staining, have their limitations in that more than one property have to be taken into consideration for identification. The new method, "the contact print method", permits identification of the elements in the specimen and indicates their distribution over the entire surface (*J. geol. Min. & metall. Soc. India*, 1950, **22**, 43). The coloured prints obtained by the method can be preserved and reproduced so that a record of the tests can be maintained; the mineral surface does not get corroded and no drilling into the specimen is necessary; the used surface may be repolished and reused for microscopic examination. Mineral grains as fine as 200 mesh may be mounted and examined.

To obtain the print, the photographic paper impregnated with the selected reagent is placed on the polished surface of the mineral and even pressure is applied on the paper for sometime, depending on the reagent used and the mineral under investigation. If the mineral is a conductor, the electrographic process is employed to reduce the time of contact. The intensity of current should be less than 50 milliamp., the voltage about 2-6. A bakelite graphite mixture (100 mesh) 80-20, has been found satisfactory for mounting the mineral.

Mineral ores such as niccolite, pyrite, chalcopyrite, pentlandite, cobaltite, violarite, etc., were examined by the contact print (electrographic) method.

For nickel test, the reagents were ammonia and alcoholic solution of dimethylglyoxime; a deep pink print was obtained. Ammonia and alcoholic solution of α-benzoinoxime on copper gave a green print. A violet colour was produced in the case of cobalt with ammonia and alcoholic solution of benzimidazole. Iron gave a brownish violet colour with dilute nitric acid and sulphosalicylic acid. The voltage applied in these cases varied between 5 and 20 V. and the period of contact with the photographic paper was about 60 sec.

The method should prove useful in mining and ore-dressing plants for studying the nature of the concentrations and tailings. Further work is necessary in the selection of suitable reagents for different elements and bring about characteristic coloured prints.

Identification of Clays

A SIMPLE, RAPID COLOUR TEST for a qualitative estimation of clay composition in soils and rocks, and staining techniques that help to distinguish between clays that are harmful and those that are beneficial in agriculture and in construction work, have been developed at the U.S. Bureau of Reclamation, Denver.

The specimens for staining are extracted with a strong solution of hydrochloric acid and after heating and dry distillation the material is filtered and stained with saffranine. The stained specimens are examined under a microscope and the composition of the soil can be quickly determined by matching it with a comparison chart. Rapid field tests can be made by adding benzidine directly to untreated soils and rocks. Colour changes are observed within 5 min.

Deposition of Copper from Cyanide-free Baths

STUDIES ON THE ELECTRO-DEposition of copper from baths containing copper salt-ethanolamine complexes are described (*Curr. Sci.*, 1950, **19**, 311). The bath appears to be a promising substitute for the cyanide bath and has advantages over the latter in respect of higher cathode efficiency (which is nearly 100 per cent except in copper nitrate-triethanolamine bath), ability for good working at room temperature, brightness of deposits and improved performance. The optimum conditions of variosu baths are given in Table I.

TABLE I

COPPER SALT (gm./l.)	ETHANOLAMINE (c.c./l.)		*p*H	TEMP., °C.	BRIGHT C.D. RANGE (amp./sq. dm.)
Oxalate 60 + Rochelle salt 60 gm./l.	(Mono-)	60	9·5	24	2·4 -4·8
Oxalate 45 + Rochelle salt 45 gm./l.	(di-)	68	9·0	24	1·2 -1·6
Oxalate 45 + Rochelle salt 60 gm./l.	(tri-)	150	8·1	24	0·68-2·0
Nitrate 45	(tri-)	135	8·3	24	0·64-1·6
Nitrate 45	(tri-)	135	8·3	40	1·2 -3·6
Citrate 30	(tri-)	150	9·3	24	0·4 -1·12
Tartrate 45	(tri-)	135	8·6	24	0·24-0·8
Carbonate 45 + ammonia (24%) 50 c.c./l.	(tri-)	135	9·5	24	1·2 -2·0

Rochelle salt as a constituent of oxalate-monoethanolamine bath reduces anode corrosion, increases the c.d. range, conductivity-cathode polarization and throwing power and yields better quality deposits by eliminating treeing and increasing the brightness.

Rammed Soil-cement Constructions

THE SOIL RESEARCH LABORATORY, Punjab P.W.D. (B. & R.), Karnal, has issued a handbook containing detailed specifications for various types of rammed earth construction which, in recent years, has attracted much attention in India on account of its low cost and the ease with which the constructions are fabricated with indigenous materials.

Rammed earth or *Pise-de-terra* has long been in use for the construction of inexpensive houses. Due to lack of proper understanding of the complex behaviour of soils in engineering structure, however, the technique did not gain much popularity. After carrying out thorough investigations over a period of 3 years in its Research Laboratory at Karnal, the Punjab P.W.D. undertook the construction of 4,000 houses using cement-soil mixtures. The project was completed in seven months and several lakhs of rupees of saving was effected. The constructions successfully withstood heavy monsoon.

The following specifications were used: Foundations and plinth and damp-proof course: cement-soil blocks with 7·5 per cent cement or 5 per cent soil rammed *in situ* with a dry bulk density of not less than 1·80; wall superstructure: 2·5 per cent cement-soil mixture rammed *in situ* between shutterings and 12″ in thickness; parapet: cement soil with burnt bricks in cement coping, projecting slightly beyond the wall on each side; finishing: a coat of cement plaster ½″ thick (1 : 5) over a coat of cement wash on the outside walls; same treatment inside the parapet was continued over its top, followed by coping.

The soil should conform to the following specifications: sand content not less than 35 per cent; liquid limit not more than 25 per cent; plasticity index not less than 8·5 and not more than 0·5; total solids not more than 0·5 per cent and sodium sulphate not more than 0·10 per cent. The cement used should be slow setting and 2·5 per cent on the weight of dry soil. The dry bulk density of the compacted cement-soil mixture should not be less than 1·80.

The crushing strength of bricks made out of the cement-soil mixture should not be less than 400 lb./sq. in., the blocks should be 2·5″ thick and 200 gm. in weight compacted under 40 blows from a 5·5 lb. hammer with a drop of 15″. The blocks should withstand the following wet and dry tests: immersion under water for 5 hr. at room temperature, heating in an oven for 42 hr. at 71°C., cooling for an hour at room temperature and brushing off loose material. The loss in weight at the end of these treatments should not be more than 3 per cent.

Vertical joints should not be more than 6′ apart and horizontal joints 3′ to 4·5′ apart. The latter are formed by finishing smooth the rammed surface at the end of the day and sprinkling dry sand over the surface before starting the next morning. Individual layers should be finished smooth. Vertical joints should be formed using end plates supported by two bolts with suitable wedges in between to facilitate their withdrawal after compaction.

The form work is of the sliding type. Suitable wooden boarding, 9″ wide and 2″ thick, is supported by vertical stiffeners, at least 4″ × 4″ if wooden, or angle iron, 1½″ × 1½″ × 1¼″, spaced not more than 3½″ apart. The stiffeners are held in position by means of spacer bolts of ⅝″ dia. passing through the stiffeners and the boarding and adjusted to the exact thickness of the wall. Special flexible device should be provided for each corner. The shuttering is made in lengths each 11′ and in case of angles and tees, of wall corners, each leg being 8′. The end plates should be plain or tongued, depending on whether it is an opening or a vertical joint and are supported by at least two spacer bolts of the shuttering. There should be four sliding boards 9″ each, 3′ in height. The first 3′ of wall is first compacted, the bolts loosened, and the vertical stiffeners raised by 27″ by turning round the top bolt. The three lower boards are taken out and refixed on to the top of the form by means of the spacer bolts. The verticality of the boards is carefully checked. The same method applies to flexible corner forms.

When fixing holdfasts in the walls, a hole is bored into the wall after removing the shuttering and scooped; the holdfast is inserted in the hole which is then filled with cement concrete.

Finally, the compacted walls are cured for 10-14 days depending on weather conditions, by sprinkling water from time to time. After this curing, the walls are allowed to dry for 2 to 3 weeks. The walls exposed completely are preferably coated with a weather-resisting plaster.

Baule Gasification Process

THE L'ELECTROGAZ BAULE GASIfication process recently worked out in France at *Recherches and Industrie* claims to produce illuminating and heating gas for domestic and industrial purposes from a variety of organic matter such as peanut shells, cotton waste, marc of grapes, bagasse, oleaginous residues and residual muds, organic matter from paper mills, brewery draff, tanneries, etc. Peat or brown coal and petroleum refinery wastes and crude petrol also can be directly treated to yield a range of light hydrocarbons.

The process is economical and can utilize inferior fuels and waste materials even in the wet condition. It involves the total cracking of the material by means of an electric discharge through the material. As no high temperatures are involved, ordinary sheet-iron generators can be employed. The gas produced is free from tar and ashes which are reduced to metallic compounds during the process.

Tests on the process carried out in several laboratories have shown the possibility of gasifying instantaneously, wood, fuel oil, saw dust and cork impregnated with gas oil. The non-condensable gas contained more than 40 per cent methane and its heating value was 5 calories per cu. m. In another test one kg. of dry wood required about 2 kWh. or 1,700 calories for complete gasification which yielded one cu. m. of gas with a heat of 3·5 calories and 1·7 calories in the form of hot water. The gasification reaction described has led to the construction of gas generators of various outputs ranging from 1 cu. m. per hr. up to 100 cu. m. and over.

The utilization of gas as a fuel in industrial furnaces and radiation dryers for laundries, bakeries, paper, fabrics, granulated products and drying of synthetic varnishes on metals may effect considerable savings in heating costs. The gas can also become a raw material in chemical processes. The gasification of brewery draff, for instance, produces a gas containing 72 per cent hydrogen which can be isolated at a very economical cost and used in metallurgical and other operations. Besides, the possibility of gasifying crude petroleum should allow the direct production of synthesis gas and help in the development of certain chemical industries in areas abounding in such fuels and wanting in coal.

Organization of Science in Egypt

SCIENTIFIC RESEARCH IN THE modern sense was introduced in Egypt only towards the beginning of the nineteenth century when the Government took over the organization of scientific research and various scientific departments have since been established forming an integral part of the scientific organization of the country. Different scientific institutions now in existence in the country may be classified into Governmental, educational and industrial institutions, and learned societies and private organizations.

Egyptian manufacturers have not yet taken the initiative to conduct scientific research on their own. Many of these concerns are affiliated, technically or financially, to foreign houses which conduct their own researches abroad ; notable examples are the oil companies. The Government is fostering industrial research in its own departments and making the results available free to the industry. There is an Industrial Investigation Institute in the Department of Industry, Ministry of Commerce and Industry. The Fouad I National Council of Industrial & Scientific Researches is establishing a National Chemical Laboratory and a National Physical Laboratory to render technical aid to industry.

The majority of Egyptian scientific societies depend for their finances on the government and many of their members are government officials. A notable exception is the Royal Agricultural Society founded 50 years ago. The society conducts agricultural research with the aid of prominent experts and is run on commercial lines. Its funds are derived from members' contributions, profits from distributing select seeds and manures and from the revenue from industrial and agricultural exhibitions held under its auspices.

Bengal Immunity Research Institute, Calcutta

THE BENGAL IMMUNITY RESEARCH Institute, Calcutta, has published a brochure on the occasion of its third anniversary giving the set up, aims and objects of the Institute, which include research work bearing on medicine, chemistry, biochemistry, pharmacy, etc. One of the important additions to the Institute is a museum to display the different varieties of Indian medicinal plants and their active principles.

Announcements

Royal Society Awards — The following awards have been announced : Royal Society Medals for 1950 — Sir Edward Appleton, for his work on the transmission of electromagnetic waves round the earth and for his investigations into the ionic state of the upper atmosphere ; Dr. C. F. A. Pantin, for his contribution to the comparative physiology of invertebrates. Other awards are : Copley Medal to Sir James Chadwick ; Rumford Medal to Sir Frank Whittle ; Davy Medal to Sir John Simonsen, Darwin Medal to Prof. F. E. Fritsch and Hughes Medal to Prof. M. Bora.

The Indian Roads Congress will hold its 15th Annual Meeting at Calcutta during February 18-24, 1951 under the presidentship of Mr. A. C. Mukherjee, Chief Engineer, Uttar Pradesh. A technical engineering exhibition has also been organized for the occasion.

UNESCO Book Coupons of the value of $20,000 are available for distribution during 1951 among educational, scientific and cultural organizations in India. Individuals working in the above organizations may also take advantage of the scheme. Applications for allotment of quotas should be addressed to the Deputy Secretary to the Government of India, Ministry of Education, New Delhi.

Indian Science Congress, 1952 — Dr. J. N. Mukherjee, Director of the Building Research Institute, Roorkee, has been elected General President of the 39th Session of the Indian Science Congress to be held in Calcutta.

The following have been elected Presidents of the respective sections : *Mathematics* : Dr. B. B. Sen (Calcutta) ; *Statistics* : Mr. B. N. Ghosh (Calcutta) ; *Physics* : Dr. S. Ramachandra Rao (Bangalore) ; *Chemistry* : Mr. R. D. Desai (Bombay) ; *Geology* : Dr. L. A. N. Aiyar (Lucknow) ; *Botany* : Dr. S. Ramanujam (Patna) ; *Zoology* : Dr. B. R. Seshachar (Mysore) ; *Anthropology & Archaeology* : Mr. T. C. Roy Chaudari (Calcutta) ; *Medical & Veterinary* : Dr. B. R. Kanolkar (Bombay).

The following have been elected to the Executive Committee of the Indian Science Congress Association : Prof. P. C. Mahalanobis, Drs. B. Mukherjee, A. S. S. Singh, S. S. Jalotta, S. K. Mitra, K. Banerjee (Calcutta), B. C. Kundu (New Delhi), S. L. Hora (Calcutta), S. P. Chandrasekharaiya (Poona), D. Chakravarti (Calcutta), P. C. Guha (Bangalore) and Prof. K. N. Bahl (Lucknow).

Indian Botanical Society — Prof. P. Maheshwari, Head of the Botany Department, Delhi University, has been elected General President of the Indian Botanical Society for 1951. Prof. Maheshwari is also Chairman of the Plant Embryology Section of the International Union of Biological Sciences.

National Institute of Sciences — Dr. S. L. Hora, Director, Zoological Survey of India, was elected President of the National Institute of Sciences for 1951 at the annual meeting held in Bangalore in January 1951.

The following foreign scientists were elected Honorary Fellows : Sir Alexander Fleming, Prof. Richard Kuhn, Prof. Herman Joseph Müller, and Prof. Selman A. Walksman.

Errata

This Journal. 1950, Vol. **9A**, No. 12, December issue : Article entitled "Mechanism of Boiling "; page 456 : The Figs. 9 and 10 have been inadvertantly presented upside down.

This Journal, 1951, Vol. **10B**, No. 1, January issue : Article entitled "Studies in Anti-malarials: Part I — Synthesis of β-Quinindene Series " : The first author's name is to be *read* as Mohindra Singh Chadha.

Page 1 : In the graphic formulae III the double bond at position 6 and R- between positions 8 and 9 have to be inserted as in II and IV.

Page 2 : Table I, under substituent, lines 12 and 13, *for* 8/10-hydroxy *read* 8/10 chloro.

Progress Reports

TEA RESEARCH IN INDIA

RESEARCH ON TEA CULTIVATION UNDERTAKEN AT the Tocklai Experimental Station during the year 1949 was mainly directed towards manurial and pathological studies. Valuable data have been published as a result of extensive field experiments spread over a number of years.

It is conclusively proved that the application of sodium nitrate to tea on light sandy well-drained soils initially produces increased crops but its continued application over a number of years produces harmful effects due to damage to soil tilth. Severe plasmolysis and browning of the cells in the cortex of the root and collar region are observed. Application of manures containing high percentages of sodium nitrate on heavy clay soils, especially in wet weather, produces extremely harmful effects even in the first year of application. Addition of ammonium sulphate corrects the adverse effects. A mixture of 3 parts sulphate of ammonia to 1 of nitrate of soda to 1 of organic manure (oil cake) has been adopted as a standard mixture during 1950. An increase of 6 md. per acre in yield over check was obtained on application of 80 lb. N per acre as ammonium sulphate as compared to 2·5 md. obtained from similar quantity of oil cake. The comparative cost of application was Rs. 71/8 for ammonium sulphate and Rs. 100 for oil cake. Trials conducted over a period of 15 years showed that N as inorganic fertilizer is more effective than N as cattle manure ; 90 lb. of the latter consistently gave a lower yield than 40 lb. of sulphate of ammonia. Variations in shade densities and in types of tea caused variation in nitrogen responses. Where shade is light, tea approaching *Assamica* type responds to nitrogen of 80 lb. as sulphate of ammonia and also responds to 200 lb. N as oil cake, though less strongly. The greatest response is with the highest shade. Under heavy shade at Balipara, tea approaching the *China* type responds to sulphate of ammonia less strongly ; oil cake gives a good return. When used together, a complex interaction in terms of growth response occurs, determined by N/P ratio and absolute dosage of N.

Phosphatic manures in small doses have shown significant increase in yield of tea but the response is influenced by the type of plant and the amount of weed growth. If the tea has good spread and, if because of this, the weed growth under the tea is comparatively low, the effect is likely to be more pronounced. Inorganic nitrogenous manures (in the form of sulphate of ammonia) significantly reduce weed growth. The extensive use of green crops as a source of N supply in recent times has increased the risk of *Exobasidium vexans* infection. The danger is greater in spring and autumn. Cultural methods to ensure adequate sunlight reaching the tea and also movement of air to dry up morning dew have been tried with some success. The method may also reduce risk of *Cephaleuros parasiticus* (red rust) infection.

During the year under review, the Plant Pathology Department undertook a series of investigations to control and eradicate the more commonly prevalent tea pests and diseases : *Red spider* — A completely effective, economical and non-poisonous acaricide has not been found but sprays of Dynone wettable powder and lime-sulphur are fairly satisfactory. *Aphids* — A number of insecticidal compositions have been tested and Dynone, 1 lb. tobacco leaf in 1 gal. of water and 4 oz. soap, and nicotine sulphate have been found partially effective. *Cricket Control* — Two methods have been tried ; the use of poison bait spread on the ground and pouring of poisons down cricket holes. The former is time saving. DDT and BHC were effective down to about one-fourth of the previous level. The second method is highly effective when employed immediately following heavy rain. *Scale insects* — Lime-sulphur spray (two rounds) at normal strengths effects 95 per cent kill against soft-bodied naked scale insects but those having a hard chitinous covering appear to be immune to the treatment. *Psychid caterpillar* — No effective control has been found. *Termite control* — Gammexane-treated bushes remained free from attack. *Shade tree pest* — DDT is not effective in controlling the pest but continuous prophylactic treatment with DDT from the start provides protection to the seedlings against the attack. *Boga medeloa* — A new caterpillar pest *Maruca testurlalis* Geyer (*Pyralidae*) of Boga medeloa (*Tephrosia candida*) has been reported from many places in Upper Assam Dooars, Darjeeling and Cachar and has caused severe damage to seed crop. Reliable control measures have not been found. The caterpillar reappears one to three weeks after DDT spraying. Re-spraying with DDT and Gammexane wettable powder at different strengths seems to eradicate. *Looper caterpillar* — Attempts were made to isolate the bacterium which is found in Looper and Bunch caterpillars when they are killed by epidemics of a disease. A series of isolates were made and suspensions of cultured pure bacteria were sprayed on to Bunch caterpillars. Isolates fron sprayed caterpillars were compared with the original isolates. Increased larval mortality was caused with two of the isolates, BCA and LCA bacilli. A similar bacillus BCA was obtained from larvae which died after spraying with BCA. BCA produced similar mortality when sprayed on Bunch caterpillars.

