LEICESTER
16 APR 1959
505705A

Journal of Scientific & Industrial Research

IN THIS ISSUE

A: GENERAL

Domestic solar water heater

Corrosion of metals in synthetic atmospheres

Determination of thickness of chromium electrodeposits

B: PHYSICAL SCIENCES

Studies on atmospheric radio noise

Mechanism of lithium aluminium hydride reduction

Persulphate oxidation of xanthones

C: BIOLOGICAL SCIENCES

Possible oral hypoglycemic agents

Influence of total hybridization on phosphatases

Analysis of synthetic food colours

NATIONAL LENDING LIBRARY
Boston Spa, Yorkshire
ON LOAN FROM THE NATIONAL LENDING LIBRARY FOR SCIENCE & TECHNOLOGY
Boston Spa, Yorkshire
Please return as quickly as possible and not later than date shown below.
17. JUL. 1972
DB 60331
Date

J. Sci. industr. Res.
Vol. 18A, No. 2, Pp. 41-96
FEBRUARY 1959

A—GENERAL

THE COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, NEW DELHI

Wilh. Lambrecht

Instruments for the Equipment of Meteorological Stations, Expeditions, and Research Institutes

ATMOSPHERIC MOISTURE

Hygrometers

Hygrographs with Special Measuring Element " Pernix " DRPa (German Patent)

Psychrometers: Aspiration Psychrometers and Standard Psychrometers

Psychrographs with Psychrometer Evaluation Device (Registered Design)

Vapour Pressure Recorders

AIR & SOIL TEMPERATURE

Thermometers: Maximum & Minimum, Earth, and Whirling

Thermographs

ATMOSPHERIC PRESSURE

Mercury Barometers

Fortin Barometers

Station Barometers

Marine Barometers

Precision Aneroid Barometers

Barographs

Minute Pressure Recording Devices Micro-Barographs

PRECIPITATION & EVAPORATION

Indicating or Recording

Rain Gauges

Dew Balances

Evaporation Gauges

WIND

Wind Vanes

Cup Anemometers

Remote Indicating and Recording Devices for Wind Direction, Wind Velocity, and Wind Run