Experiments were conducted to work out a spraying system to control endemic pests and diseases such as black-rot, thread blight, red spider, etc., at or after the time of pruning so as to reduce the amount of spraying necessary. Only minor pests were controllable, tar oils were effective in removing mosses and lichens and nest-building ants disappeared from areas sprayed with DDT. Experiments are also in progress with systemic

insecticides. Two insects have been selected for the work, tea aphids and tea-seed bug. The trials are being conducted in collaboration with *Pest Control Ltd.*, Cambridge.

BOTANICAL SURVEY OF INDIA

THE ACTIVITIES OF THE BOTANICAL SURVEY OF India are to collect and disseminate scientific information on Indian flora and offer advice to institutions and individuals on botanical subjects. During the year 1948-49 the department carried out extensive field explorations for collections. About 20,000 specimens for the herbarium were procured for preservation and cultivation from the Singalila range on the western borders of Sikkim, the Cinchona Plantation at Mungpoo, the *terai* forests near Siliguri, the Shevoroy Hills in Salem district and the Shola forest on the Nilgiris. Explorations were also conducted in the interior of Nepal along the Kosi river and in the forests of Manipur and Nanga Hills.

4,500 specimens collected by the department and received from research institutions were identified during the year. 1,054 specimens received in exchange and as gifts from foreign countries were added to the herbarium. Notable gifts were: 137 specimens by the West Virginia University, U.S.A., 712 from Royal Botanic Gardens, Edinburgh, 200 from Black Hill Teachers College, South Dakota, U.S.A., and 31 photographic prints of *Lespedeza* sps. from the Smithsonian Institution. 29,241 sheets in the herbarium were indexed and brought up to date incorporating the changes in the names of Indian plants appearing in current international literature.

Several papers incorporating results of research work in the herbarium were published during the year. These included investigations on Indo-Burmese species of *Grewia*, the fig, the lichen flora of India, cultivation of *Ipecacuanha* and *Datura metel* and *Datura fastuosa*. A compilation has been made of the common fresh and brackish water algal flora of India and Burma including the recorded Indian diatomaceae, blue-green and green algae has been made. A treatise on medicinal plants of India is also nearing completion. The work on the classification of bananas (being published serially in the Kew Bulletin) has shown that *Musa paradisiaca L.*, the plantain, and *Musa sapientum L.*, the banana, are not strictly conspecific and the combination *Musa paradisiaca* var. *sapientum* is taxonomically unsound. Some new species of *Musa* have also been established for India.

The Industrial Section of the Indian Museum, Calcutta, continued to disseminate information on economic botany. A diaroma consisting of a set of 50 models to illustrate the " Story of Cotton " from grower to the consumer was prepared. Other features prepared on similar lines relate to Pen and Pencil Industry in India, Colour Transparencies (illustrating production of catechu, sandalwood, rosin and turpentine, sabai grass, rosha grass oil, etc.), and sugar-cane exhibits.

INDIAN STANDARDS INSTITUTION

THE ANNUAL REPORT OF THE INDIAN STANDARDS Institution for the year ended March 1950 records considerable progress in the activities of the Institution. 110 standards were published and finalized as against the target fixed at 100. A new division, the Building Division Council, was created and the Certification Marks Bill under the Certification Marking Scheme was finalized.

The Unified Screw Thread System recently evolved jointly by U.K., Canada and U.S.A. is under the consideration of the Institution and a Sectional Committee under the Engineering Division Council is proposed to be constituted to consider the adoption of the system in India. The Council has decided to prepare standards for bicycles and bicycle parts and expanded metal. Two new committees are proposed to be set up, the Indian National Committee for the International Electrotechnical Commission to deal with electrical subjects pending the formation of the Electrical Engineering Division Council, and the Manganese Ore Advisory Committee.

The total number of subjects approved by the Executive Committee for standardization during the year was 664. 69 standards were finally published, 41 were under publication, 157 were in circulation and 213 were in the drafting stage. The Institution continued to receive active assistance for laboratory investigations and trials from the Central Standards Office, Ministry of Railways, Government Test House, Alipore, National Physical Laboratory, National Chemical Laboratory and several other institutions.

The ISI, which provides the secretariats for the ISO Technical Committees on Shellac and Mica, convened meetings of the International Committees during the year. The committee on seedlac, shellac and dry bleached lac has formulated proposals for international standardization of these commodities. The proposals for the classification and grading of mica could not be finalized but a considerable amount of agreement was reached. The matter has been referred to a Working Commission. During the meetings, the ISI organized an exhibition of mica and shellac products. Two interesting documentary films on the subjects have also been prepared.

The Special Committee on Weights and Measures submitted its report during the year. The report, which is under the consideration of the Government of India, has recommended early adoption of the metric system.

A draft ISI Certification Marks Bill was submitted to the Government of India and is now under the consideration of the Ministry of Law. The Bill aims at implementation of the ISI standards besides serving to convey to the consumers a guarantee of quality in respect of goods to which the Mark is applied.

The Library has over 10,000 specifications which have been catalogued and indexed for ready reference. Arrangements have been made for the translation of literature on standards from French, German, Italian and Russian languages.

The Institution was represented at the ISO Council and at the General Assembly meeting held in Paris in July 1949. For the second time in succession, its Director was elected by the Council as the Vice-President of the ISO.

INDIAN PATENTS

[The following is a list of a few of the Patent Applications notified as accepted in the *Gazette of India*, Part II, Section I, for December 1950.]

Organic Chemicals

42998. Manufacture of bis-(benzene-sulphonyl)-4-(OR-6-)-amino-pyrimidines : *Treating* 1 *mol of 4-aminopyrimidine with at least* 1·5 *mols of abenzenesulphonic acid halide in presence of trimethylamine* — FIRMA NORDMARK-WERKE GASELLSCHAFT MIT BESCHRANKTER HAFTUNG

43172. Process for obtaining amino diol derivatives : *Reacting amino hydroxy compound with amino ether, followed by acylation nitration and hydrolysis* — PARKE, DAVIS & Co.

42608. Vat dyestuffs : *Adding to the dyestuff paste* 20-50 *per cent of a viscous water soluble ether acid of a high polymer carbohydrate and finally drying the paste* — CIBA LTD.

43693. Polythene dispersions : *Passing molten polythene with water, above* 115°C. *and under pressure, through an emulsifying device and releasing the pressure* — I.C.I. LTD.

Food & Kindred Products

43072. Evaporators used in sugar industry : *An embedded semicircular canal is provided round the top end of the heating tubes in each vessel* — MATHUR

43565. Higher sucrose recovery in the manufacture and/or refining of beet and/or cane sugar : *Final molasses left after the final crystallization in sugar refining is freed from ash and organic salt and then it is subjected to boiling and crystallization for sugar recovery* — KLOPPENBURG

Leather & Leather Products

42481. Apparatus for the treatment of hides, skins and the like : *Immersing the leather in tanning liquor, causing the leather to follow a travel path in which it is guided around means whereby it is curved or bent, straining out said liquor, straining out the leather and then supporting it in proper length of time* — WILSON

43363. Apparatus for the drying of leather : *Comprising a drying chamber having a continuous internal conveyer, external conveyer and means to transfer skin-loaded panels for external to internal conveyer and vice versa* — TUSTING & OVERSTALL

Machinery (except Electricals) : Miscellaneous

42506. Pressure rollers for use in jute spinning : *A light-weight metal such as aluminium or an alloy cast as a single piece, the peripheral surface being also of the same metal* — DON WATSON & Co. LTD.

Metals & Metal Products

41552. Recovery of zinc from zinc wastes : *Reacting zinc wastes with an alkaline reagent and/or an ammonium or ferrous salt* — VIJNAHA PARISHAT

43415. Process for making steel : *Introducing molten iron, iron oxide bearing material, a basic slag forming reactant in basic lined refining zone, creating turbulent agitation of molten metal by introducing an oxidizing gas having oxygen about* 21 *per cent by volume* — INLAND STEEL CO.

Drugs & Pharmaceuticals

42205. Production of aureomycin : *After fermentation, aureomycin is adsorbed chromatographically and separated by subsequent elution* — AMERICAN CYNAMID CO.

43227. Water-solubilized vitamin compositions : *A liquid-soluble, fat-free vitamin containing material and a solubilizing agent which is a water-soluble polyoxy-alkylene derivative of a partial ester of a fatty acid* — U.S. VITAMIN CORP.

42467. Manufacture of a new condensation product of sulphanilamidopyrimidine : *By reacting 2-sulphanilamidopyrimidine with formaldehyde and propanol* — CIBA LTD.

43853. Process for the recovery of vitamin B_{12} : *Vitamin* B_{12} *containing material is subjected to counter-current distribution utilizing a two-phase partition solvent* — MERCK & Co. INC.

Physics : General

42999. Cathode-ray deflection apparatus : *Having deflection winding and a storage capacity connected in series in the output circuit of a driving tube and a unilaterally conductive device connected parallel to the series combination of said winding and capacitance* — RADIO CORP. OF AMERICA

Rubber & Rubber Products

42048. Adhesive compositions : *Mixing a first part comprising rubber solution and second part comprising polyisobutylene and vulcanizing ingredient* — B. B. CHEMICAL CO. LTD.

41460. Manufacture of building or roofing elements : *Rubber is compounded with sulphur if necessary and with fillers, the mix is formed into a sheet and the sheet is placed between the corrugated moulding plates and subjected to heat and pressure* — CRESSON

Stone, Clay & Glass Products

41784. Production of cellular concrete with tight-sealed cell structure : *Chemical substances capable to generate said cells through their swelling are mixed with cement and sand* — MUSETTI

43650. Production of cellular concrete : *Causing a metal, an alkaline metal oxide and water to react in admixture with cement and other ingredients* — RELIANCE PRODUCTS LTD.

43957. Kilns : *Comprising a pair of walls with inwardly sloping louvres providing between them*

a space for a falling change of material and a flue passing through the opening of the louvres — ERNEST NEWELL & CO. LTD. & HOWDEN

41728. Reinforced concrete ribbed floors: *Cement concrete is cast in situ over an arched centring provided along and between two successive precast reinforced concrete joints* — REJMAN

Textile & Textiles Products

43387. Crease-resistant cotton fabric: *Treating fabric with a water-insoluble copolymer of methylol melamine and a methylated methylol melamine* — JOSEPH BANCROFT & SONS CO.

Miscellaneous

43795. Separators for electric batteries: *Powdered absorbent mixed with binder is coated on a flexreinforcing sheet* — MULATORS LTD.

43771. Separation according to specific gravity of mixtures of particles: *Separating the mixtures by means of a suspension of magnetizable particles* — MAATSCHAPPIJ VOOR KOLENBEWERKING STAMICARBON N.V.

43014. Electric furnace: *Comprising an annular electrode located horizontally in the upper region of furnace and a secondary electrode located at the bottom, both the electrodes are spaced inwards from the side wall of the furnace* — RAJTORA

41988. Manufacture of anisotropic permanent magnets: *Magnet consisting of iron-base alloy containing 6 to 11 per cent aluminium, 10 to 20 per cent nickel, 16 to 30 per cent cobalt, 0 to 10 per cent niobium, 0·5 to 12 per cent tantalum, 0 to 7 per cent copper, and 0 to 5 per cent titanium* — N. V. PHILIPS' GLOEILAMPENFABRIEKEN

41987. Manufacture of anisotropic permanent magnets: *Magnet consisting of iron base alloy containing 6 to 11 per cent aluminium, 10 to 20 per cent nickel, 16 to 30 per cent cobalt, 0·5 to 10 per cent niobium, up to 7 per cent copper and 5 per cent titanium* — N. V. PHILIPS' GLOEILAMPENFABRIEKEN

PATENTED INVENTIONS OF THE C.S.I.R.

40970. MANUFACTURE OF PRISTIMERIN: The invention relates to the manufacture of active principle of therapeutic value designated by the authors as *Pristimerin*, from *Pristimera indica* (Willd.) A. C. Smith, syn. *Hippocratea indica* Willd. (Celastraceae), a wildly growing climber of Indian forests. Pristimerin is an entirely new therapeutic agent and shows considerable activity against the following pathogens: Diplococcus pneumoniae, Streptococcus pyogenes, Streptococcus viridans and Staphylococcus aureus.

The process according to the present invention consists in extracting the roots of *Pristimera indica* with petroleum ether at room temperature. The petroleum ether extract is distilled, the residue washed with cold petroleum ether and the crude product recrystallized from a suitable solvent like alcohol, petroleum ether, etc., when bright orange-coloured needles of *Pristimerin* are obtained — COL. S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA

40968. A THERAPEUTICALLY ACTIVE ANTIBIOTIC SUBSTANCE FROM *Pristimera indica* (WILLD.) A. C. SMITH: The preferred process for maximizing the yield of *Pristimerin* from *Pristimera indica* by extraction of the roots with petroleum ether is described in the specification of our co-pending patent No. 40970. The present patent describes an alternative process which consists in extracting the roots with organic solvents other than petroleum ether such as sulphuric ether, ethyl acetate, acetone or alcohol and which yields a therapeutically active antibiotic substance containing *Pristimerin*. The extraction is preferably carried out at room temperature — COL. S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA

40969. MANUFACTURE OF DULCITOL: Dulcitol is largely used as a laboratory reagent and fermentative sugar. This sugar, which is an expensive chemical, has not hitherto been manufactured in India.

The present invention consists in extracting the root-bark of *Pristimera indica* with an organic solvent, such as alcohol, which gives the maximum yield of dulcitol.

The yield of dulcitol is more when the root-bark is refluxed with rectified spirit. The extract is filtered hot, most of the alcohol is removed by distillation under vacuum and the residue is kept in the refrigerator when the crystals of dulcitol sediment slowly. The crude dulcitol is purified by recrystallization through dilute alcohol after being decolourized with activated animal charcoal — COL. S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA

39320. ACTIVATION OF BAUXITE FOR BLEACHING VEGETABLE OILS AND FATS: Decolourization of vegetable fats and oils using activated clays like fullers' earth and bentonites and activated charcoal are well known. Activated bauxite has not hitherto been used for the purpose as thermally activated bauxite has been found to have poor bleaching qualities in the case of vegetable oils and fats.

The authors of the patent have found that a combination of thermal treatment and acid treatment improves the bleaching properties of bauxite with reference to vegetable oils and fats.

The patented process consists in subjecting finely powdered bauxite of 60 mesh and above to thermal dehydration at a temperature above 300°C., followed by acid treatment, washing and drying. Dehydration of the resulting product by gradual heating at 250° to 400°C. still further improves the bleaching quality of the product.— G. G. SUTAONE, S. A. SALETORE & P. S. MENE

THE WEALTH OF INDIA

A DICTIONARY OF INDIA'S RAW MATERIALS & INDUSTRIAL PRODUCTS

The Council of Scientific & Industrial Research have pleasure in announcing the publication of Vol. II of THE WEALTH OF INDIA.

Printed in double column on Art Paper ; number of pages : 428 + xx, with 17 plates and 152 text illustrations. Size 11" × 8½". Bound in deep blue rexine.

The following Volumes are now available :

RAW MATERIALS, VOL. I (A–B)

Pages 254 + xxviii, with 39 plates

Price Rs. 15

RAW MATERIALS, VOL. II (C)

Pages 428 + xx, with 17 plates and 152 text illustrations

Price Rs. 25

INDUSTRIAL PRODUCTS, PART I (A–B)

Pages 184 + xii, with 8 plates

Price Rs. 8

INDUSTRIAL PRODUCTS, PART II (C)

Pages 252 + xii, with 7 plates and 85 text illustrations

For further details, please write to :

THE CHIEF EDITOR
THE WEALTH OF INDIA
20 PUSA ROAD
NEW DELHI 5

Announcing our appointment as sole agents

by

H&B M/s HARTMANN & BRAUN A.G. OF GERMANY

for their

ELECTRICAL MEASURING INSTRUMENTS

Portable & Switchboard Instruments
Standard and Sub-standard Units and Measuring Sets
Portable Instruments for Service, Test and Electrical Insulation Work
Portable Precision Instruments for Laboratories and Test Rooms
Galvanometers

TEMPERATURE MEASURING INSTRUMENTS

Electrical, Optical and Radiation Pyrometers
Remote Transmitters
Measuring, Regulating and Remote Control Plants

INDUSTRIAL INSTRUMENTS

Boiler House Equipment
Chemical Gas Analysis Apparatus & Recorders
Potentiometers
Pressure Gauges
Flow Meters

TOSHNIWAL BROTHERS LTD.

LADY JAMSHEDJI ROAD, MAHIM, BOMBAY 16

Phone : 88336 Grams : " ANUSANDHAN "

Foreign Offices : { 10 DEVONSHIRE ROW, LONDON E.C. 2
8 WEST 40TH STREET, NEW YORK 18, N.Y.

Journal of
Scientific & Industrial Research

V. 10B, No. 2, FEBRUARY 1951

EDITORIAL BOARD

S. S. BHATNAGAR, O.B.E., F.R.S., D.Sc., F.Inst.P., F.R.I.C., Director, Scientific & Industrial Research (ex officio Chairman)

H. J. BHABHA, Ph.D., D.Sc., F.R.S., Tata Institute of Fundamental Research, Bombay

J. C. GHOSH, D.Sc., F.N.I., Director, Eastern Higher Technical Institute, Calcutta

JIVARAJ N. MEHTA, M.D., M.R.C.P., F.C.P.S., Minister for Public Works, Government of Bombay, Bombay

S. KRISHNA, C.I.E., Ph.D., D.Sc., F.R.I.C., F.N.I., Scientific Liaison Officer, London

K. S. KRISHNAN, D.Sc., F.R.S., National Physical Laboratory, Delhi

MATA PRASAD, D.Sc., F.R.I.C., F.N.I., Royal Institute of Science, Bombay

C. V. RAMAN, F.R.S., N.L., Raman Research Institute, Bangalore

M. N. SAHA, D.Sc., F.R.S., University College of Science, Calcutta

D. N. WADIA, F.G.S., F.R.G.S., F.R.A.S.B., Geological Adviser to the Department of Scientific Research, New Delhi

B. N. SASTRI, M.Sc., F.R.I.C., A.I.I.Sc., Editor & ex officio Secretary

A. KRISHNAMURTHI, M.Sc., Assistant Editor

S. B. DESHAPRABHU, Liaison Officer (Production)

CONTENTS

Field Intensity as a Determinant of Negative Joshi Effect 27
N. Atchuta Ramaiah

Studies in Anti-malarials : Part II — Synthesis in β-Quinindene Series 30
Mohindra Singh Chadha, K. K. Chakravarti & S. Siddiqui

Utilization of Tobacco Seed & Safflower Seed Oils in Varnishes & Paints — Part I ... 33
P. Gopal Sharma, N. C. Budhraja & J. S. Aggarwal

Preservation of Citrus Fruit Juices ... 36
Jiwan Singh Pruthi & Girdhari Lal

Studies on Indian Bricks 41
L. C. Jain & B. C. Raychaudhuri

Letters to the Editor

SPIN DOUBLETS IN THE L-SPECTRUM OF PLATINUM 45
G. B. Deodhar & Chintamani Mande

A SIMPLE ELECTROLYTIC POLISHING CELL ... 46
M. N. Parthasarathi, B. S. Srikantiah & B. R. Nijhawan

CHEMICAL CONSTITUENTS OF *Nardostachys jatamanshi* : PART I — ISOLATION OF A CRYSTALLINE ACID & AN ESSENTIAL OIL 48
Govind Rai Chaudhry, Vishwa Nath Sharma & Salimuzzaman Siddiqui

ELECTRODEPOSITION OF COPPER POWDER ... 48
M. V. Joshi, H. J. Modi & G. S. Tendolkar

CHANGES IN PLANT NAMES 49
H. Santapau, S.J.

The JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH *is issued monthly.*

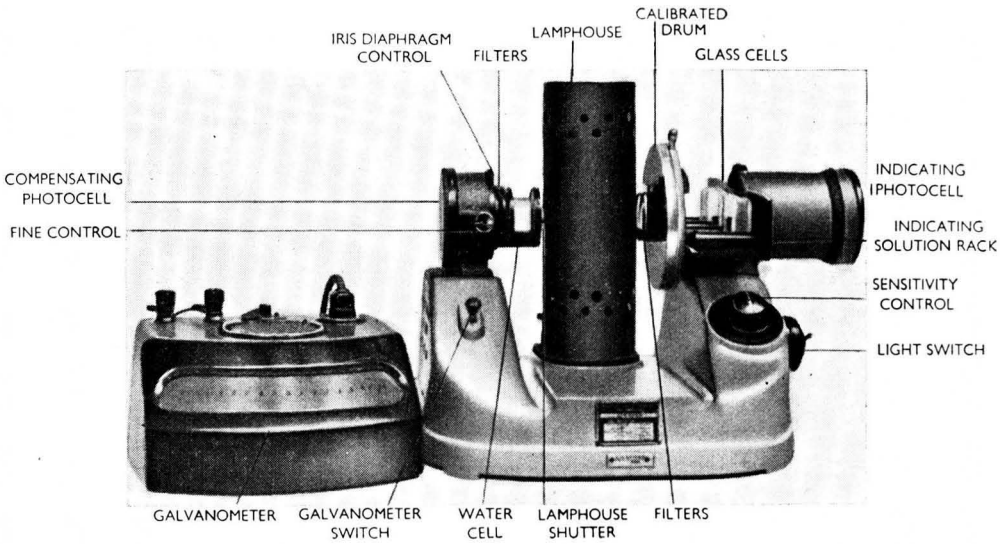
The Council of Scientific & Industrial Research assumes no responsibility for the statements and opinions advanced by contributors.

The Editorial Board in its work of examining papers received for publication is assisted, in an honorary capacity, by a large number of distinguished scientists working in various parts of India.

Communications regarding contributions for publication in the JOURNAL, *books for review, subscriptions and advertisements should be addressed to the Editor,* JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH, *Hillside Road, New Delhi* 5.

ANNUAL SUBSCRIPTION : Rs. 9 (inland) ; 18 sh. (foreign). SINGLE COPY : Re. 1 (inland) ; 2 sh. (foreign)

HILGER . . . .



SPEKKER PHOTOELECTRIC ABSORPTIOMETER

Suitable for use wherever colorimetric tests are employed in chemical, biochemical, metallurgical or similar analyses. Self-compensated against fluctuations in the mains supply, and of a robust and compact design. Its null method of operation renders readings independent of variations in the electrical circuits. Also available as a Photoelectric Fluorimeter especially applicable to analyses of vitamins B_1 and B_2.

The absorptiometer is available in different forms for various applications and models for microcells and also for extra-long tubes for pale solutions can be supplied.

Sole Agents in India for

HILGER WATTS LTD.

Associated Instrument Mnfrs. (India) Ltd.

B5 Clive Buildings

Calcutta

BOMBAY
P.O. BOX 119

NEW DELHI
76 QUEENSWAY

Field Intensity as a Determinant of Negative Joshi Effect

N. ATCHUTA RAMAIAH
Chemical Laboratories, Banaras Hindu University, Banaras

Influence of electrode spacing on potential variation of $-\triangle i$ in excited chlorine showed its dependence on the surface field intensity (E), in agreement with Joshi's theory that $-\triangle i$ is a space charge effect due to negative ion formation and in an inverse function of E.

EARLIER results[1-3] showed that an appreciable ionization by collision under external fields was a necessary precedent to the production of the above phenomenon, defined as an instantaneous and reversible photo-diminution ($-\triangle i$) of the discharge current i due to a constant applied potential V, observed in a number of gases, especially halogens. In a recent theory (*vide infra*), Joshi has shown the importance *inter alia* of the intensity of the applied electrical field. This was investigated in some detail.

Experimental

The discharge was produced in the annular space between tubes sealed coaxially as in Siemens' type ozonizers A, B and C of the same length 22 cm. and outer dia. 19 mm., with inter-electrode distance d of 2, 4 and 6 mm. respectively and filled at 300 mm. Hg (found optimum for $-\triangle i$ by trial experiments) of chlorine purified carefully by fractionation over liquid air. The ozonizers were excited with A.C. potentials obtained from rotary converters and stepped up by a high-tension transformer. The secondary potentials V were observed with a Kelvin-White electrostatic voltmeter and expressed in kilovolts (r.m.s.), kV. The essential part of the experimental arrangement and circuit are shown in Fig. 1. i was measured with a galvanometer (G) actuated by a Cambridge vacuo-junction (FIG. 1) ; the deflections were observed on a two meter-distant

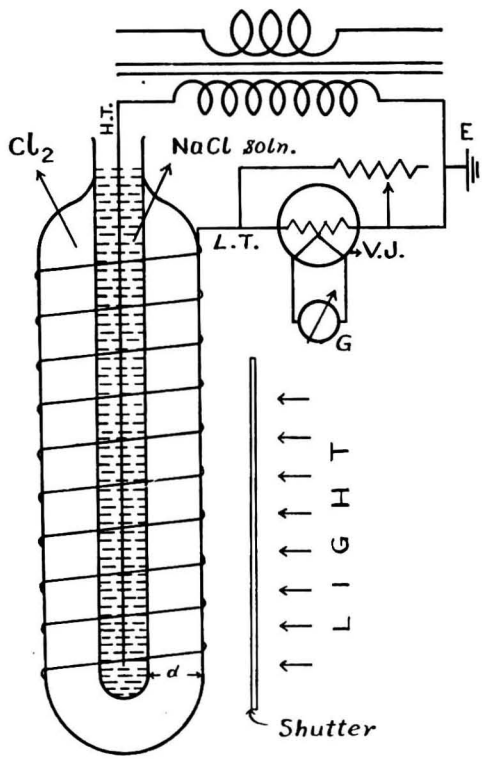


FIG. 1 — EXPERIMENTAL SET UP FOR THE STUDY OF JOSHI EFFECT IN CHLORINE.

scale. i_{Light} and i_{Dark} measured with excited ozonizer irradiated by a 100 watt bulb and screened therefrom respectively give the net ($\triangle i = i_{Dark}$-i_{Light}) and relative ($\%\triangle i = 100\triangle i/i_{Dark}$) *Joshi effect*. One typical set of results for *A*, *B*, *C* are given in Tables I and II with 50 and 500 cycle potentials respectively.

Discussion

Below the "threshold potential" V_m[5] where the gas breaks down as dielectric, the ohmic conductivity is negligible. The potential across the gas space is given by $V_g = V_m.C/C_g$ (i) where the total capacity C is $1/C = 1/C_w + 1/C_g$. Being dependent on the dielectric constant of the gas, C_g is small compared with C_w. C_g is therefore equal to C and V_m in (i) is a measure of the potential on the gas space, to a first approximation. The fundamental significance of the "threshold potential" in especially ozonizer type discharges has been stressed by Joshi[5]. Below V_m, *Joshi effect* $-\triangle i$ is unobserved, despite the use of intense and even short-wave radiations. For the three ozonizers *A*, *B* and *C*, V_m was respectively 3·0, 6·2 and 8·9 kV. (50~) ; the corresponding ratio V_m/d was 1·5, 1·55 and 1·5. At 500 cycles, V_m was 2·4, 4·8 and 6·9 and V_m/d was 1·2, 1·2 and 1·15. These results show that roughly V_m is a linear function of the inter-electrode distance, which is analogous to that observed in "spark" potentials at constant gas pressure. As in a cylindrical condenser, the field at the surface of the inner electrode of the ozonizer $E = V_g/r_2 . \log_e \frac{r_1}{r_2}$ (ii) where r_1 is the inner radius of the outer electrode and r_2 the outer one of the inner electrode. For *A*, *B* and *C*, E at the "threshold potential" was respectively 17, 20·6 and 25·5 with 50~ ; 13·6, 16 and 19·8 kV./cm. at 500~. For a frequency change from 50 to 500 cycles, V_m and the corresponding field reckoned at the surface decreased by about 22 per cent. As emphasized by Joshi[5], this reduction would appear to be greater than that familiar with Paschen potentials. Whitehead[6] found that the Paschen potential in air decreased by about 6 per cent when the frequency was altered from 25 to 90 cycles/sec. The results of Rukema[7], also for air, showed that even for much larger frequencies, viz. of 22-66 kc./sec., the decrease was about 17 per cent.

In agreement with a general finding due to Joshi[1,4,5] $-\Delta i$ increased (numerically) with *V* above the "threshold potential" over a limited range, and decreased thereafter. Thus e.g. with ozonizer *A* and 50~(TABLE I), Δi changed from 0·51 at 3·5 kV. to 1·53 at 10·1 kV. and then decreased to 0·95 at 11·2 kV. The results with 500 cycles were similar (TABLE II) ; the decrease of Δi at large *V*, anticipated from Joshi's theory[4], could not, however, be recorded, since the increase of *i* with applied *V* (500~) was much too rapid for observation with the available current indicator. In agreement with Joshi's generalization[1], $\%\Delta i$ is maximum near V_m and decreased at larger *V*. Thus e.g. with *C* and 50~ (TABLE I), $\%\Delta i$ at 9·6 kV. was 62 and decreased to 47 at 13·9 kV. Potential variation of $\%\Delta i$ at 500~ was similar (TABLE II). The data in Tables I and II show that at a given potential which is about the same multiple of the corresponding V_m, the relative *Joshi effect* $\%\Delta i$ is smaller at larger frequency. Thus e.g., with *B* it was 56 and 34 at 7·5 (50~) and 5·5 (500~) kV. which were above V_m by about 20 per cent.

It is instructive to consider from results in Table I the influence of inter-electrode distance *d* on Δi and $\%\Delta i$ at constant applied *V*: At 10·1 kV. (50~) Δi was 1·53(*A*), 6·11(*B*) and 7·86(*C*) ; and $\%\Delta i$ was 23, 42 and 63. A like comparison at 500 cycles was not possible since data could not be obtained at identical values of *V* in the three systems due to rapid increase of *i* with applied *V*. Since, however, *i* is a continuous increasing function of *V*, the above influence of *d* on $-\Delta i$ is revealed by considering the results for identical current values (cf. TABLE III). At $i_{Dark} = 20$ units, Δi for *A*, *B* and *C* was respectively 5·7, 7·0 and 8·2.

Joshi[4] has suggested the formation, under discharge, of an electrode layer derived, in part, from adsorption of ions, electrons and excited particles, as primary to $-\Delta i$. Electrons released from this layer under irradiation are captured by the excited neutral particles resulting in the formation of slow-moving negative ions which reduce *i* as a space charge effect. The relative surface field E, for *low* current values, calculated from (ii) was 100, 59 and 50 respectively for *A*, *B* and *C*. Since, as emphasized

TABLE I — INFLUENCE OF INTER-ELECTRODE DISTANCE ON POTENTIAL VARIATION OF *JOSHI EFFECT* IN CHLORINE (50 CYCLES)

kV.	i_D	i_L	$\triangle i$	$\%\triangle i$
	Ozonizer *A*: inter-electrode distance, 2 mm.			
2·96	1·00 (1·0)	0·71 (0·5)	0·29	29·0
3·50	1·73 (3·0)	1·22 (1·5)	0·51	29·5
3·93	2·35 (5·5)	1·41 (2·0)	0·94	40·0
5·27	2·83 (8·0)	1·73 (3·0)	1·10	38·9
5·80	3·24 (10·5)	2·12 (4·5)	1·12	34·5
6·14	3·67 (13·5)	2·45 (6·0)	1·12	33·0
6·67	4·00 (16·0)	2·83 (8·0)	1·17	29·3
7·20	4·36 (19·0)	3·16 (10·0)	1·20	27·5
7·73	4·74 (22·5)	3·54 (12·5)	1·20	25·5
8·27	5·20 (27·0)	3·94 (15·5)	1·26	24·3
9·33	6·16 (38·0)	4·90 (24·0)	1·26	20·4
9·60	6·33 (40·0)	5·40 (25·5)	1·29	20·4
10·10	6·63 (44·0)	5·10 (26·0)	1·53	23·1
10·68	7·00 (49·0)	5·75 (33·0)	1·25	17·8
11·21	7·35 (54·0)	6·40 (41·0)	0·95	12·9
	Ozonizer *B*: inter-electrode distance, 4 mm.			
6·14	5·20 (27·0)	3·00 (9·0)	2·20	42·3
6·67	6·63 (44·0)	3·32 (11·0)	3·31	49·9
7·20	8·31 (69·0)	3·74 (14·0)	4·57	55·0
7·73	9·80 (96·0)	4·19 (17·5)	5·61	57·2
8·27	11·14 (124·0)	5·00 (25·0)	6·14	55·1
8·81	12·21 (149·0)	5·75 (33·0)	6·46	52·9
9·60	13·56 (184·0)	6·93 (48·0)	6·63	48·9
10·10	14·74 (217·0)	8·63 (74·5)	6·11	41·5
10·68	18·30 (336·0)	12·21 (149·0)	6·09	33·3
11·21	18·65 (348·0)	12·65 (160·0)	6·00	32·2
11·75	19·07 (364·0)	13·26 (176·0)	5·81	30·4
	Ozonizer *C*: inter-electrode distance, 6 mm.			
8·91	6·78 (46·0)	2·83 (8·0)	3·95	58·3
·05	9·72 (94·5)	3·87 (15·0)	5·85	60·2
9·60	11·70 (137·0)	4·47 (20·0)	7·23	61·9
10·10	12·33 (152·0)	4·47 (20·0)	7·86	63·8
10·68	13·28 (176·5)	4·47 (20·0)	8·81	66·7
11·21	14·24 (203·0)	4·74 (22·5)	9·50	66·7
11·74	14·87 (221·0)	6·00 (36·0)	8·87	59·6
12·27	16·12 (260·0)	6·33 (40·0)	9·79	60·7
12·80	18·03 (325·0)	7·71 (59·5)	10·32	57·3
13·35	19·00 (361·0)	9·19 (84·5)	9·81	51·6
13·88	19·79 (392·0)	10·37 (107·5)	9·40	47·1

The quantities within the brackets represent the actual galvanometer readings, i.e. the values of i_D^2.

TABLE II — INFLUENCE OF INTER-ELECTRODE DISTANCE ON POTENTIAL VARIATION OF *JOSHI EFFECT* IN CHLORINE (500 CYCLES)

kV.	i_D	i_L	$\triangle i$	$\%\triangle i$
	Ozonizer *A*: inter-electrode distance, 2 mm.			
2·43	3·46 (12·0)	3·00 (9·0)	0·46	13·3
2·54	5·09 (26·0)	3·80 (14·5)	1·29	25·3
2·65	6·63 (44·0)	3·94 (15·5)	2·69	42·5
2·76	8·83 (78·0)	5·48 (30·0)	3·35	37·9
2·86	11·40 (130·0)	7·28 (53·0)	4·12	37·0
2·97	13·92 (194·0)	8·86 (78·5)	5·06	36·4
3·07	16·55 (274·0)	10·77 (116·0)	5·78	34·9
3·18	18·44 (340·0)	12·65 (160·0)	5·79	31·4
3·29	20·25 (410·0)	14·45 (210·0)	5·80	29·1
3·39	21·81 (476·0)	15·49 (240·0)	6·32	29·0
	Ozonizer *B*: inter-electrode distance, 4 mm.			
4·77	4·58 (21·0)	2·34 (5·5)	2·24	48·9
4·88	5·48 (30·0)	3·16 (10·0)	2·32	42·9
4·98	7·28 (53·0)	4·24 (18·0)	3·04	41·8
5·08	9·80 (96·0)	5·70 (32·5)	4·10	41·8
5·19	12·75 (162·5)	7·42 (55·0)	5·33	41·7
5·30	16·46 (271·0)	11·20 (125·5)	5·26	31·9
5·41	18·52 (343·0)	12·02 (144·5)	6·50	35·1
5·51	20·22 (409·0)	13·26 (176·0)	6·96	34·4
5·62	21·82 (476·0)	14·19 (201·5)	7·63	34·9
	Ozonizer *C*: inter-electrode distance, 6 mm.			
6·90	5·48 (30·0)	2·00 (4·0)	3·48	63·5
7·01	6·70 (45·0)	2·65 (7·0)	4·05	60·4
7·11	7·41 (55·0)	3·24 (10·5)	4·17	56·3
7·28	10·61 (115·0)	5·04 (25·5)	5·57	52·2
7·32	12·69 (160·0)	6·71 (45·0)	5·98	47·1
7·43	15·16 (230·0)	8·27 (68·5)	6·89	45·4
7·55	19·00 (361·0)	11·18 (125·0)	7·82	43·3
7·65	20·57 (423·5)	12·24 (150·0)	8·33	40·5
7·76	22·15 (491·0)	13·23 (175·0)	8·92	40·3

The quantities given in the brackets represent the actual galvanometer readings, i.e. the values of i_D^2.