SOLAR RADIATION & CLOUDS

Solar Radiation Thermometers

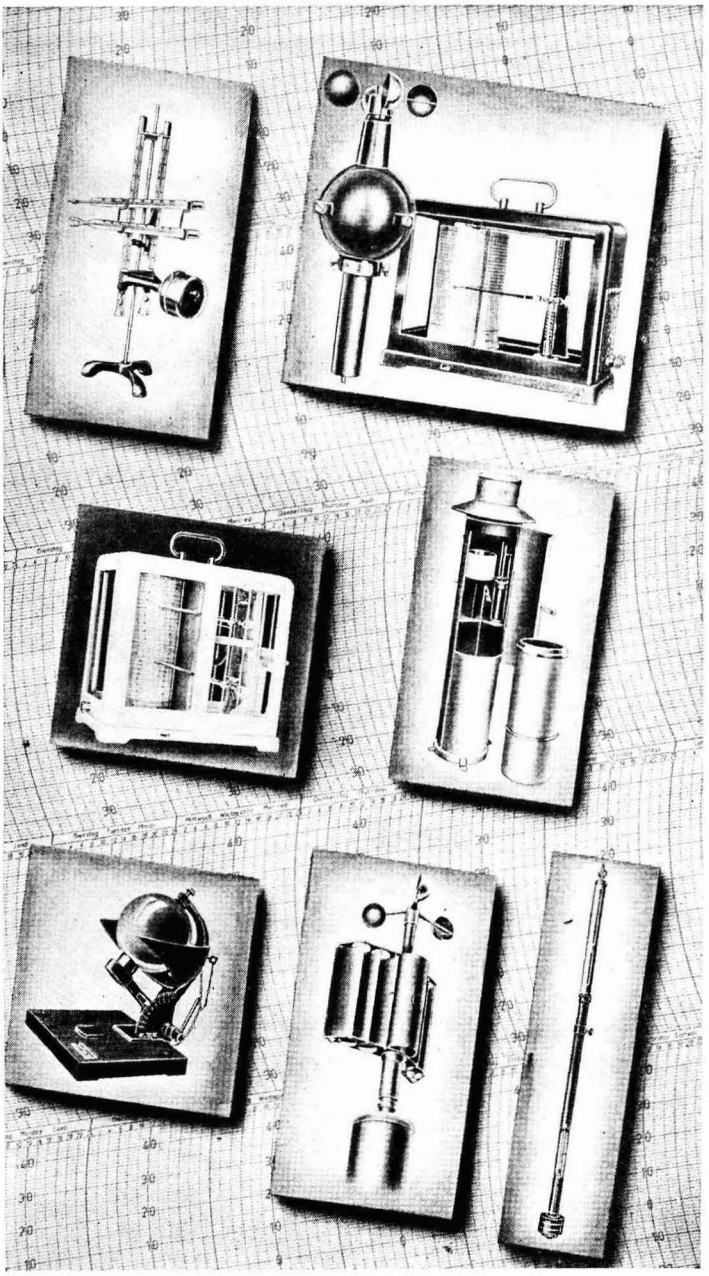
Sunshine Recorders

Cloud Mirrors

Thermo-Hygrographs

Meteorographs: Baro-Thermo-Hygrographs

etc. etc. etc.



For particulars and prices please contact

SOLE DISTRIBUTORS

THE SCIENTIFIC INSTRUMENT COMPANY LIMITED

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI

This document should be returned to:

LOANS DEPARTMENT,
NATIONAL LENDING LIBRARY FOR
SCIENCE AND TECHNOLOGY,
BOSTON SPA,
YORKSHIRE.

not later than the last date shown below, using the label provided

Req. No.	Return Date	Req. No.	Return Date
HF35215	21 AUG 1962		
RR5946			
NLF.33305	-3. JUN. 1964 20 JAN 1965		
NLC46915	25 JAN 1965		

In any correspondence regarding this loan please quote the requisition number and return date as shown above.

Wt. 15951/238603 20m JAJLtd/232/860/6/62—B

Sunshine Recorders

Journal of Scientific & Industrial Research

Vol. 18A, No. 2, FEBRUARY 1959

EDITORIAL BOARD

Prof. M. S. THACKER, Director-General, Scientific & Industrial Research (*ex officio* Chairman)

Dr H. J. BHABHA, Secretary, Department of Atomic Energy, Bombay

Dr S. KRISHNA, 88 Rajpur Road, Dehra Dun

Dr K. S. KRISHNAN, Director, National Physical Laboratory, New Delhi

Dr JIVRAJ N. MEHTA, Minister for Finance, Prohibition & Industries, Bombay State, Bombay

Dr D. N. WADIA, Geological Adviser, Department of Atomic Energy, Government of India, New Delhi

Shri B. N. SASTRI, Chief Editor & *ex officio* Secretary

Shri A. KRISHNAMURTHI, Editor

CONTENTS

Current Topics

THE INDIAN INSTITUTE OF SCIENCE: GOLDEN JUBILEE CELEBRATIONS 41

FORTY-SIXTH INDIAN SCIENCE CONGRESS SESSION, DELHI ... 41

UNITED STATES SCIENCE INFORMATION SERVICE ... 42

Role of Physical & Biological Sciences in the Progress of Medicine 43

Domestic Solar Water Heater 51
K. N. Mathur, M. L. Khanna, T. N. Davey & S. P. Suri

Gelation Time Studies of Some Resorcinol Adhesives ... 58
A. G. Ghosh

Measurement of the Electrical Resistance of Sized Powders at Different Bulk Densities: Part II — Graphite Powders 60
T. R. Gopalaswamy, N. R. Subramanian & G. D. Joglekar

Studies on Indigenous Cottonseed: Part VI — Delinting & Hulling 66
K. S. Chari, V. R. Harwalkar, S. A. Saletore & S. H. Zaheer

The Corrosion of Metals in Synthetic Atmospheres Containing Sulphur Dioxide 69
B. Sanyal & D. V. Bhadwar

Anodic Stripping Method for the Determination of Local Thickness of Electroplates: Part I — Design of Electronic Relay & Its Application to Measurement of Thickness of Chromium Electrodeposits 75
S. Satyanarayana & D. L. Roy

Reviews 79

Publications Received 84

Notes & News 85

Progress Reports 93

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

© 1959 THE COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, NEW DELHI

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, OLD MILL ROAD, NEW DELHI 1.