TABLE III — COMPARATIVE *JOSHI EFFECT* IN OZONIZERS *A*, *B*, *C* AT CONSTANT CURRENT i_D (500 CYCLES)

i_D	$\triangle i$			$\%\triangle i$		
	A	*B*	*C*	*A*	*B*	*C*
6	2·0	2·7	3·8	38·5	47·0	62·5
8	3·2	3·8	4·7	41·0	44·8	57·0
10	4·0	4·6	5·5	40·0	42·5	52·5
12	4·6	5·2	6·3	38·0	40·5	48·5
14	5·1	5·8	6·9	36·2	38·5	45·0
16	5·3	6·3	7·4	34·5	37·0	43·0
18	5·6	6·7	7·8	32·5	35·5	41·5
20	5·7	7·0	8·2	30·0	34·0	40·5

These results were obtained from the curves drawn for the data given in Table II.

by Joshi[8], the probability of electron capture leading to negative ion formation is an inverse function of E at constant gas pressure, it is to be anticipated that the *Joshi effect* should vary in the order, $A<B<C$, as actually found.

Grateful thanks are due to Prof. Joshi for suggesting the problem, kind interest and valuable guidance during the work; to the Ministry of Education, Government of India, for a fellowship; and to the Council of Scientific & Industrial Research for permission to use the apparatus under their grant.

REFERENCES

1. Joshi: *Proc. Ind. Sci. Cong.*, Presidential Address, Chem. Sec., 1943.
2. Joshi & Lad: *Proc. Ind. Acad. Sci.*, 1945, **22**, 293.
3. Das Gupta: *Sci. & Cult.*, 1945-46, **11**, 318.
4. Joshi: *Proc. Ind. Sci. Cong.*, Phys. Sec., 1946 Abs. 26; ibid., 1947, Abs. 27; *Curr. Sci.*, 1947, **16**, 19.
5. Joshi: *Trans. Farad. Soc.*, 1929, **127**, 140; *Curr. Sci.*, 1939, **8**, 548; 1946, **15**, 281; *Proc. Ind. Acad. Sci.*, 1945, **22**, 389.
6. Whitehead: *Amer. Inst. Elect. Eng.*, 1911 (June).
7. Rukema: *Trans. Amer. Inst. Elect. Eng.*, 1928, **47**, 38.
8. Ramanarao & Sarma: *Jour. Phys. & Colloid Chem.*, 1949, **53**, 753.

Studies in Anti-malarials—Part II: Synthesis in β-Quinindene Series

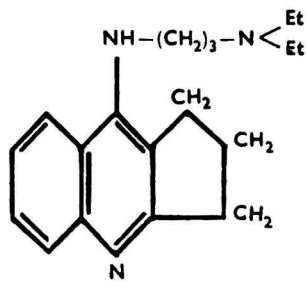
MOHINDRA SINGH CHADHA, K. K. CHAKRAVARTI & S. SIDDIQUI

Chemical Laboratories, C.S.I.R., Delhi

A series of 12-(arylamino) and 12-(diethyl-amino-propylamino)-substituted-2 : 3-dihydro-β-quinindenes have been synthesized. The physical and chemical properties of these compounds are described.

IN the previous communication[1] the synthesis of a number of 2 : 3-dihydro-β-quinindenes with various mono and di-substituents in the benzene ring, by the condensation of ethyl-cyclopentanone-2-carboxylate with appropriate arylamines and subsequent cyclization of the condensation product, by the method of Conrad and Limpach[2], was reported. The present paper describes the synthesis of 12-(arylamino)- and 12-(diethyl-amino-propylamino)-substituted-2 : 3-dihydro-β-quinindenes.

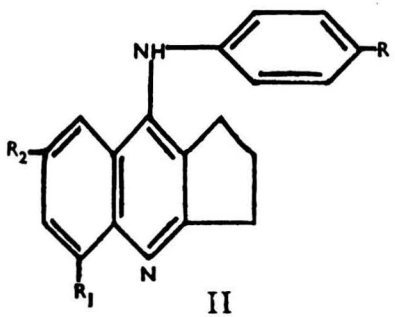
It is well established that a dialkylamino-alkylamine chain in *para*-position to the nitrogen atom in compounds like atebrin and chloroquin is essential for their anti-malarial activity. The introduction of an alkylamino-alkylamine chain at position 12 in 2 : 3-dihydro-β-quinindenes was, therefore, expected to yield compounds more basic in nature and with enhanced anti-malarial activity. In view of these considerations 12-(diethyl-amino-propylamino)-9-chloro (and 9-methoxy)-2 : 3-dihydro-β-quinindenes (I) have been prepared by the introduction of diethyl-amino-propylamine chain through the respective 12-chloro-derivatives.



I

It was also considered of interest to observe the effect of arylamine substituents at

position 12 of the quinindene nucleus. With this object in view, 12-(*p*-methoxy-anilino)-9-methyl, (9-methoxy, 9-ethoxy, 9-chloro and 9-bromo)-2 : 3-dihydro-β-quinindenes (IIa), 12-(*p*-ethoxy-anilino)-9-methoxy, (9-ethoxy, 9-chloro and 7-methoxy)-2 : 3-dihydro-β-quinindenes (IIb), 12-(*p*-chloro-anilino)-9-methoxy, (and 9-ethoxy)-2 : 3-dihydro-β-quinindenes (IIc) and 12-(*p*-methyl-anilino)-9-methoxy, (and 7-methoxy)-2 : 3-dihydro-β-quinindenes (IId) have been prepared by condensing suitable arylamines with respective 12-chloro-2 : 3-dihydro-β-quinindenes.



II

(IIa) R=OCH_3, R_1=H, R_2=CH_3, OCH_3, OC_2H_5, Cl, and Br
(IIb) R=OC_2H_5, R_1=H, R_2=OCH_3, OC_2H_5, Cl, R_1=OCH_3, R_2=H_5
(IIc) R=Cl, R_1=H, R_2=OCH_3, OC_2H_5
(IId) R=CH_3, R_1=H, R_2=OCH_3
R_1=OCH_3, R_2=H

Experimental

12-chloro-substituted-2 : 3-dihydro-β-quinindenes were prepared from respective 12-hydroxy-substituted-2 : 3-dihydro-β-quinindenes[1] by the following procedure. The appropriate 12-hydroxy base was heated with 4-5 parts of $POCl_3$ at 110°-20°C. for 2-3 hr., heating being continued for another half an hour after the stoppage of HCl fumes. Excess $POCl_3$ was then distilled off under reduced pressure at 90°-100°C. The oily liquid residue was repeatedly washed with cold petroleum ether and the base liberated by treating with 10 per cent ice-cold ammonia. In most of the cases the chloro base could be filtered and crystallized from alcohol or methanol. In other cases where the precipitated base formed a slimy unfilterable mass, it was extracted with chloroform, washed with ether, dried over calcium chloride and crystallized from alcohol or methanol. The 12-chloro-substituted-2 : 3-dihydro-β-quinindenes are described in Table I.

12-(*Diethyl-amino-propylamino*)-9-*methoxy*-2 : 3-*dihydro-β-quinindene* — To 0·4 gm. (1 mol.) of 12-chloro-9-methoxy-2 : 3-dihydro-β-quinindene in 3 c.c. of freshly distilled phenol was added 0·28 gm. of diethylamino-propylamine (1·1 mol.) and the mixture heated in the presence of a trace of copper powder in a sealed tube at 140°-50°C. for 20 hr. (As a result of a number of experiments at different temperatures, e.g. 120°-30°C., 140°-50°C., 160°-70°C. and 180°-90°C., the optimum temperature range for the condensation was found to be 140°-50°C.) After cooling, the reaction mixture was treated with 20 c.c. of 5 per cent solution of NaOH and the resulting turbid solution extracted with ether. The reddish ethereal extract was repeatedly extracted with 5 per cent acetic acid. The acidic extract was cooled, made alkaline with 5 per cent NaOH solution and extracted with ether and the extract was washed with water, dried over Na_2SO_4 and freed of the solvent. The oily liquid residue did not give a characterizable hydrochloride but formed a crystalline dipicrate, m.p. 226°C. Found N, 16·12, the picrate, $C_{20}H_{29}N_3O(C_6H_3N_3O_7)_2$ requires N, 16·05 per cent.

TABLE I — 12-CHLORO-SUBSTITUTED-2 : 3-DIHYDRO-β-QUININDENES (I)

Substituent	(I)	M.P., °C.	Yield, %	Formula	Analysis			
					Found		Requires	
					N %	Cl %	N %	Cl %
9-methyl	Colourless needles	89	50	$C_{13}H_{12}NCl$	6·51	16·31	6·44	16·32
9-methoxy	do	126	42	$C_{13}H_{12}ONCl$	6·02	15·32	5·99	15·2
9-ethoxy	do	131	48	$C_{14}H_{14}ONCl$	5·68	14·42	5·65	14·34
9-chloro	Slight pinkish needles	119	40	$C_{12}H_9NCl_2$	5·96	29·65	5·90	29·59
7-methoxy	Greyish needles	133	52	$C_{13}H_{12}ONCl$	6·12	15·38	5·99	15·2
9-bromo	Colourless needles	141	44	$C_{12}H_9NClBr$	5·12	...	4·95	...

TABLE II

Substituent		M.P., °C.	Yield, %	Formula	Nitrogen, %	
					Found	Requires
	12-(*p-methoxy-anilino*)-*substituted*-2 : 3-*dihydro*-β-*quinindene* (*IIa*)					
9-methyl	Light-brown needles	308	52	$C_{20}H_{20}ON_2$	9·13	9·21
9-methoxy	Colourless needles	186	70	$C_{20}H_{20}O_2N_2$	8·82	8·75
9-ethoxy	Light-grey needles	286	70	$C_{21}H_{22}O_2N_2$	8·42	8·38
9-chloro	Colourless needles	189	58	$C_{19}H_{17}ON_2Cl$	8·68	8·63
9-bromo	Light-grey needles	303	65	$C_{19}H_{17}ON_2Br$	7·68	7·59
	12-(*p-ethoxy-anilino*)-*substituted*-2 : 3-*dihydro*-β-*quinindene* (*IIb*)					
9-methoxy	Colourless needles	168	65	$C_{21}H_{22}O_2N_2$	8·42	8·38
9-ethoxy	Light-grey needles	196	60	$C_{22}H_{24}O_2N_2$	8·02	8·05
9-chloro	Light-brown needles	207	72	$C_{20}H_{19}ON_2Cl$	8·35	8·27
7-ethoxy	Colourless needles	238	75	$C_{21}H_{22}O_2N_2$	8·54	8·38
	12-(*p-chloro-anilino*)-*substituted*-2 : 3-*dihydro*-β-*quinindene* (*IIc*)					
9-methoxy	Colourless needles	207	65	$C_{19}H_{17}ON_2Cl$	8·81	8·63
9-ethoxy	do	178	68	$C_{20}H_{19}ON_2Cl$	8·25	8·27
	12-(*p-methyl-anilino*)-*substituted*-2 : 3-*dihydro*-β-*quinindene* (*IId*)					
9-methoxy	Light-grey needles	196	75	$C_{20}H_{20}ON_2$	9·12	9·21
7-methoxy	do	218	65	$C_{20}H_{20}ON_2$	9·14	9·21

12-(*Diethylamino-propyl amino*)-9-*chloro*-2 : 3-*dihydro*-β-*quinindene* — It was obtained by heating 0·4 gm. of 9 : 12-dichloro-2 : 3-dihydro-β-quinindene in 3 c.c. of phenol with 0·26 gm. of diethylamino-propylamine in presence of a trace of copper powder in a sealed tube at 140°-50°C. for 20 hr. It was worked up according to the method followed for the previous condensation, and the oily liquid obtained was characterized through its crystalline dipicrate, m.p. 212°C. Found N, 16·02; the picrate, $C_{19}H_{26}N_3Cl(C_6H_3N_3O_7)_2$ requires N, 15·96 per cent.

12-(*Arylamino*)-2 : 3-*dihydro*-β-*quinindenes* substituted in the ring were prepared from the respective 12-chloro-2 : 3-dihydro-β-quinindenes by the following procedure. The appropriate 12-chloro-2 : 3-dihydro-β-quinindene was dissolved in 5-6 parts of freshly distilled phenol in a pyrex test-tube. 1-1·2 molar proportions of the desired arylamine was added to it, and the test-tube was sealed and heated in a water bath at 100°C. for 8-10 hr. After cooling and dilution with anhydrous ether, the addition of a few drops of ethereal HCl precipitated out the hydrochloride of the resultant base, which was filtered and washed with ether and acetone till free of phenol. The base was liberated from the hydrochloride with 10 per cent ammonia, filtered, washed, dried and crystallized from alcohol or methanol. The 12-(arylamino)-2 : 3-dihydro-β-quinindenes obtained are described in Table II.

REFERENCES

1. Chadha, Mohindra Singh, Chakravarti, K. K. & Siddiqui, S. : *J. sci. industr. Res.*, 1951, **10B**, 1.
2. Conrad & Limpach : *Ber.*, 1887, **20**, 944; Limpach : *Ber.*, 1931, **64B**, 969.

Utilization of Tobacco Seed & Safflower Seed Oils in Varnishes & Paints — Part I

P. GOPAL SHARMA, N. C. BUDHRAJA & J. S. AGGARWAL
National Chemical Laboratory, Poona

Methods for the preparation of modified oils from tobacco seed and safflower seed oils have been described. Varnishes and ready-mixed paints containing the modified oils are superior to those formulated with linseed oil.

LINSEED oil is the common drying oil mostly used in India in coating compositions. Although formulations containing this oil give hard and glossy films, they become yellow with ageing. Moreover, the impetus which the paint industry has received during recent years has led to a search for linseed oil substitutes. Dehydrated castor oil, either in admixture with linseed oil or alone, is used for coating compositions. Besides, oils containing linoleic acid as a major component fatty acid are available in fairly larger amounts in India. Of such oils tobacco seed[1] and safflower seed oils are the more important ones. These oils have a high linoleic acid content (51-78 per cent) and possess high iodine values (131-50). As large quantities of these oil seeds are available in the country, it was thought necessary to find out methods for their modification for use in paint and varnish industry.

Attempts in this direction have been made by Rao and Ramanayya[2] who prepared double-boiled tobacco seed oil and found it to be inferior to double-boiled linseed oil. The films of the oil became tacky after a few days, but were more lustrous and flexible than linseed oil films. Blown tobacco seed oil was found to be identical with blown linseed oil. Poinot[3] has reported the use of tobacco seed oil in paints and varnishes.

Rowaan[4] also finds tobacco seed oil satisfactory in the formulation of special paints. Safflower oil has been regarded a potential oil crop for paint manufacture in Australia[5] and its mixture with soyabean and linseed oils has been recommended[6] as an efficient coating material. Stand oil has also been prepared from safflower seed oils[7].

The present investigation was undertaken with a view to prepare modified drying oils from raw tobacco seed and safflower seed oils and to utilize them in the preparation of varnishes and paints[8]. The results obtained are reported in this paper.

Double-boiled and stand oils were prepared from raw tobacco seed and safflower seed oils and were found to be similar to the corresponding linseed oil products. The oils were heated with resorcinol[9] and sodium bisulphate and the physical and chemical properties of the products so obtained were determined. With a view to hydroxylate these oils so that they could further be dehydrated for introducing conjugated linkages, the raw oils were treated with selenium dioxide according to the method of Armitage and Cotrell[10] ; but it was found that selenium enters into combination with the oils. Hydroxylation of the oils in presence of lead peroxide and potassium permanganate gave poor results.

Isomerization of these oils was tried in the presence of anthraquinone[11], nickel-carbon catalyst[12] and activated silica[13]. Modified oils having good drying properties were obtained with the first two catalysts.

Varnishes of medium oil range using ester gum were made from some of the oils treated as above and they have been found similar to the corresponding linseed oil varnishes.

White paints using titanium dioxide and the above oils gave films similar to films obtained with similar linseed oil paints, but the colour retention property of the former was better. The red lead paints were also similar to linseed oil paints, but when iron oxide was employed the films were darker than the linseed oil ones. Cobalt driers are better than manganese or lead driers or their mixtures. Lead drier gives the film a slightly tacky property.

Experimental

Alkali-refined tobacco seed and safflower seed oils used in the present investigation had the following characteristics:

	Tobacco seed oil	*Safflower seed oil*
Colour	Brownish yellow	Yellow
Sp. gr., 40°C.	0·9100	0·9158
Viscosity, 40°C. (centistokes)	37·7	34·72
Acid val.	1·8	0·5
Sap. val.	190·2	192·1
Iod. val. (Wijs)	140·2	139·9

Double-boiled & Stand Oils

Double-boiled oils were prepared from raw tobacco seed and safflower seed oils by heating them in open pans at 220°-30°C. for 8 hr. Stand oils were produced by heating the raw oils at 270°-80°C. for 6-7 hr. 0·5 per cent of cobalt naphthenate was added to each product.

The characteristics of the two oils and that of the corresponding linseed oil are given in Table I.

The films of double-boiled and stand oils from tobacco seed and safflower seed oils stick as tenaciously to a tin plate as the corresponding linseed oil films. They were resistant to white spirit, turpentine, petrol ether, rectified spirit and carbon tetrachloride, while benzene, acetone and ether remove them rapidly. The films of the products from safflower seed and tobacco seed oil blushed when kept in water for 24 hr., but regained their original colour after drying in air. The blushing with linseed oil films was permanent. 10 per cent sulphuric acid had no effect on the films but they dissolve easily within 5-10 min. in 5 per cent caustic soda.

Treatment of Raw Oils with Catalysts

Tobacco seed and safflower seed oils were heated with 2 per cent resorcinol at 150°C. for 2 hr. Double-boiled and stand oils were then prepared from these products. These materials were also prepared from the raw oils treated with 0·5 per cent sodium bisulphate. 0·5 per cent cobalt naphthenate was used as the drier. The characteristics of the modified oils are given in Table II.

It has been found that if the double-boiled oil from safflower oil be prepared by heating it with 5 per cent resorcinol, the time taken for the film to become touch dry is reduced to 4·5 hr. The resistance of the films towards organic solvents was of the same order as in the case of oils prepared without catalysts. They were, however, more resistant to water. The blushing of the films in water was less marked and disappeared entirely after the plate was dried at ordinary temperature.