Annual Subscription: Rs 20 (inland), £ 2 or $ 6.00 (foreign). Single Copy: Rs 2 (inland), 4 sh. or $ 0.60 (foreign)

CONTENTS

SECTION B

Measurement & Description of the Characteristics of Atmospheric Radio Noise 43
S. V. Chandrashekhar Aiya

Atmospheric Radio Noise Levels at Poona in the 2·5-20 Mc/s. Band 47
S. V. Chandrashekhar Aiya, K. R. Phadke, S. V. Padmanabhan & C. K. Sane

Atmospheric Noise Interference in the Standard Broadcast Band at Poona 54
S. V. Chandrashekhar Aiya & C. G. Khot

Studies in Properties of Capillary-held Liquids: Part VI — Hysteresis Effect in Adsorption by Porous Bodies 67
Balwant Rai Puri, S. N. Khanna & Y. P. Myer

Studies on a Synthetic Iron Oxide Hydrate for Desulphurization of Industrial Gases ... 70
B. K. Banerjee, N. G. Basak & A. Lahiri

Mechanism of Lithium Aluminium Hydride Reduction 73
V. N. Gupta

Xanthones: Part VIII — Elbs-Seshadri Persulphate Oxidation of Xanthones 75
V. V. Kane, A. B. Kulkarni & R. C. Shah

Thiophenes & Thiapyrans: Part XIX — Cyclodehydration of Phenacyl Phenyl Sulphide & Its Derivatives 77
D. S. Rao & B. D. Tilak

Letters to the Editor

OBSERVATIONS ON NUCLEAR MAGNETIC RESONANCE: VARIATION OF SPIN RELAXATION TIME WITH CONCENTRATION OF PARAMAGNETIC ION & VISCOSITY OF THE MEDIUM 84
V. Nagarajan

ETCH FIGURES ON TIN & ZINC 85
N. S. Pandya & C. J. Shah

STRUCTURAL CHANGES IN HIGH-CARBON STEEL ATTACKED BY SHAPED CHARGES 86
A. Soundraraj & Sampooran Singh

REACTION OF COPPER PYRITES ORE WITH CUPRIC CHLORIDE 87
(Late) G. C. Mitter, B. K. Bose, S. G. Dighe, S. D. Gokhale & Y. W. Gokhale

RELATIVE CORRODIBILITY OF ZINC & STEEL IN UNPOLLUTED ATMOSPHERES 87
K. S. Rajagopalan & G. Ramaseshan

SPECTROPHOTOMETRIC ESTIMATION OF IRON IN PLANT MATERIALS 89
Baldev Kapoor & C. Dakshinamurti

CHEMICAL EXAMINATION OF *Feronia elephantum* CORR. 90
D. P. Chakraborty

ISOLATION OF ERGOSTEROL FROM *Roccella montagnei* 91
T. Krishna Murty & S. Sankara Subramanian

SECTION C

Studies in Possible Oral Hypoglycemic Agents: Part I — Synthesis of Some Hydantoins, Hydantoic Esters & Related Compounds 21
R. Paul, S. P. Popli & M. L. Dhar

Antifungal Activity of Some Sulphur Containing Compounds against Dermatophytes & Yeast-like Fungi 25
O. P. Srivastava

Screening of Antimalarials against *P. gallinaceum* in Chicks: Part VII 28
G. P. Sengupta, H. L. Bami & G. K. Sharma

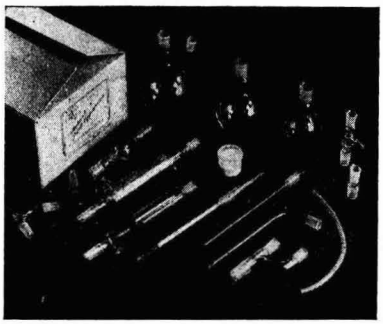
Influence of Total Body X-irradiation on the Acid & Alkaline Phosphatases, Glucose-6-phosphatase, ATPase & Phosphorylase Enzymes in Rats 34
M. B. Sahasrabudhe, A. D. Rahalkar, M. K. Nerurkar & D. K. Mahajan

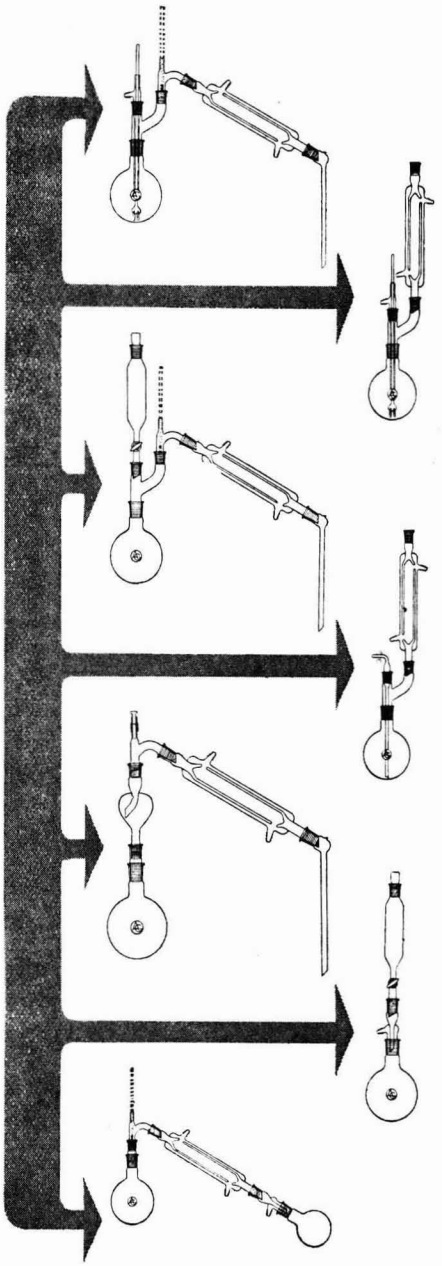
Analysis of Synthetic Food Colours Prescribed in India 38
B. R. Roy, A. R. Sundararajan & S. N. Mitra

Maximum Adaptability
at Minimum cost

WITH THE AG BASIC SET OF

STANDARD JOINT APPARATUS





The set consists of 14 carefully designed and well-made units out of which can be made more than 18 major assemblies commonly used for organic processes in chemistry. Several of these are illustrated and more than 40 variations are possible. Some of the components have many other uses in the laboratory. The pump connector and flask, for example, form a simple filtration unit suitable for a small Buchner funnel or crucible.

Ask for Publication No. 589

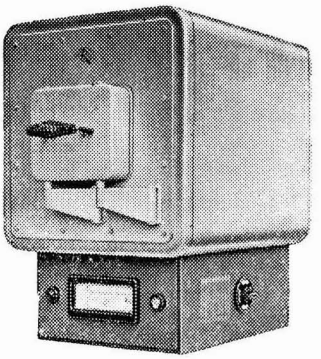
Manufactured by

A. GALLENKAMP & CO. LTD.
LONDON, ENGLAND

Accredited Agents

MARTIN & HARRIS (PRIVATE) LTD.
SCIENTIFIC DEPARTMENT SAVOY CHAMBERS WALLACE STREET BOMBAY 1

Electrically Heated
MUFFLE FURNACES
for Laboratories & Workshops



Manufactured by

Messrs GEBR RUHSTRAT, Germany

Outstanding Features

▪ Regulator with scale ▪ Built-in temperature ▪ Built-in thermocouple ▪ Heating muffle of high quality clay (sillimanite) with chrome-nickel heating coils embedded ▪ Muffle can be changed while furnace is still hot ▪ Rapid heating time to full temperature in approximately 90 minutes ▪ Uniform temperature inside heating chamber ▪ Excellent temperature regulation (±10°C.) ▪ Double hinged door ▪ Modern compact design ▪ Low operating costs ▪ Ideal for bench use for the annealing, tempering and hardening of metals

SOLE AGENTS IN INDIA:

TOSHNIWAL BROTHERS PRIVATE LIMITED

198 JAMSHEDJI TATA ROAD, BOMBAY 1

Branches:

'RIVAL'
KACHERI ROAD
AJMER

172 DHARAMTALA
STREET
CALCUTTA 13

14-B/4 N.E.A.
UTTARI MARG
NEW DELHI 5

ROUND TANA
MOUNT ROAD
MADRAS 2

Telephone { 35-2052 / 35-4356

Telegram : JABAKHARA

Director-in-Charge

Dr. B. N. Dutta, M.Sc., D.Phil.

Support the Government's Import Policy by using OSTER'S Products

* ACID SULPHURIC
* ACID HYDROCHLORIC
* ACID NITRIC
* AMMONIUM HYDROXIDE
* LABORATORY REAGENTS
* ANALYTICAL REAGENT ACIDS
* INDUSTRIAL CHEMICALS, ETC.

★

OSTER CHEMICAL & PHARMACEUTICAL WORKS (PRIVATE) LTD.