Isomerization of the Raw Oils

Treatment with Anthraquinone — Tobacco seed and safflower seed oils were heated at 270°C. in presence of 2 per cent anthraquinone for 5 hr. The catalyst which

TABLE I

Characteristics	Double-boiled oil			Stand oil		
	Linseed	Tobacco seed	Safflower seed	Linseed	Tobacco seed	Safflower seed
Sp. gr., 40°C.	0·938	0·928	0·9365	0·9639	0·9550	0·9515
Viscosity, 40°C. (centistokes)	319·2	216·4	260·3	2249	2187	2116
Acid val.	3·86	2·5	0·81	2·8	3·5	1·2
Sap. val.	198·7	194·9	194·9	201·4	197·4	196·8
Iod. val. (Wijs)	144·4	121·7	128·5	110·4	108·5	105·2
Time taken for the film to become touch dry (hr.)	4	5	4·5	4	4·5	4

TABLE II

Characteristics	Catalyst — resorcinol				Catalyst — sodium bisulphate			
	Tobacco seed oil		Safflower seed oil		Tobacco seed oil		Safflower seed oil	
	Double boiled	Stand	Double boiled	Stand	Double boiled	Stand	Double boiled	Stand
Sp. gr., 40°C.	0·929	0·955	0·9386	0·9614	0·928	0·961	0·9392	0·9619
Viscosity, 40°C. (centistokes)	161·2	2525·4	250·1	2972·6	269·7	2837·0	275·9	2409·8
Acid val.	2·6	4·14	1·7	2·1	2·43	3·77	1·8	2·3
Sap. val.	204·2	208·5	195·8	196·4	206·0	209·5	197·2	199·5
Iod. val. (Wijs)	129·4	124·2	131·2	127·8	118·3	99·1	116·7	93·6
Time taken for the film to become touch dry (hr.)	4·5	4	8	4·5	4·5	4	4	3·5

separated on cooling was removed by centrifuging the oils. The Diene values (Ellis and Jones) were 13·3 and 11·5 respectively. When 5 per cent anthraquinone was used in the above experiments, the Diene values were 14·4 and 12·4 respectively. As the difference between the first and second series of values is small, treatment of these oils with 2 per cent of anthraquinone was adopted for the preparation of varnishes and paints described in the paper.

Treatment with Nickel-carbon Catalyst — The nickel-carbon catalyst was prepared by stirring a solution of 116 gm. of nickel nitrate in 160 c.c. distilled water and 100 gm. of activated carbon. A solution of 68 gm. ammonium carbonate in 400 c.c. of water was then added and the ingredients were mixed thoroughly until the evolution of the gas ceased. The mixture was filtered and the residue was washed with about 200 c.c. of water in small portions and then dried at 90°C. The material was then reduced in a current of hydrogen at 350°-70°C. for 2 hr. To 10 gm. of the nickel-carbon catalyst prepared as above was added 200 gm. of the raw oil and the mixture was heated with stirring at 168°-72°C. for 6 hr. The catalyst was removed by filtration.

The characteristics of the isomerized oils are given in Table III. The colour of these treated oils fluctuated between yellow to pale brown as compared to the dark reddish-brown tints obtained by the first two methods.

When the plates of the dried films were immersed in water at ordinary temperature for 24 hr., the anthraquinone-treated oil films blushed slightly but they regained their original colour when the films were dried in the air. In the nickel-carbon treated oils films, the original colour was not regained completely. 10 per cent sulphuric acid had no effect on the films, while 5 per cent caustic soda dissolved them in about 10 min.

TABLE III

Characteristics	Tobacco seed oil		Safflower seed oil	
	Anthra-quinone treated	Nickel-carbon treated	Anthra-quinone treated	Nickel-carbon treated
Sp. gr., 40°C.	0·921	0·912	0·9592	0·9335
Viscosity, 40°C. (centistokes)	435·0	52·1	450·0	75·92
Acid val.	4·43	2·0	2·13	0·51
Sap. val.	195·6	213·4	193·6	194·1
Iod. val. (Wijs)	125·7	137·2	119·5	132·1
Time taken for the film to become touch dry (hr.)	4	4·5	4	5·5

All the films were resistant to common organic solvents. Treatment of both the oils with activated silica did not give materials with improved drying properties.

Treatment of the Raw Oils with Selenium Dioxide — A mixture of tobacco seed oil (110 gm.), ethyl alcohol (400 c.c.) and selenium dioxide (13 gm.) was refluxed on the water bath for 3 hr. The insoluble selenium salt was separated and ethyl alcohol was distilled off when a clear, crimson coloured, viscous oil having acetyl value 120 was obtained. It, however, became turbid after a few days. When dehydrated at 275°-300°C., it first became very turbid and then turned brownish black, giving off an unpleasant odour. A black precipitate of selenium separated out. It was found that the modified oil contained 1·8 per cent selenium. Safflower seed oil behaves similarly, while with linseed oil the selenium content of the modified oil was 2·8 per cent.

Hydroxylation of tobacco seed oil was also tried in presence of lead dioxide and potassium permanganate but the acetyl value did not rise above 27·8 and 27·4 respectively.

Varnishes from Modified Oils

The following modified oils from raw tobacco seed and safflower seed oils were employed in the preparation of ester gum medium oil range varnishes: (1) ordinary double-boiled oils; (2) resorcinol-treated oils; (3) oils obtained after isomerization with anthraquinone catalyst; and (4) oils obtained after isomerization with nickel-carbon catalyst.

Cobalt linoleate as drier and turpentine as thinner were used in all cases. Varnish was also prepared from double-boiled linseed oil for comparison.

As the nickel-carbon catalyst treated oils (4) were of lower viscosity than the other oils, less thinner was required in this case to bring the varnish to the required limit of 1-2 poises. The varnishes from the oils (3) and (4) were less coloured (9-10 red and 29 yellow: Lovibond) as compared to 16-20 red and 9-10 yellow obtained from the oils (1) and (2). When applied to glass and tin plates, the films became surface dry in about 8 hr. and hard dry within 24 hr. The films were quite flexible and no detachment or damage to the films was observed when bent round a mandrill. The films could be scratched free from jagged edges. The varnishes from modified oils (2), (3) and (4) were

found to be more resistant towards white spirit and turpentine than those obtained from ordinary double-boiled oils. All had similar action towards rectified spirit and benzene. The films blushed when kept in water for 24 hr. but they regained their original colour and strength after drying. Dilute sulphuric acid (5 per cent) had no action.

Paints from Modified Oils — Ready-mixed paints using titanium dioxide, red lead and red oxide of iron as pigments were prepared from the modified tobacco seed and safflower oils (1), (2), (3) and (4), and double-boiled linseed oil. The films of all these paints on tin plates dried overnight to a glossy surface. The titanium dioxide paint films made from modified oils (1) and (2) were paler than those made from samples (3) and (4) which were white. The film of the linseed oil paint became slightly yellow after some time, while the paint films made from modified tobacco and safflower seed oils retained their white colour even after six months. The films of paints from red lead remained quite bright on keeping, but the red oxide of iron pigment films became dark after a fortnight. None of the paint films cracked on exposure to weathering for three months.

REFERENCES

1. MAHANT, S. D. & PANDIT, P. N.: *J. sci. industr. Res.*, 1948, **7**, 229.
2. RAO, M. N. & RAMANAYYA, S. V.: ibid., 1948, **7**, 87.
3. POINOT, M.: *Chem. Zentra.*, 1942, **112**, 537.
4. ROWAAN, P. A.: *Olien, Velt Olerzaden*, 1942-43, **27**, No. 629.
5. PUGSLEY, A. T. & WINTER, G.: *Australia Department of Munitions Labs. Report*, 1947, **171**, 57.
6. CARRICK, I. L. & NIELSON, H. K.: *Am. Paint J.*, 1937, **22**, 20, 24, 28.
7. STOCK, E.: *Farben Ztg.*, 1938, **43**, 134.
8. AGGARWAL, J. S., BUDHRAJA, N. C. & SHARMA, P. G.: *Ind. Pat.* 42885 (1950).
9. AUER, L.: *U.S. Pat.* 2406337 (1946).
10. ARMITAGE, F. & COTRELL, J. A.: *Paint Technology*, 1948, **13**, 353.
11. FALKENBURG, L. B., DE JONG, W. M., HANDKE. D. P. & RADLOVE, S. B.: *J. Am. Oil Chem. Soc.*, 1948, **25**, 237.
12. RADLOVE, S. B., TEETER, H. M., BOND, W. H., COWAN, J. C. & KASS, J. P.: *Ind. Eng. Chem.*, 1946, **38**, 997.
13. BAILEY, A. E.: *Industrial Oil & Fat Products* (Interscience Publishers Inc.,New York, N.Y.), 1945, p. 696.

Preservation of Citrus Fruit Juices

JIWAN SINGH PRUTHI & GIRDHARI LAL

Central Food Technological Research Institute, Mysore

The comparative efficiencies of different methods for preserving and storing citrus fruit juices (lime, *khatta, galgal,* orange, *mosambi,* grape-fruit and sweet lime), with reference to ascorbic acid content, colour, sedimentation and flavour, have been investigated. The effect of factors such as type of container, head space, storage temperature, addition of cane sugar, etc., on stored juices has also been investigated. Deaeration combined with flash pasteurization gave the best results.

THE Indian fruit preservation industry is still in its infancy and little research has been carried out in India on the preservation of citrus fruit juices. A number of methods[1-3] have been worked out in other countries for this purpose, but a comparative evaluation of their efficiencies has not been made.

Investigations on the relative merits of the different methods reported in literature for the preservation of citrus fruit juices, with particular reference to colour changes and ascorbic acid content, have been undertaken in these laboratories. The effect of factors such as head space, type of container, addition of cane sugar, storage temperature, etc., on stored juices has also been investigated. The results have been subjected to statistical analysis.

Experimental

The juices from 7 varieties of citrus fruits have been investigated. Fresh fruits were purchased in Delhi market and the juice was packed, immediately after extraction, as follows :

(i) as such (control) ;
(ii) with 5 per cent cane sugar ; and
(iii) after deaeration.

8 oz. white glass bottles and 12 oz. plain tin cans were used as containers. The methods of preservation employed were :

(a) holding pasteurization at 175°F. ;
(b) overflow pasteurization at 175°-80°F. ;
(c) flash pasteurization at 195°-200°F. ; and
(d) addition of sodium benzoate (1,000 p.p.m.) and SO_2 (700 p.p.m.).

For studying the effect of entrapped air, some sets were packed with more head space than is usual in commercial practice. The packages were stored at 0°-2°C., 25°C. and 35°-37°C.

Analytical Procedure

Monthly analyses of stored samples were carried out for ascorbic acid content, *p*H, acidity, sp. gr. and colour. Ascorbic acid was determined by a modified 2 : 6 dichlorophenol indophenol titration[4]. SO_2 present in sulphited samples interferes with the determination of ascorbic acid, and samples should be completely freed of SO_2 before titrating. The selective condensation method[5] employing formaldehyde[6] for the estimation of ascorbic acid was found satisfactory ; in this method, 10 c.c. of 2 per cent metaphosphoric acid was first added to 10 c.c. of the citrus juice, followed by 1 c.c. of 1 per cent formaldehyde and 0·1 c.c. of conc. hydrochloric acid (sp. gr. 1·15) ; titration was carried out after an interval of 15 min.

Colour determinations were made with a Lumetron photoelectric colorimeter (Model 400Å) using filters of wavelengths ranging between 70 mμ and 650 mμ. The juices were mixed with an equal volume of acetone to precipitate suspended matter, stored overnight in a refrigerator (0°-2°C.) and filtered. Clarified juices were used for colour determination.

Quality Tests — Organoleptic tests were carried out by a score-card system.

The results of the analyses have been analysed statistically and summarized in Tables I-III.

Discussion

Ascorbic Acid—The loss of ascorbic acid during processing was 0·5-3·0 per cent in acid juices (lime, *khatta*, *galgal* and grapefruit), while in less acid juices (*sangtra* and *mosambi*) it was 3-7 per cent. Deaeration of juices prior to packing helps in the better retention of ascorbic acid. This is in accordance with the findings of Heid and Scott[7], and Tressler *et al.*[8].

TABLE I — RETENTION OF ASCORBIC ACID IN PROCESSED CITRUS FRUIT JUICES STORED AT ROOM TEMPERATURE (*c.* 25°C.)

Ascorbic acid in mg./100 gm.; SO_2, 700 p.p.m. for sangtra, orange and grape-fruit, and 350 p.p.m. for lime and khatta ; 0·25" head space in tin cans and 5-8 c.c. in 8 oz. bottles except in overflow pasteurization and flash pasteurization in bottles in which case the juice was allowed to overflow

Treatment	Lime			*Sangtra*			*Mosambi*			*Khatta*			Grape-fruit		
	Control	After 10 months	% retention	Control	After 8 months	% retention	Control	After 7 months	% retention	Control	After 7 months	% retention	Control	After 6 months	% retention
Ord. pasteur. (bottles)	21·4	15·3	71·2	30·2	20·6	68·1	38·3	30·2	78·0	17·8	13·7	76·8	39·4	29·2	74·2
Ord. pasteur. (cans)	22·0	16·6	75·4	31·6	23·2	73·2	38·7	30·9	80·0	18·1	14·9	82·4	41·3	34·3	82·9
Overflow pasteur. (bottles)	21·7	15·9	73·4	31·3	22·9	73·1	38·8	30·7	79·2	18·1	14·1	78·0	41·3	33·8	81·9
Sod. benzoate, 0·1% (bottles)	21·4	15·2	71·1	30·0	20·3	67·7	38·3	30·1	78·5	17·8	13·7	76·6	39·4	29·2	74·1
SO_2	21·9	16·4	74·8	31·7	23·1	73·2	38·8	30·8	79·5	18·1	14·6	80·5	41·1	33·9	82·5
Flash pasteur. (bottles)	22·0	16·4	74·7	31·2	22·9	73·2	...	...	...	18·1	14·4	79·6	41·5	31·7	76·4
Flash pasteur. (cans)	22·0	16·6	75·6	31·7	23·2	73·3	...	...	...	18·1	15·0	82·5	41·7	34·6	83·0
+ 5% Cane Sugar															
Ord. pasteur. (bottles)	21·5	15·4	71·5	30·3	20·7	68·3	38·6	30·5	79·2	17·8	13·7	76·8	39·6	29·4	74·3
Ord. pasteur. (cans)	22·0	16·6	75·6	31·8	23·3	73·4	38·9	31·2	80·2	18·1	14·9	82·4	41·5	34·4	82·9
Overflow pasteur. (bottles)	21·8	16·0	73·7	31·5	23·1	73·4	38·9	30·9	79·5	18·1	14·1	78·0	41·5	34·2	82·3
Sod. benzoate, 0·1% (bottles)	21·5	15·3	71·3	30·1	20·4	67·7	38·6	30·5	79·0	17·8	13·7	76·6	39·8	29·6	74·4
SO_2	21·9	16·4	74·9	31·1	23·3	73·3	38·9	31·1	80·0	18·1	14·6	80·4	41·3	34·3	82·9
Flash pasteur. (bottles)	22·0	16·5	74·0	31·4	23·0	73·2	...	...	...	18·1	14·4	79·7	41·4	32·8	79·2
Flash pasteur. (cans)	22·0	16·6	75·6	31·8	23·4	73·5	...	...	...	18·1	15·0	83·1	41·7	34·6	83·0
De-aerated															
Ord. pasteur. (bottles)	21·0	15·4	73·2	30·0	20·8	68·5	38·6	30·7	79·5	17·9	13·7	76·8	39·8	29·6	74·4
Ord. pasteur. (cans)	22·0	16·6	75·7	31·8	23·3	73·4	38·8	31·3	80·5	18·1	14·9	82·5	41·5	34·4	82·9
Over-flow pasteur. (bottles)	21·9	16·2	73·9	31·5	23·1	73·3	39·0	31·0	79·7	18·1	14·1	78·1	41·5	34·0	82·0
Sod. benzoate 0·1% (bottles)	21·5	15·3	71·1	30·3	20·5	67·8	38·6	30·6	79·2	17·9	13·7	76·7	39·8	29·6	74·4
SO_2	22·0	16·5	75·0	31·7	23·3	73·4	39·0	31·2	80·2	18·1	14·6	80·0	41·5	34·3	82·5
Flash pasteur. (bottles)	22·0	16·5	75·1	31·5	23·1	73·3	...	...	...	18·1	14·4	79·8	41·5	31·8	76·5
Flash pasteur. (cans)	22·0	16·6	75·7	31·8	23·4	73·5	...	...	...	18·2	15·1	83·2	41·7	34·6	83·0

TABLE II — EFFECT OF STORAGE TEMPERATURE, HEAD SPACE (H.S.) & OTHER TREATMENTS ON ASCORBIC ACID RETENTION

Sodium benzoate, 0·1 per cent; SO_2, 700 p.p.m. for sangtra, orange, grape-fruit and sweet lime and 350 p.p.m. for khatta and lime; samples packed in 6" × 0·75" pyrex glass test-tubes, corked tight and waxed; ascorbic acid is expressed in mg./100 gm. of juice