78B MANICKTOLA STREET
CALCUTTA 6

Established 1922

PHARMA TRUST

114 PRINCESS STREET
BOMBAY 2

★

for all your

LABORATORY REQUIREMENTS

★

Grams : 'ANTIGEN'

TO COMBAT
PROTEIN MALNUTRITION

insist on

HYDROPROTEIN

(Oral & Injection)

- Rich in Essential Amino Acids
- Biologically Adequate

Lysine
Histidine
Arginine

Threonine

Proline

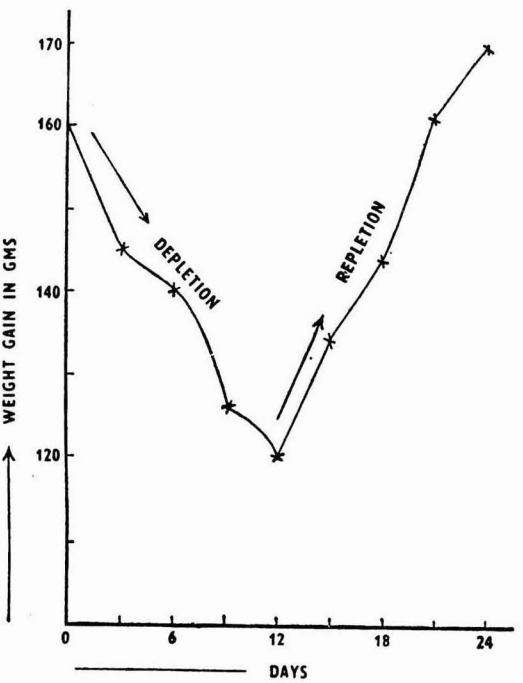
Tryptophane

Methionine

Valine

Phenylalanine
Iso-leucine
Leucine

Chromatogram from Hydroprotein



Weight response of protein depleted rats to feeding of Hydroprotein.

BENGAL IMMUNITY Co. Ltd.

153 DHARAMTALA STREET, CALCUTTA 13

THE TRADE MARK

T M
INDIA

FOR YOUR GUARANTEE

LABORATORY EQUIPMENT

Students' Microscopes — Dissecting Microscopes — Microscope Lamps
Slide Viewers — Adjustable Stand Magnifiers — Colony Counters
Laboratory Stirrers — Water Stills — Cork Boring Machines
Water Baths — Paraffin Baths — Serological Baths
Ovens — Incubators — Hot Plates

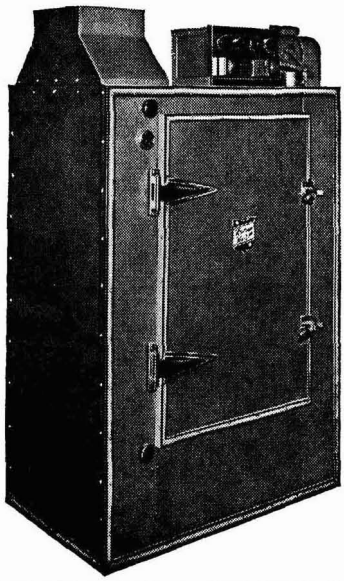
For prices and particulars enquire from your regular suppliers or
SELLING AGENTS :

J. T. JAGTIANI

National House, 6 Tulloch Road, Apollo Bunder
BOMBAY 1

SP/JT/2

WIDE RANGE ALL PURPOSE OVEN
OVERALL HEIGHT 6 FT.



FREDERICK HERBERT
POST BOX No. 6055, BOMBAY 5

SP/FH/3

Equip your laboratory with

LABORATORY & PHARMACEUTICAL CHEMICALS, ANALYTICAL & LABORATORY REAGENTS, AMINO ACIDS, STAINS, DRUGS, VITAMINS, ETC.

Directly imported by

S. MATHURADAS & CO.

P.O. BOX No. 2113
PRINCESS STREET
BOMBAY 2

Gram : " SMATHURCO " Phone : 30273

Tel: 22373 Gram: 'CRUCIBLE'

PLATINUM

LABORATORY APPARATUS

PIONEER MANUFACTURERS IN INDIA

R & CO.

TRADE MARK

* WIRES * CRUCIBLES * DISHES * FOILS * TIPPED TONGS * J. LAWRENCE SMITH TYPE CRUCIBLES * SPOONS * SPATULAE * WIRE GAUGE * TRIANGLES

All items manufactured from 'Special Platinum' guaranteed 99·9% and over

ALL ITEMS
AVAILABLE FROM READY STOCKS

Reshaping of damaged platinum apparatus undertaken at Rs. 3 per gram.

Replacement of damaged platinum apparatus at Rs. 4 per gram.

Any article in platinum manufactured and supplied as per specification.

ILLUSTRATED CATALOGUE ON REQUEST

RAVINDRA & CO. (PLATINUM)
11, DR. ANNIE BESANT ROAD,
WORLI, BOMBAY 18.

Scientific Equipment

'SOLAR' Brand German Microscopes

'STAR' Brand Japanese & Indian Microscopes

'WENZEL' Microscope, Optics — Wetzlar, German

'ERMA' Precise Standard Japan Make Refractometer, Polarimeter, Colorimeter, Spectrophotometer, Electrophoresis Apparatus, Blood Test Apparatus, Blood Sugar Colorimeter, Colony Counter, Microscope, Microtome, Kymograph, etc.

Balance Analytical — 'HARTNER', German

Dairy Appliances — 'MILKMAN' Brand, German

Centrifuge — 'MARUSAN' Brand, Japan Make

Filter paper — Macherry & Nagel 'ROTA', German

Laboratory Glassware — 'SOLIDEX', French & 'AVON', German

Hydrometer & Thermometer — 'AVON', German

Slide Rules — 'RELAY' Finest, Japanese

Precision Measuring Instruments, Japanese

Blood Test Instruments, German & Japan

'ANSEL' Rubber Gloves, Australian

'GANGA' Brand Laboratory Glassware, Indian

General Equipment: Glassware, Porcelainware, Silicaware, Earthenware, Enamelware, Metalware, Woodware

Chemicals — Pure, Analytical & Solutions

We Quote Special Prices for Import against Your License

Write to Authorized Representative:

ZILL & Co.

128 PRINCESS STREET
BOMBAY 2

Grams: 'LABORATORY' Phone: 38841

SAUTER'S

ANALYTICAL RAPID SINGLEPAN BALANCE

'MONOPAN'

Capacity : 200 gm.

Range of optical scale : 110 mg.

One scale division : 2 mm. or 1 mg.

Readability : half of a vernier division : or 1/20 mg.

Sole Agents in India :

GORDHANDAS DESAI PRIVATE LIMITED

PHEROZSHAH MEHTA ROAD, BOMBAY 1

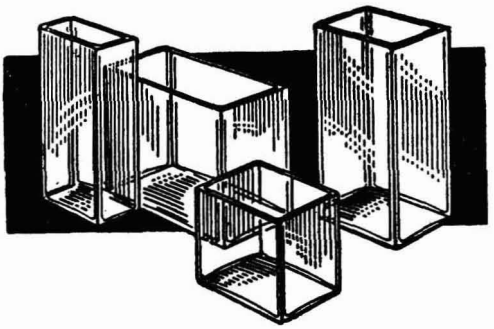
Branches :

P-7 MISSION ROW EXTENSION
CALCUTTA 1

4/2B ASAF ALI ROAD
NEW DELHI

22 LINGHI CHETTY STREET
MADRAS 1

SP/GD/81



CRYSTAL MUSEUM JARS WITH COVERS

MADE IN CZECHOSLOVAKIA

For use in the Preservation of Pathological and Anatomical Specimens

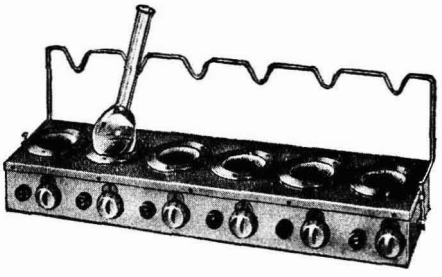
Each jar is carefully inspected to insure perfect finish, free from striations, bubbles and waves. Perfect annealing, followed by polariscopic inspection, guarantees a strain-free jar to withstand any shock or temperature change encountered in ordinary use.

Fourteen sizes now available from stock. Latest price list on request.

LEADING IMPORTERS & STOCKISTS OF SURGICAL & SCIENTIFIC GOODS

B. PATEL & COMPANY

27/29 POPATWADI, KALBADEVI ROAD
POST BOX No. 2040, BOMBAY 2



We manufacture:

★ **I. & E. "MULTITHERM" OVEN**
High Temperature (+40°C. to 300°C.)
Variation ±1°C.

★ **I. & E. "PRECISION THERMOSTATIC WATER BATH"**
From −10°C. to 90°C.
Variation ±0·1°C.