Treatment		Lime			*Sangtra*			*Mosambi*			*Khatta*			Grape-fruit			Sweet lime		
Preservative	Head space, c.c.	Before packing	After 10 months' storage	% retention	Before packing	After 8 months' storage	% retention	Before packing	After 8 months' storage	% retention	Before packing	After 7 months' storage	% retention	Before packing	After 6 months' storage	% retention	Before packing	After 6 months' storage	% retention
Storage temp., 0°-2°C.																			
Control																			
Sodium benzoate	1	25·2	19·9	78·7	28·1	17·9	63·7	47·1	36·5	77·5	22·7	19·4	85 3	42·3	31·2	73·7	50·1	35·9	71·7
„ „	2	25·2	19·2	76·0	28·1	14·6	51·9	47·1	33·3	70·7	22·7	18·0	78·9	42·3	29·5	69·6	50·1	33·7	67·3
SO_2	1	25·2	20·2	79·9	28·1	20·8	74·0	47·1	39·0	82·8	22·7	19·8	87·0	42·3	35·5	83·7	50·1	38·9	75·7
„	2	25·2	19·6	77·7	28·1	16·9	60·1	47·1	35·7	75·8	22·7	18·2	80·0	42·3	32·1	75·7	50·1	34·7	69·3
+5% *Cane Sugar*																			
Sodium benzoate	1	25·2	19·9	78·7	28·1	18·0	64·0	47·1	36·6	77·7	22·7	19·5	85·8	42·3	31·4	74·0	50·1	36·0	71·9
„ „	2	25·2	19·2	76·0	28·1	15·2	54·2	47·1	33·7	71·6	22·7	18·0	79·0	42·3	29·8	68·7	50·1	33·8	67·5
SO_2	1	25·2	20·2	80·0	28·1	21·0	74·7	47·1	39·1	83·0	22·7	20·0	87·8	42·3	35·5	83·7	50·1	38·9	75·7
„	2	25·2	19·7	78·0	28·1	17·0	60·5	47·1	36·3	77·1	22·7	18·4	80·8	42·3	32·4	76·5	50·1	34·8	69·5
Storage temp., 25°C.																			
Control																			
Sodium benzoate	1	25·2	19·4	76·9	28·1	16·4	58·3	47·1	35·7	75·7	22·7	18·6	81·7	42·3	29·3	62·2	50·1	33·7	67·2
„ „	2	25·2	18·9	75·0	28·1	12·9	46·0	47·1	32·5	69·0	22·7	17·0	74·8	42·3	25·7	60·7	50·1	31·8	63·3
SO_2	1	25·2	19·8	78·5	28·1	18·0	62·0	47·1	37·4	79·4	22·7	19·0	83·5	42·3	33·8	79·8	50·1	35·1	70·1
„	2	25·2	19·3	76·4	28·1	14·0	49·7	47·1	34·8	73·9	22·7	17·6	77·4	42·3	31·7	74·8	50·1	32·1	64·1
+5% *Cane Sugar*																			
Sodium benzoate	1	25·2	19·4	77·0	28·1	17·0	60·5	47·1	36·2	76·9	22·7	18·6	81·8	42·3	29·7	70·1	50·1	33·7	67·3
„ „	2	25·2	18·9	75·0	28·1	13·1	46·9	47·1	33·0	70·1	22·7	17·3	76·0	42·3	25·8	60·9	50·1	31·8	63·5
SO_2	1	25·2	19·9	78·8	28·1	18·0	64·9	47·1	37·5	79·7	22·7	19·3	84·8	42·3	33·9	80·0	50·1	35·3	70·5
„	2	25·2	19·3	76·6	28·1	14·0	49·8	47·1	35·1	74·5	22·7	17·8	78·1	42·3	31·9	75·3	50·1	33·5	66·9
Storage temp., 35°-37°C.																			
Control																			
Sodium benzoate	1	25·2	19·1	75·7	28·1	14·4	51·3	47·1	33·7	71·6	22·7	17·4	76·4	42·3	28·1	66·4	50·1	31·4	62·7
„ „	2	25·2	18·6	73·7	28·1	11·2	39·8	47·1	30·0	63·7	22·7	16·9	70·3	42·3	24·7	58·2	50·1	29·5	58·9
SO_2	1	25·2	19·5	77·4	28·1	16·9	60·1	47·1	35·3	75·0	22·7	17·9	78·6	42·3	32·9	77·6	50·1	33·0	66·0
„	2	25·2	18·7	74·1	28·1	12·9	45·7	47·1	30·8	65·4	22·7	16·4	71·4	42·3	30·6	72·2	50·1	32·0	64·0
+5% *Cane Sugar*																			
Sodium benzoate	1	25·2	19·1	76·0	28·1	15·0	53·3	47·1	33·7	71·6	22·7	17·6	77·5	42·3	28·5	67·5	50·1	31·7	63·3
„ „	2	25·2	18·6	73·7	28·1	11·2	39·8	47·1	30·1	64·0	22·7	16·0	70·3	42·3	24·7	58·4	50·1	29·6	59·1
SO_2	1	25·2	19·6	77·0	28·1	16·9	60·1	47·1	35·8	76·0	22·7	18·0	79·0	42·3	33·0	77·0	50·1	33·2	66·3
„	2	25·2	18·8	74·4	28·1	13·4	47·6	47·1	30·9	65·6	22·7	16·5	72·4	42·3	30·9	73·0	50·1	32·2	64·3

Packing in plain tin cans is superior to packing in white glass bottles with respect to ascorbic acid retention. This is in line with the findings of Daniel and Rutherford[9], Hauck[10], and Moore *et al.*[11], but is in contradiction to the results obtained by Tressler and Curran[12] who found that the loss in ascorbic acid was about the same, both in bottles and in tin cans, provided the containers are completely filled — a condition which is difficult to ensure in commercial practice.

Air or oxygen, dissolved in the juice or present in the head space, adversely influences ascorbic acid retention. This confirms the finding of Lueck and Pilcher[13], and Moore *et al.*[14].

The loss of ascorbic acid is least when the juice is packed in tin cans and flash pasteurized (FIG. 1). Holding pasteurization in cans, sulphitation, flash pasteurization in bottles and overflow pasteurization follow in order. Considerable losses in ascorbic acid are brought about by ordinary pasteurization in bottles and by sodium benzoate addition.

The effects of (1) storage temperature, (2) head space and (3) chemical preservatives on the retention of ascorbic acid in packed juices are shown in Fig. 2. Using the same method of packing, ascorbic acid is better retained when stored at 0°-2°C.; at 35°-37°C. the loss is considerable.

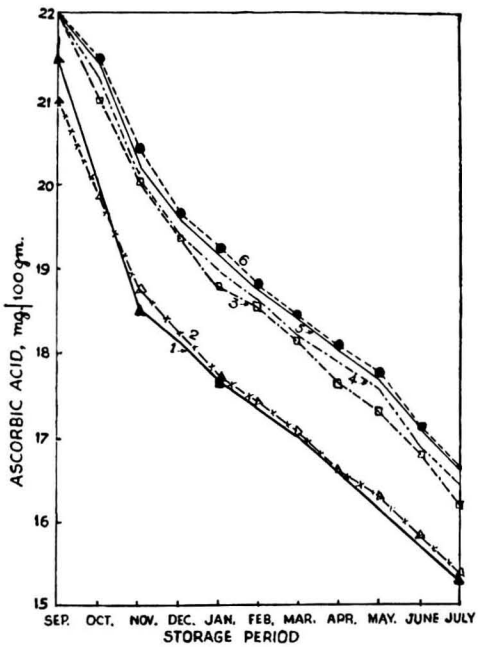


FIG. 1 — ASCORBIC ACID CONTENT OF LIME JUICE AS AFFECTED BY DIFFERENT METHODS OF STORAGE. [(1) Sodium benzoate, 0·1 per cent; (2) holding pasteurization in bottles; (3) overflow pasteurization in bottles; (4) SO_2, 350 p.p.m.; (5) holding pasteurization in cans; (6) flash pasteurization in cans.]

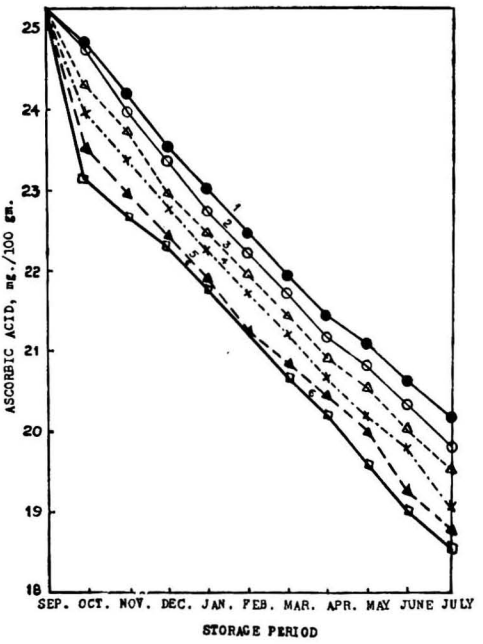


FIG. 2 — EFFECT OF STORAGE TEMPERATURE, HEAD SPACE AND CHEMICAL PRESERVATIVES ON THE RETENTION OF ASCORBIC ACID DURING STORAGE. [(1) 0°-2°C.; (2) 25°C.; (3) temp. 35°-37°C., SO_2, 350 p.p.m., head space 1 c.c.; (4) sodium benzoate, 0·1 per cent, head space 1 c.c., temp. 35°-37°C.; (5) SO_2, 700 p.p.m., head space 2 c.c., temp. 35°-37°C.; (6) sodium benzoate, 0·1 per cent, head space 2 c.c., temp. 35°-37°C.]

Colour — There is, generally, an increase in the yellow, orange or red colour of juices during storage (TABLE III). Discolouration is observed in ordinary pasteurized juices, while in flash-pasteurized juices discolouration is comparatively less. Addition of cane sugar and the presence of air in head space accelerate discolouration. Deaeration is necessary for maintaining the normal colour of citrus juices. These observations are in accord with the findings of Moore *et al.*[11,14], Wagner *et al.*[15], Rust *et al.*[16], Weiderhold *et al.*[17] and Lamb[18].

Under identical conditions of treatment and storage, discolouration is least in juices packed in cans and flash pasteurized (FIG. 3). Other methods in decreasing order of

TABLE III — OVERALL COLOUR CHANGE IN LIME JUICE DURING 10 MONTHS' STORAGE AT ROOM TEMPERATURE EXPRESSED IN TERMS OF OPTICAL DENSITY

Observations carried out in a Lumetron photoelectric colorimeter, model 400 A : transmission has been converted into optical density by the formula O.D. = (2-log G), where G is the observed percentage light transmission at a particular wavelength ; 10 c.c. of the original juice diluted with an equal volume of acetone was filtered and observations taken with filtered liquid

Method of preservation	Blue, mμ 420			Blue Green, mμ 490		
	Control	5% cane sugar	Deaerated	Control	5% cane sugar	Deaerated
Untreated juice	·1871	·1871	·1871	·0177	·0177	·0177
Ordinary pasteurization (bottle)	·2967	·3010	·2840	·0757	·0809	·0706
Ordinary pasteurization (can)	·2218	·2291	·2076	·0555	·0605	·0506
Overflow pasteurization (bottle)	·2798	·2840	·2757	·0655	·0706	·0605
Sodium benzoate, 0·1% (bottles)	·3979	·4202	·3565	·0969	·1192	·0915
SO_2, 350 p.p.m. (bottles)	·2676	·2757	·2441	·0555	·0655	·0531
Flash pasteurization (bottles)	·2798	·2844	·2757	·0655	·0731	·0630
Flash pasteurization (can)	·2182	·2218	·2182	·0531	·0555	·0503

efficiency are : holding pasteurization, sulphitation, flash pasteurization, overflow pasteurization, and ordinary pasteurization in bottles. The addition of sodium benzoate, irrespective of the storage condition and treatment, leads to marked discolouration of juices.

Colour changes do occur in juices immediately after processing, and these can be detected with the help of the photoelectric colorimeter. Visible changes take place only after 1½-3 months' storage. This finding is in agreement with that of Loeffler[19].

Storage at 0°-2°C. prevents discolouration of juices to a considerable extent.

Sedimentation— Sedimentation of suspended matter in packed juices was highest in samples preserved with sodium benzoate or sulphur dioxide. There is little sedimentation in flash-pasteurized samples. In samples pasteurized by other methods, partial sedimentation was observed ; gel formation was observed in grape-fruit juice.

Quality Tests—Deaerated and flash-pasteurized samples (in bottles and cans) are superior to samples preserved by other methods. Preservation by SO_2 was found to be the next best, followed by overflow pasteurization, ordinary pasteurization and sodium benzoate preservation.

Storage at room temperature (*c.* 25°C.) leads to the development of off-flavours. The addition of cane sugar to the extent of 5 per cent has little effect on the retention of natural flavour or aroma.

Summary

The comparative efficiencies of different methods for preserving and storing citrus fruit juices with reference to ascorbic acid content, colour, sedimentation and flavour have been investigated.

Deaeration combined with flash pasteurization has given the best results.

Better retention of ascorbic acid and colour is secured by packing in tins than in bottles. The loss of ascorbic acid in juices stored at 25°C. after 6-10 months, is 17-33 per cent.

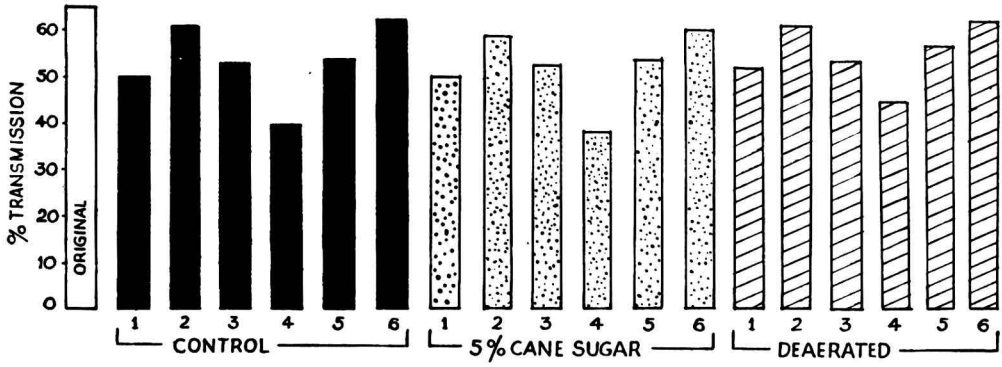


FIG. 3 — COLOUR DETERIORATION OF LIME JUICE DURING 10 MONTHS' STORAGE UNDER DIFFERENT METHODS OF PRESERVATION. [Percentage transmission observed through a blue filter (420 mμ) in a Lumetron photoelectric colorimeter : (1) ordinary pasteurization in bottles ; (2) same as in (1) but in cans ; (3) overflow pasteurization ; (4) sodium benzoate, 0·1 per cent ; (5) SO_2, 350 p.p.m. ; (6) flash pasteurization in cans.]

Low temperature (0°-2°C.) storage helps retention of ascorbic acid and retards discolouration.

Addition of cane sugar (5 per cent) accelerates the discolouration of juices and does not help in the retention of ascorbic acid.

In most citrus juices, visible discolouration takes place only after 1½-3 months' storage at 25°C.

REFERENCES

1. SHEARON, W. H. & BURDICK, E. M.: *Ind. Eng. Chem.*, 1948, **40**, 370.
2. MOORE, E. L. *et al.*: *Food Prod. J.*, 1944, **23**, 270.
3. ROSS, E.: *Food Res.*, 1944, **9**, 27.
4. LAL, GIRDHARI & PRUTHI, JIWAN SINGH: *Ind. Food Packer*, 1950, **4**, 9, 25.
5. LUGG, J. W. H.: *Nature*, 1942, **150**, 384, 557.
6. PRUTHI, JIWAN SINGH & LAL, GIRDHARI: *Ind. Food Packer*, 1950, **4**, 11, 26.
7. HEID, J. L. & SCOTT, W. C.: *Fr. Prod. Jr.*, 1937, **16**, 136.
8. TRESSLER, D. K., MARSH, G. L. & JOSLYN, M. A.: *Fruit & Vegetable Juices*, 1939 (Avi Publishing Co. Inc., N.Y.).
9. DANIEL, E. P. & RUTHERFORD, M. B.: *Food Res.*, 1936, **I**, 341.
10. HAUCK, H. M.: *Jr. Home Econ.*, 1938, **30**, 183.
11. MOORE, E. L., WIEDERHOLD, E. *et al.*: *Canner*, 1944, **98**, 6.
12. TRESSLER, D. K. & CURRAN, K. M.: *Jr. Home Econ.*, 1938, **30**, 487.
13. LUECK, R. H. & PILCHER, R. W.: *Ind. Eng. Chem.*, 1941, **33**, 292.
14. MOORE, E. L. *et al.*: *Canner*, 1945, **100**, 12.
15. WANGER, J. R. *et al.*: *Food Res.*, 1945, **10**, 469.
16. RUSTS, D. W. *et al.*: *Food Indus.*, 1945, **17**, 742.
17. WIEDERHOLD, E. *et al.*: *Canner*, 1945, **100**, 12.
18. LAMB, F. C.: *Ind. Eng. Chem.*, 1946, **38**, 860.
19. LOEFFLER, J. S.: ibid., 1941, **33**, 308.

Studies on Indian Bricks

L. C. JAIN & B. C. RAYCHAUDHURI

Building Research Unit (C.S.I.R.), Roorkee

The effect of firing temperature on the compressive strength of bricks made from (1) Roorkee soil representing Indo-Gangetic alluvium and (2) black cotton soil from Poona has been investigated. The influence of silica to sesquioxide ratio and of active to inactive silica ratio in the soils on the compressive strength and saturation coefficient of bricks made from them have been determined.

THE results of preliminary investigation on the properties of some Indian bricks were reported in a previous paper[1]. It was suggested that the temperature of firing may influence the compressive strength of bricks. Further studies were undertaken to assess quantitatively the effect of firing temperature on the compressive strength and saturation coefficient of bricks made from different soils. The results obtained with bricks made from a Roorkee soil, representing the Indo-Gangetic alluvium, and a black cotton soil from Poona are reported in this paper. The influence of silica to sesquioxide ratio and of active silica to inactive silica ratio in soils on the compressive strength of bricks made from them has also been investigated.

Experimental

The soil samples were powdered, passed through a 30-mesh sieve, mixed with water (to its plastic limit) and kneaded. The kneaded clay was allowed to mature for 24 hr. and moulded into bricks (4·5″×2″×1·5″). The bricks were prepared under uniform conditions, air dried and fired for 7 hr. at different temperatures. Bricks were also made from soil samples to which were added : (i) different proportions of " fines " from the original soils and (2) different proportions of coarse and powdered river sand from Roorkee.*

The composition of various soil mixtures used for moulding bricks is recorded in Table I.

* Soil fraction passing through a 200-mesh sieve on wet sieving is termed fine fraction or " fines " ; that passing through a 30-mesh sieve and retained on a 200-mesh sieve is termed coarse fraction. Powdered river sand from Roorkee passing through a 30-mesh sieve and retained on a 200-mesh sieve is termed coarse sand ; that passing through a 200-mesh sieve is called fine sand. The silica present in the fine fraction is said to be " active " and that in the coarse fraction " inactive ".

The silica and sesquioxide contents of different soils and soil fractions were determined. The results are recorded in Tables II to IV.

The compressive strength of fired bricks was determined according to B.S.S. No. 1257 (1945). The bricks were crushed between 2 thin pieces of plywood ($\frac{1}{8}$" thick) in a hydraulic press applying a load of 2,000 lb./sq. in. per min. across the flat surfaces. The results are recorded in Table V.

The saturation coefficient of fired bricks was determined by determining the ratio of water absorbed by the bricks when immersed in water for 24 hr. at room temperature to the amount absorbed when the brick is boiled in water for 5 hr. and allowed to cool overnight under water.

Discussion

The compressive strength of bricks from Roorkee soil mixtures increases with the increase in temperature used for firing the bricks (FIG. 1). In the case of black cotton soil, the compressive strength of the brick does not vary with the temperatures used for firing the brick. Addition of coarse sand decreases the compressive strength of bricks made from such mixtures (FIG. 1).

The chemical composition of the coarse and fine fractions of black cotton soil are similar (TABLE III); the two fractions behave similarly with respect to the effect of firing temperature on the compressive strength of bricks made from them. The compositions of the coarse fractions from Poona and Roorkee soils are different and fired bricks made from these soils have varying compressive strengths.