★ **ELECTROPHORESIS APPARATUS — up to 500 volts**

★ **SPECTROPHOTOMETER — diffraction grating type**

★ **All types of SHAKERS, STIRRERS, etc.**

Instruments and Equipments

35, Chittaranjan Avenue, Calcutta-12

Gram : **LABGOODS** Phone : **23-3259**

The New handy and easy-to-carry

MICROSCOPE

MODEL MII

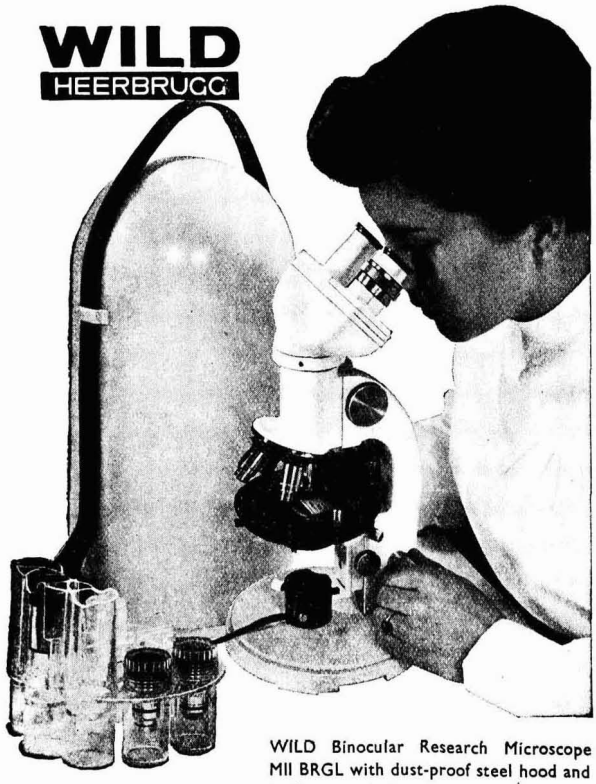
suitable for field work

•

Available as

★ **Monocular**
or
★ **Binocular**

WILD
HEERBRUGG



WILD Binocular Research Microscope MII BRGL with dust-proof steel hood and leather carrying strap

Extra Attachments for :

* **POLARISING** * **DARK GROUND** * **PHASE CONTRAST**
* **PROJECTION** * **PHOTOMICROGRAPHY, ETC. ETC.**

Equipped with modern, High Precision Swiss Machines, Tools, Gauges and Collimators and with an expert Swiss trained Engineer, our SERVICE DIVISION undertakes repairs to Wild Microscopes and other Optical and Fine Mechanical Instruments.

SOLE AGENTS

RAJ-DER-KAR & Co.

Sadhana Rayon House, Dr. D. Naoroji Road
BOMBAY

Telephone : **26-2304** Telegram : **TECHLAB**

OUR SUB-AGENTS

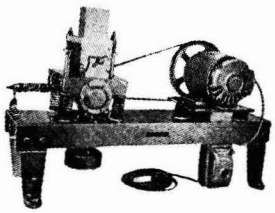
VULCAN TRADING CO. PRIVATE Ltd.

38C Mount Road
MADRAS 6

Manufactured in India

(British Standard Specifications)

Equipment for Testing



VIBRATING MACHINE
2800 R.P.M.
(B.S.S. 1370)

• SOIL
• • CEMENT
• • • CONCRETE
• • • • ASPHALT

For particulars write to

SCIENTIFIC EQUIPMENT WORKS

1/777 NICHOLSON ROAD, DELHI 6

Telegram : CHEMBIO

Telephone : 27029

Please send your enquiries for

- PHYSICS, CHEMISTRY & BIOLOGY LABORATORY INSTRUMENTS & APPARATUS
- MICROSCOPES — ALL TYPES
- LABORATORY GLASSWARES
- PORCELAIN & SILICAWARES
- OVENS, INCUBATORS & OTHER EQUIPMENT

to

INTERNATIONAL AGENCIES

Lucky Mansion, 79 Ghoga Street

BOMBAY 1

Gram: 'SCIENAPP'

Phone : 253753

Ex-Stock

'PYREX'

BRAND

(Made in England)