A small increase in the compressive strength of brick made from sample B_3 (80 per cent Poona soil + 20 per cent coarse sand) is observed when the temperature of firing is 900°C. The value is higher if the firing temperature is raised to 1,000°C. (FIG. 1). These observations indicate that the activity of coarse and fine sand increases with temperature, and the fine sand shows greater activity at all the temperatures. A gradual increase in the compressive strength of bricks made from sample B_2 (80 per cent Poona soil + 20 per cent fine sand) is observed as the firing temperature rises. At a given firing temperature, the compressive strength of bricks from sample B_2 is greater than that of bricks from sample B_3.

TABLE I — COMPOSITION OF SOILS USED FOR MAKING BRICKS

SAMPLE	DESCRIPTION
R_1	Roorkee soil containing coarse fraction, 44·85 per cent; fines 55·15 per cent
R_2	50 per cent R_1; 50 per cent fines from R_1
R_3	80 per cent R_1; 20 per cent fine sand
R_4	80 per cent R_1; 20 per cent coarse sand
R_5	35 per cent R_1; 65 per cent fines from R_1
R_6	25 per cent R_1; 75 per cent fines from R_1
B_1	Black cotton soil from Poona containing coarse fraction, 32·4 per cent; fines, 67·6 per cent
B_2	80 per cent B_1; 20 per cent fine sand
B_3	80 per cent B_1; 20 per cent coarse sand
B_4	71·4 per cent B_1; 28·6 per cent fine sand

TABLE II — SILICA & SESQUIOXIDE CONTENTS OF SOILS & SAND FRACTIONS

		SiO_2, %	SESQUIOXIDE (R_2O_3), %
1	Roorkee soil	70·50	20·32
2	Coarse fraction from (1)	85·61	9·64
3	Black cotton soil from Poona	48·45	27·52
4	Coarse fraction from (3)	49·21	27·79
5	River sand from Roorkee	90·20	6·94

TABLE III — SILICA-SESQUIOXIDE CONTENTS OF THE FIRED BRICKS

	SiO_2, %	SESQUIOXIDE (R_2O_3), %	$\frac{SiO_2}{R_2O_3}$
R_1	74·06	21·33	3·47
R_2	69·00	26·56	2·60
R_3	77·45	18·92	4·04
R_4	77·45	18·92	4·04
R_5	67·44	28·13	2·40
R_6	66·39	29·20	2·27
B_1	53·70	30·51	1·76
B_2	61·66	25·39	2·42
B_3	61·66	25·39	2·42
B_4	65·0	23·27	2·78

TABLE IV — RATIO OF ACTIVE TO INACTIVE SILICA

	ACTIVE SILICA, %	INACTIVE SILICA, %	ACTIVE SILICA/ INACTIVE SILICA
R_1	35·70	38·40	0·98
R_2	49·79	19·21	2·35
R_3	30·90	46·61	0·66
R_4	30·90	46·61	0·66
R_5	54·00	13·44	4·03
R_6	56·80	9·59	5·91

TABLE V — COMPRESSIVE STRENGTH OF BRICKS, LB./SQ. IN.

SAMPLE	FIRING TEMP., °C.				
	600	700	800	900	1,000
R_1	900	1510	2100	2810	3930
R_2	1100	1730	2380	3500	4300
R_3	650	900	1560	2310	3420
R_4	665	1060	1710	2370	2960
R_5	1030	1770	2300	4020	4620
R_6	1070	1660	2290	4360	7000
B_1	1420	1310	1270	1340	1270
B_2	640	820	1010	1210	1650
B_3	590	700	680	790	1110
B_4	600	770	910	1160	1460

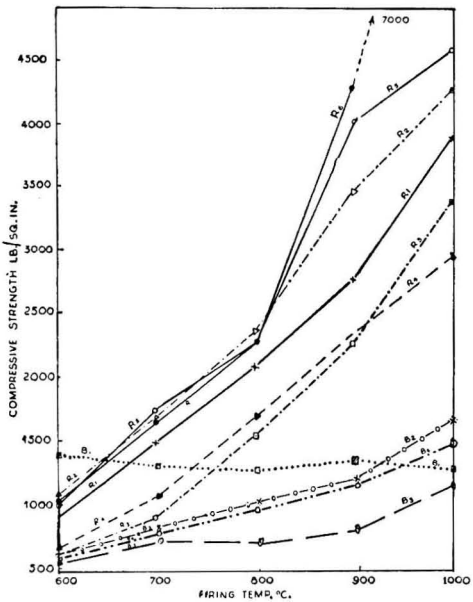


FIG. 1 — EFFECT OF FIRING TEMPERATURE ON COMPRESSIVE STRENGTH OF BRICKS MADE FROM DIFFERENT SOIL MIXTURES.

Active & Inactive Silica — The compressive strength of bricks prepared from black cotton soil and fired at temperatures ranging from 600° to 1,000°C. is practically constant. This may be ascribed to the similarity in the chemical composition of coarse and fine fractions of the soil. On the other hand, the composition of the fine and coarse fractions of the Roorkee soil are different and, as the ratio of active to inactive silica increases in the soil mixture used in making bricks, there is steep rise in the compressive strengths of bricks as the firing temperature is raised from 600° to 1,000°C. (FIG. 2). The slope of the curve at 900°C. and above is steeper than that at lower temperatures and this indicates that at 900°C. there is a marked increase in the activity of silica derived from the fine fraction.

Kaolinite[2] undergoes an exothermic transformation when heated at 900° to 1,000°C. Roorkee soil contains kaolinite and this may be responsible for the steep slope of the curve above 900°C. (FIG. 2). Black cotton soil is deficient in kaolinite and no significant change in the compressive strength with temperature is noticeable.

These observations indicate that from a knowledge of the nature of the clay minerals present in a soil, it may be possible to predict the burning characteristics of bricks made from such soils.

In order to secure bricks of good compressive strength from Roorkee soils, it is necessary to use a firing temperature exceeding 900°C. The compressive strength of bricks made from Roorkee soil (active silica to inactive silica ratio, 4·04) and fired at 900°C., is 4,000 lb./sq. in. The same value is obtained for bricks made from a soil in which the ratio of active silica to inactive silica is 2·35, provided the firing temperature is raised to 1,000°C. (FIG. 2).

Silica to Sesquioxide Ratio — When the compressive strengths of bricks fired at different temperatures are plotted against the ratio of silica to sesquioxides in the fired brick, the curves obtained (FIG. 3) for temperatures between 600°C. and 800°C. are parabolas with foci lying on the same vertical

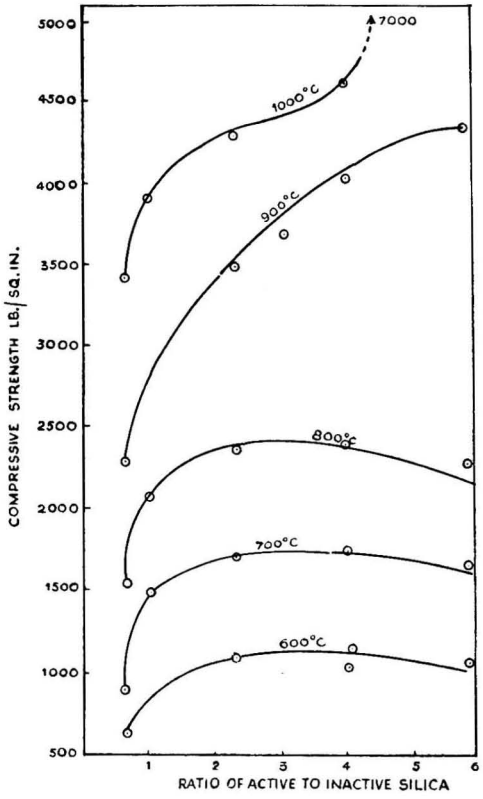


FIG. 2 — INFLUENCE OF THE RATIO OF ACTIVE TO INACTIVE SILICA ON COMPRESSIVE STRENGTH OF BRICKS FIRED AT DIFFERENT TEMPERATURES.

line and having the same value of parameter (p) in the equation $(x-h)^2 = 4p\,(y-k)$, (h and k are vertices of the parabolas). This shows that there is a definite ratio of silica to sesquioxides at which the bricks develop maximum compressive strength at firing temperatures ranging between 600°C. and 800°C. At temperatures ranging between 900°C. and 1,000°C. the curves obtained are not parabolic. This variation in behaviour may be due to the presence of kaolinite, which undergoes transformation at temperatures exceeding 900°C.

Saturation Coefficient — The saturation coefficient of soil mixtures increases as the percentage of fines increases in them. The saturation coefficient of bricks made from Roorkee soils decreases as the temperature of firing increases (FIG. 4). In the case of Poona black cotton soils, to which fine sand is added, the saturation coefficient value of bricks made from them decreases as the firing temperature is raised; on the other hand, when coarse sand is added to the soil, the saturation coefficient value of bricks made from such mixtures increases as the firing temperature increases up to 900°C. and then falls.

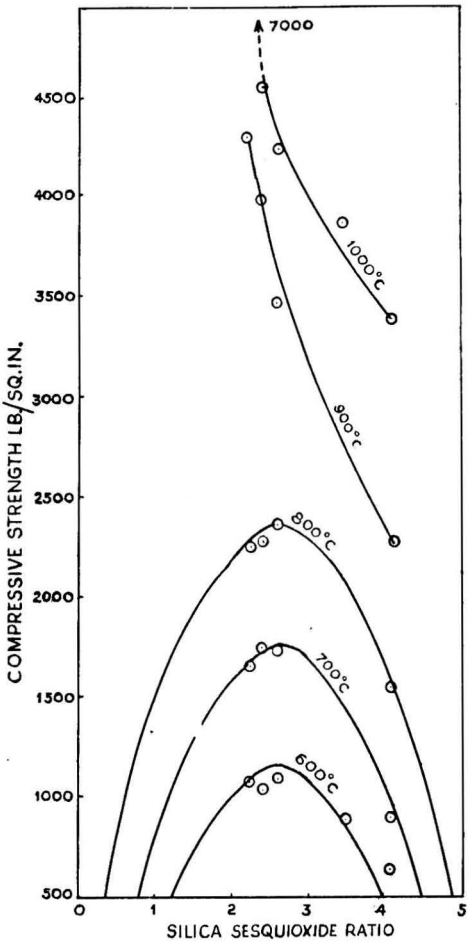


FIG. 3 — RELATIONSHIP BETWEEN SILICA TO SESQUIOXIDE RATIO OF SOIL MIXTURES AND COMPRESSIVE STRENGTH OF BRICKS MADE FROM THEM.

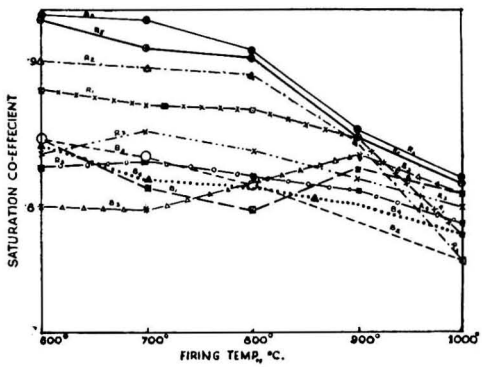


FIG. 4 — EFFECT OF TEMPERATURE ON SATURATION COEFFICIENT OF BRICKS.

Conclusions

The compressive strength of bricks made from Roorkee soil mixtures increases as the firing temperature increases. Firing temperature does not influence the compressive strength of bricks made from Poona black cotton soil.

There is a definite ratio of silica to sesquioxides in soil mixtures at which the bricks obtained from them show a maximum compressive strength.

The proportion of " fines " in soil mixtures affects the saturation coefficient of bricks made from them. The higher the proportion of " fines ", the higher is the saturation coefficient.

Acknowledgement

The authors are grateful to Dr. N. K. Patwardhan for helpful suggestions in the course of this investigation.

REFERENCES

1. JAIN *et al.* : *J. sci. industr. Res.*, 1949, **8B**, 162.
2. ROBINSON : *Soils, Their Origin, Constitution & Classification*, 1949, p. 135.

Letters to the Editor

SPIN DOUBLETS IN THE L-SPECTRUM OF PLATINUM

THE L-SPECTRUM OF PLATINUM HAS BEEN studied previously by several workers including Moseley, Siegbahn, Coster, Dauvillier, Rogers, Lang, Weber, Friman and Idei[1]. The doublets of platinum. Values of Kaufmann[2] and Cauchois[3] (who, however, did not measure all the lines of the spectrum) are also given for comparison, since these measurements were made several years after the work of Idei.

TABLE I

LINE	TRANSITION	IDEI		KAUFMANN		CAUCHOIS		AUTHORS	
		λ	ν/R	λ	ν/R	λ	ν/R	λ	ν/R
α_2	L_{III} M_{IV}	1321·55*	689·55	—	—	1321·71	689·46	1321·57	689·54
β_1	L_{II} M_{IV}	1117·58*	815·40	—	—	—	—	1117·58*	815·40
γ_1	L_{II} N_{IV}	955·99*	953·22	—	—	—	—	955·99*	953·22
l	L_{III} M_I	1496·4	608·97	—	—	—	—	1496·23	609·04
η	L_{II} M_I	1240·3	734·71	—	—	—	—	1239·97	734·91
β_6	L_{III} N_I	1141·00	798·66	—	—	1141·28	798·46	1141·03	798·64
β_{15}	L_{III} N_{IV}	1101·65	827·19	—	—	—	—	1101·46	827·33
β_7	L_{III} O_I	1079·4	844·23	—	—	1079·51	844·15	1079·53	844·14
β_8	L_{III} $O_{IV,V}$	1070·21	851·48	—	—	—	—	1070·27	851·44
γ_5	L_{II} N_I	985·7	924·51	—	—	—	—	985·69	924·50
γ_8	L_{II} O_I	938·6	970·92	939·6	969·9	939·30	970·15	939·42	970·03
γ_9	L_{II} O_{IV}	932·3	977·42	—	—	—	—	932·41	977·33

* These are originally Friman's values.

calculations of energy levels of platinum are usually made on the basis of Idei's measurements which are considered to be more accurate than those of others. However, an examination of Idei's data has revealed that the L-spin doublet differences vary among themselves by as much as 0·95 Rydberg unit and this naturally brings inconsistencies in the calculations of the energy levels of platinum. As a result of many carefully repeated measurements on several plates, the authors have been able to reduce this internal inconsistency in the L-spin doublet differences to a considerable extent.

The reference lines in these measurements were CuKα_1 for which Siegbahn's value 1537·396 X.U. was taken and platinum Lα_1, Lβ_1 and Lγ_1 for which Friman's values (Lα_1=1310·33 X.U., Lβ_1=1117·58 X.U. and Lγ_1=955·99 X.U.) were taken. It appears that Idei also in his measurements had assumed Friman's values for some of the important lines.

Table I shows the wavelength and ν/R values of those lines which occur in the spin

It is interesting to compare the spin doublet differences of Idei's results with those obtained in our work.

TABLE II

SPIN DOUBLET	$\Delta\nu/R$	
	Idei	Authors
$\beta_1-\alpha_2$	125·85	125·86
$\eta-l$	125·74	125·87
$\gamma_5-\beta_6$	125·85	125·86
$\gamma_8-\beta_8$	125·94	125·89
$\gamma_1-\beta_{15}$	126·03	125·89
$\gamma_8-\beta_7$	126·09	125·89

It will be seen that the internal consistency in the former is not so great as in the present work. It is perhaps interesting to mention here that Woodall[4] has recently removed the internal inconsistencies in the L-spin doublets of gold.

The authors wish to express their sincere thanks to the Council of Scientific & Industrial Research, Delhi, for the financial aid

which enabled them to carry out this work.

G. B. DEODHAR
CHINTAMANI MANDE

X-Ray Laboratories
Allahabad University
Allahabad
October 6, 1950

1. SIEGBAHN : *Spektroskopie der Rontgenstrahlen*, (1931) (for data of Moseley to Idei).
2. KAUFMANN, S.: *Phys. Rev.*, 1934, **45**, 385, 613.
3. CAUCHOIS, Y.: *Comptes Rendus*, 1935, **201**, 598.
4. WOODALL, E. A. : *Phil. Mag.*, 1941, No. 210, 1.

A SIMPLE ELECTROLYTIC POLISHING CELL

ELECTROLYTIC POLISHING IS FINDING INcreasing application in the preparation of metal surfaces for metallographic studies on account of its many advantages such as absence of a disturbed layer, ease and quickness of operation, etc.

A simple electrolytic polishing cell designed in this Laboratory has been giving satisfactory results. The cell (FIG. 1) consists of a glass beaker (2 l.); the cathode is a piece of rectangular stainless steel wire net of dimensions slightly less than the cross-section

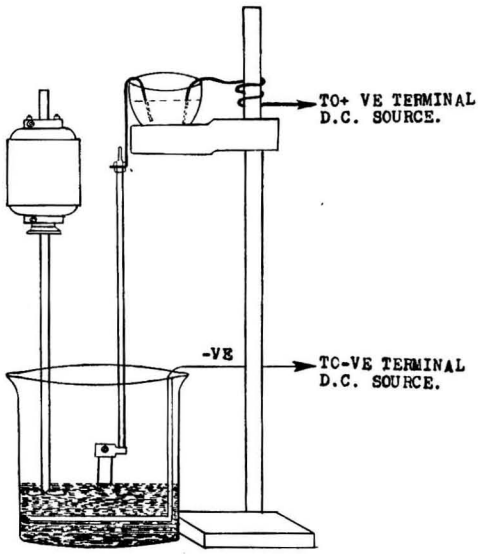


FIG. 1 — ELECTROLYTIC CELL.

FIG. 2 — PLAIN CARBON HYPOEUTECTOID STEEL. [Electrolyte : 50 per cent nitric acid + 50 per cent glacial acetic acid ; current density, 2 to 3 amp./sq. cm. ; initial finish, " OOO " ; time taken, 20 sec. ; etched in 2 per cent nital ; × 900.]

of the cell, suspended horizontally by a strip bent at right angles to the net. The specimen holder is a stainless steel rod with a bracket welded to it at the lower end. The specimens (*c.* 1 to 2 sq. cm.) are clamped in the bracket by a screw. To the other end of the specimen holder is attached a hook made out of stout copper wire which can be connected to the positive terminal of a storage battery through mercury placed in a small crucible. The cathode of the cell is connected to the negative terminal of the battery. The specimen forms the anode and the surface to be polished faces the cathode and is parallel to it. A stirrer operated by a variable speed fractional h.p. motor, a rheostat, an ammeter and a voltmeter are other components used in the set up. The specimen to be polished is dipped only to a small depth ($<0{\cdot}1''$) in the electrolyte so that except for the surface to be polished as little of the specimen as possible is in contact with the electrolyte.

External cooling or heating of the cell was unnecessary as electrolytes which give satisfactory results at room temperature can be employed.

The polished specimen should be washed in a stream of running water immediately after the completion of the operation in order to prevent etching or staining. This

FIG. 3 — PLAIN CARBON STEEL, ELECTROLYTICALLY POLISHED AND ETCHED IN ONE OPERATION USING NITRIC ACID + ACETIC ACID AS ELECTROLYTE. [Current density, 1·5 to 2 amp./sq. cm.; initial finish, "OOO"; time taken, 20 sec.; × 1100.]

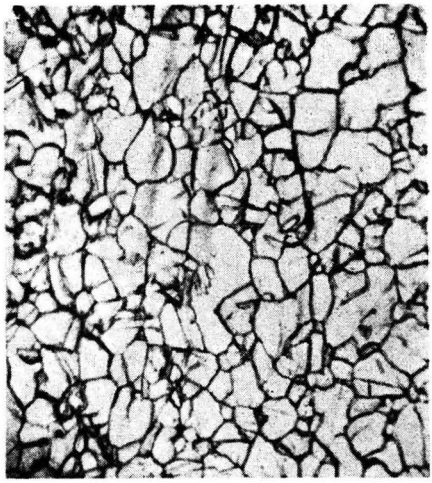


FIG. 5 — STAINLESS STEEL (ROLLED), ELECTROLYTICALLY POLISHED AND ETCHED USING NITRIC ACID + ACETIC ACID ELECTROLYTE. [Current density, 3 to 4 amp./sq., cm.; initial finish, "OO"; time taken, 30 to 40 sec.; × 500.]

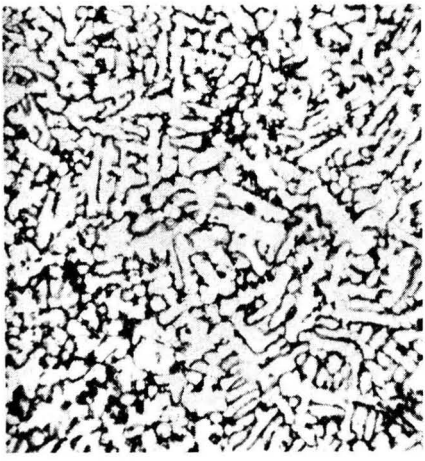


FIG. 4 — STAINLESS STEEL (CAST), ELECTROLYTICALLY POLISHED AND ETCHED USING NITRIC ACID + ACETIC ACID AS ELECTROLYTE. [Current density, 3 to 4 amp./sq. cm.; initial finish, "OO"; time taken, 30 to 40 sec.; × 150.]

FIG. 6 — COPPER SHEET, ELECTROLYTICALLY POLISHED IN CHROMIC ACID SOLUTION (200 GM./L.). [Current density, 2 amp./sq. cm.; initial finish, "OOO"; etched in ammonium persulphate solution; × 250.]

can be readily accomplished by removing the specimen holder with the specimen and washing the latter. This is one of the chief advantages of this cell over other types.

Two other advantages of the cell are: (1) the specimen is in contact with the electrolyte only when the proper P.D. exists and (2) only the surface to be polished is in contact with the electrolyte, thus avoiding the necessity of making the sides of the specimen non-conducting by vitreous enamelling or other methods.

Photomicrographs of specimens polished and etched in this cell are reproduced in Figs. 2-6.

M. N. PARTHASARATHI
B. S. SRIKANTIAH
B. R. NIJHAWAN
National Metallurgical Laboratory
Jamshedpur
October 13, 1950

CHEMICAL CONSTITUENTS OF *NARDOSTACHYS JATAMANSHI*: PART I—ISOLATION OF A CRYSTALLINE ACID & AN ESSENTIAL OIL

Nardostachys jatamanshi OR THE INDIAN spikenard (N.O. *Valerianaceae*; Hindi, *Jatamanshi* or *Balachur*) is a perennial herb growing in the Himalayas at altitudes above 6,000'. The rhizome which is profusely covered with fibres was used in the indigenous system of medicine for the treatment of hysteria, epilepsy and other nervous disorders[1]. It is also mentioned as an antidote to poisons, as a blood purifier and a cure for the affections of the throat and the respiratory organs[2]. Except for the isolation of the crude essential oil, no further chemical investigation of the drug appears to have so far been carried out.

As a result of the present investigation a crystalline, water-insoluble acid, provisionally named as jatamanshic acid, has been isolated in a yield of nearly 3 per cent on the weight of the air-dried drug. The method of its isolation was based on separation of the acid constituent from the ethereal extracts of the drug through dilute alkali and repeated alternate crystallization of the crude acid from alcohol and petrol ether. The original ethereal concentrates of the drug also yielded directly a crystallizate of the acid on keeping for a few weeks in the cold, but the yield in this case was much lower.

Jatamanshic acid melts at 123°C., shows $[\alpha]_D^{27} = -394°$ in alcoholic solution and conforms to the molecular formula $C_{15}H_{20}O_2$ or $C_{15}H_{22}O_2$. It is fairly stable to the action of heat and alkalies. On oxidation with potassium permanganate, it yields acetic acid and a crystalline dicarboxylic acid, m.p. 155°C. (decomp.) corresponding to the molecular formula $C_{15}H_{16}O_5$ or $C_{15}H_{18}O_5$. The formation of the latter apparently takes place through oxidation of a methylene group to a ketonic group and of the side chain methyl, originally present in jatamanshic acid, to a carboxyl group. Dehydrogenation of jatamanshic acid with selenium yields an intensely blue coloured liquid, the physical properties and colour reactions of which are indicative of an azulene structure. The neutral fractions yielded an essential oil which appears to be a sesquiterpene. Further work on these products is in progress.

GOVIND RAI CHAUDHRY
VISHWA NATH SHARMA
SALIMUZZAMAN SIDDIQUI
Chemical Laboratories, C.S.I.R., Delhi &
National Chemical Laboratory, Poona
September 14, 1950

1. DYMOCK, WARDEN & HOOPER: *Pharmacographia Indica*, 1896.
2. WATT: *Dictionary of Economic Products of India*, 1894.

ELECTRODEPOSITION OF COPPER POWDER

DRUMILER[1] AND OTHERS HAVE RECENTLY published the results of their investigations on the electrodeposition of copper powder from acid sulphate baths. Their apparatus consists of a circular glass vessel (O.D. 6"), fitted with an electric stirrer having a 1" propeller to provide constant agitation, the temperature of the bath being controlled by an electric immersion heater. The cell carries two anodes and one cathode, each $4" \times 6" \times \frac{1}{16}"$ and are spaced 1" apart.

In a similar investigation the cell and the auxiliary apparatus used by us differs considerably from that described above and the important features of this cell are described in this note (FIG. 1). They are:

(a) Use of an electrolytic cell, $12\frac{1}{2}" \times 10" \times 6"$, with two cathodes and three anodes, both $6" \times 4"$, spaced 2" apart, and having a thickness of $\frac{1}{32}"$ and $\frac{1}{8}"$ respectively.

(b) Suspension of the electrodes from two threaded, parallel copper rods, the electrodes being held in position by nuts. The rods are mounted on brackets, which in their turn are screwed to two spindles, one at either end. The spindles enable the raising or lowering of the whole assembly. In this way the inter-electrode distance as well as the depth of the submerged portion of the electrodes can be changed very easily.

(c) Circulation of the liquid in the bath by the use of a pump; and

(d) use of a heat exchanger to control the temperature of the bath, whereby investiga-

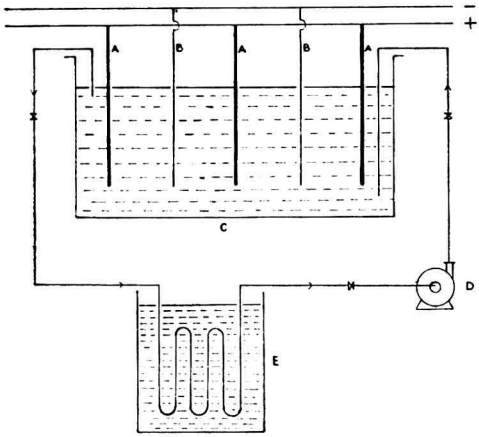


FIG. 1 — FLOW SHEET FOR THE ELECTRODEPOSITION OF COPPER POWDER. [A — anode; B — cathode; C — cell; D — pump; E — heat exchanger].

tions can be conducted at temperatures below the room temperature.

Some of the more important results so far obtained by us are recorded in Table I.

TABLE I — ELECTRODEPOSITION OF COPPER POWDER

Copper concentration, 10 gm./l.; sulphuric acid concentration, 150 gm./l.; rate of circulation, 36 l./hr.

CURRENT DENSITY, amp./sq. ft.	TEMP., °C.	POWDER CURRENT EFFICIENCY, %	APPARENT DENSITY, gm./c.c.	−200 MESH, %	SURFACE AREA, cm.²/gm.
40	30	85·4	0·460	79·9	3665
60	30	87·4	0·392	70·5	4585
150	33	77·9	0·677	62·1	2115
40	21·5	84·5	0·575	75·2	2955
60	21·5	86·0	0·554	80·2	3155
40	40	87·5	0·507	74·6	3309
60	40	89·4	0·587	68·4	3270

The apparent density of the powder was determined according to A.S.T.M. standard[2] (without tapping). The surface area was measured according to the method of Lea and Nurse[3].

M. V. JOSHI
H. J. MODI
G. S. TENDOLKAR
Department of Chemical Technology
University of Bombay
December 20, 1950

1. DRUMILER, MOULTON & PUTNAM: *Ind. Eng. Chem.*, 1950, **42**, 2099.
2. *A S.T.M. Designation*: *B* 212-48.
3. LEA & NURSE: *J. Soc. Chem. Ind.*, 1939, **58**, 277T.

CHANGES IN PLANT NAMES

IN RECENT NUMBERS OF THIS JOUNAL[1] THERE have appeared several notes on the subject of changes in plant names. It is indeed regrettable that such changes should occur; to a botanist the constant shifting of plants from one species to another, and even more, from one genus to a totally different one, causes much confusion and annoyance.

The reaction of many botanists to such frequent changes has been to demand that the next International Botanical Congress publish a list of *Nomina Specifica Conservanda* along the same lines as the list of *Nomina Generica Conservanda*.

Changes in plant names, against which so many complaints have been raised, fall into several well-defined groups. Using Bombay plants as examples, I shall try to explain how necessary such changes are and how poorly founded are the criticisms against them.

1. *Changes of Specific Names* — Among the commonest of Bombay trees there is one that has been listed by both Hooker and Cooke as *Bridelia retusa* Spr. According to Hooker (Fl. Brit. Ind. 5 : 268) the tree has "flowers in clusters . . . both axillary and in long spikes". Gehrmann (in Engl. Bot. Jahrb. 41, Beibl. 95 : 30, 1908) separated the complex group into two different species: *Bridelia retusa* Spr. with paniculate flowers and *B. squamosa* Gehrm. with axillary clusters. The reason for the new name is the need of separating two different plants that, in the first instance, should not have been united together.

Salisbury in 1806 described *Woodfordia floribunda*, a plant that had been known for over 40 years under the Linnean name of *Lythrum fruticosum*; Kurz in 1871 changed the name of the plant to *Woodfordia fruticosa*, and this is the only valid name for our plant. Changes of this type are generally the ones that have caused most of the agitation among botanists; but such changes are necessary if the rule of priority is to be followed and credit is to be given to whom credit is due. This is, however, one case where a list of *Nomina Specifica Conservanda* might be useful without, at the same time, interfering with the development of botany.

Artemisia vulgaris Linn. is listed as one of our Bombay plants by both Hooker and Cooke. In recent years Pampanini has given much consideration to the study of the

genus *Artemisia*, and his conclusions are that the Indian species is not the same plant as that of Linne. In consequence he has named our plant *A. nilagirica*. The common European plant is medicinally an important one and much work has been done on its chemical constituents ; similarity of name may cause much trouble in India and, therefore, I consider the change of name as done by Pampanini a help to Indian research workers.

2. *Changes of Generic Names*—Under the name *Phyllanthus*, for reasons that any modern taxonomist may consider very slender, a complex group of plants has been assembled. Some of these plants are *small herbs with capsular fruit*, others are *trees with fleshy fruit* ; the structure of the flower is about the only feature that is common to the whole group. Modern botanical works have accepted the division of the old genus *Phyllanthus* into several genera : *Phyllanthus* proper in a restricted sense, *Emblica* Gaertn., *Kirganelia* Baill. and *Cicca* Linn.

Another notable example of change in the generic name of our Bombay plants is that of *Loranthus* ; in the most recent work on the family, the name *Loranthus* has been entirely suppressed and several old or new names put in its place. Danser, who has monographed the family in recent years, states : " The only genus bearing rightly the name *Loranthus* is nowadays called *Psittacanthus* and is restricted to tropical America " (New Syst. Loranth. & Nomencl., p. 65). The case of the genus *Bombax* is similar to that of *Loranthus* ; most recent monographers consider the genus *Bombax* as an American one without representatives in Asia ; the oldest name already in existence for the same group of plants is *Salmalia* and in consequence our Bombay plants have been named *Salmalia malabarica* and *S. insignis*.

3. *Changes of Family Names* — Hutchinson, in his book *The Families of Flowering Plants*, 1926 and 1934, has changed a number of family names ; generally such changes are due to a more precise determination of the limits of each family. Such limits are not usually fixed arbitrarily but after consideration of all the relevant points in the morphology and anatomy of the plants in question. For a lucid explanation of the " Considerations for the Delimitation of Families ", see Hutchinson op. cit., 1926, p. 5 and following.

To demand that specific, generic or even family names be fixed by international agreement is to condemn systematic botany to stagnation. It is unfortunate that in the past writers of Indian floras have been rather uncritical in their judgement on Indian plants ; Wallich in his Catalogue or List often collected several different plants under one and the same name, and Hooker in his Fl. Brit. Ind. often followed Wallich. Cooke, the author of the *Flora of Bombay Presidency*, seems to have followed Hooker rather blindly. In consequence it is my opinion that for a number of years we shall have to be troubled with changes in nomenclature ; generally speaking, however, every such change is a decided advance in our knowledge of Indian plants, and the time is already being envisaged when the need for such changes will have altogether ceased to exist.

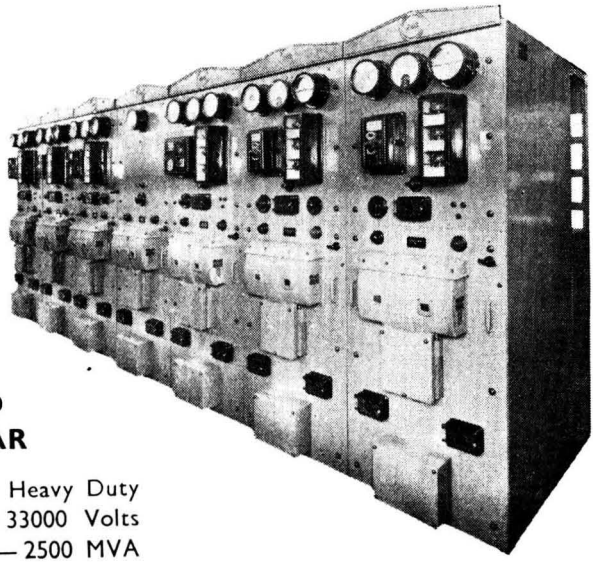
H. SANTAPAU, S.J.
St. Xavier's College
Bombay
December 2, 1950

1. RAO, V. S. : *J. sci. industr. Res.*, 1949, **8**, 163, 337.

G.E.C.

THE LARGEST BRITISH ELECTRICAL MANUFACTURING ORGANISATION

Pioneers in every phase of electrical development



11 K.V. 250 MVA solenoid operated truck cubicle Switchboard.

METALCLAD SWITCHGEAR

Light, Medium or Heavy Duty
Voltages : 400 — 33000 Volts
Capacities : 150 — 2500 MVA

FOR

POWER STATIONS ■ SUB-STATIONS ■ MILLS ■ CEMENT WORKS
COAL MINES ■ IRON & STEEL WORKS ■ ETC., ETC.

THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND

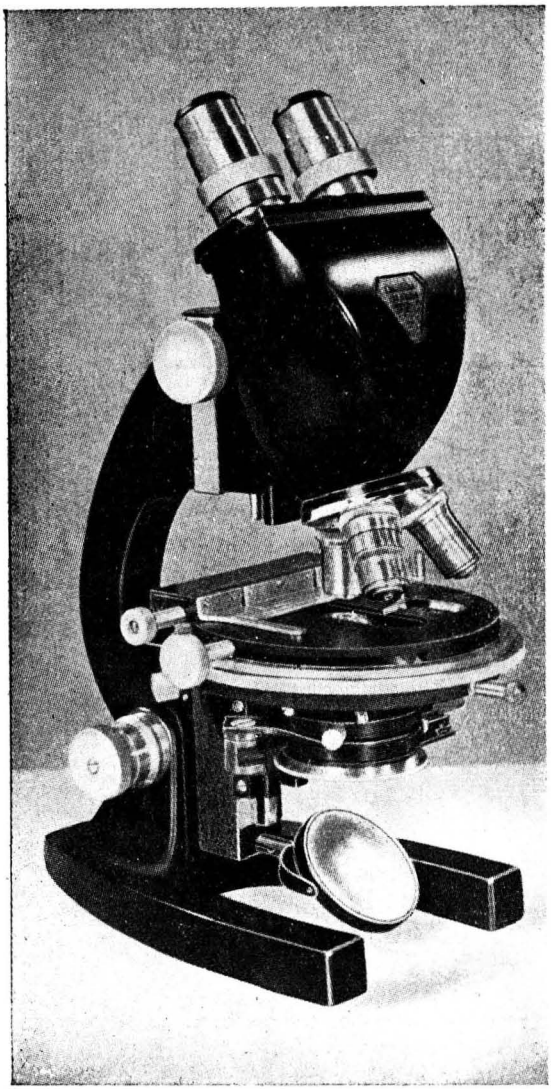
Represented by **THE GENERAL ELECTRIC COMPANY OF INDIA LIMITED**

Bombay • Calcutta • Delhi • Kanpur • Madras • Bangalore • Coimbatore • Secunderabad

Also represented in Karachi • Lahore • Chittagong • Rangoon

ARISTOCRATS

and they will work for you !



BAUSCH & LOMB
RESEARCH
MICROSCOPES
SERIES E

Optically and mechanically the new Series E are superb examples of advances in production and design resulting from years of research and experimentation by the Bausch & Lomb Optical Company, Rochester, U.S.A.

Sole Agents

MARTIN & HARRIS, LTD.
SCIENTIFIC DEPARTMENT
SAVOY CHAMBERS, WALLACE STREET
BOMBAY 1

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.