Laboratory Glassware

•

ALL OTHER BRANDS OF GLASSWARE ARE ALSO AVAILABLE FROM READY STOCK

•

For further details please contact

LABORATORY FURNISHERS

DHUN MANSION, VINCENT ROAD

DADAR, BOMBAY 14

Telephone : 62761

Branch :
AHMEDABAD

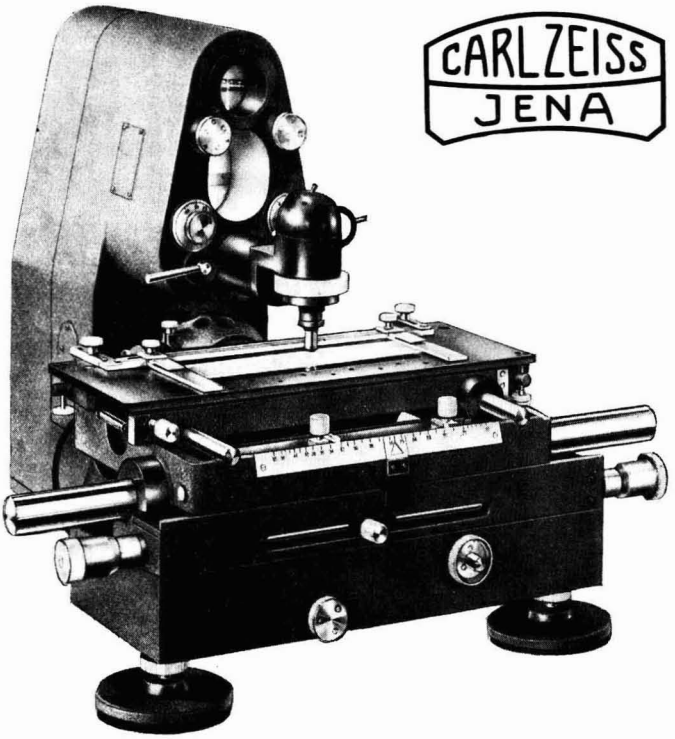
SP/IA/1

ZEISS RAPID PHOTOMETER II

Quick, convenient and reliable evaluation of Spectrogram by photoelectric method.

Magnification changing facilities and advantageous exclusive frontal manipulation.

Measurement accuracy up to 0.01 mm. Optional millimeter, density or transformed scales.



VEB CARL ZEISS JENA

"PLEASE PAY US A VISIT AT THE LEIPZIG SPRING FAIR"

Sole Agents in India :

GORDHANDAS DESAI PRIVATE LIMITED

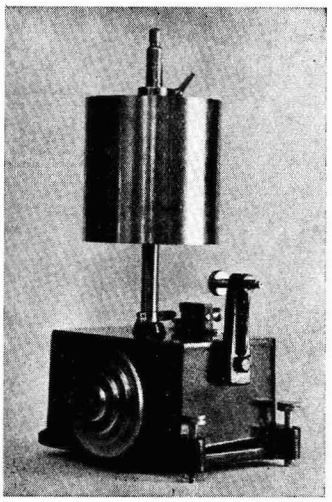
PHEROZSHAH MEHTA ROAD, BOMBAY 1

Branches:

22 LINGHI CHETTY STREET MADRAS 1

4/2B ASAF ALI ROAD NEW DELHI

P-7 MISSION ROW EXTENSION CALCUTTA 1



We offer

PHYSIOLOGICAL, PATHOLOGICAL, BIOLOGICAL & PHARMACEUTICAL LABORATORY REQUIREMENTS

such as:

AUTOCLAVES, INCUBATORS, DISTILLATION PLANTS, OVENS, VACUUM STILLS, FILTERS, BATHS & ALL SORTS OF GAS, WATER & VACUUM TAPS, ANIMAL CAGES & BOTTLE FILLING UNITS

M. RAMCHANDRA & SONS

Estd. 1920

'RAM DOOT' 12B KELEWADI

GIRGAUM, BOMBAY 4

B O R O S I L

LABORATORY GLASSWARE

such as

FLASKS, BEAKERS, CONDENSERS, MEASURING FLASKS, MEASURING CYLINDERS, PIPETTES & ANY SPECIAL APPARATUS MADE TO DESIGN

and

PENICILLIN VIALS, VACCINE BULBS — WHITE & AMBER

•

ALL OTHER APPARATUS & EQUIPMENT MANUFACTURED TO CLIENT'S DESIGN

INDUSTRIAL & ENGINEERING APPARATUS CO. PRIVATE Ltd.

CHOTANI ESTATES, PROCTOR ROAD

GRANT ROAD, BOMBAY 7

Direct Importers

for

* LABORATORY CHEMICALS

* PHARMACEUTICAL CHEMICALS

* FINE CHEMICALS

* VITAMINS

* STAINS, etc.

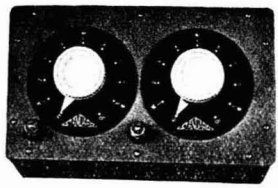
Please refer to:

B. BABULAL & Co.

71 PRINCESS STREET

POST BOX No. 2409, BOMBAY 2

Gram : **PETROLIUM** Phone : **28465**



STANDARD

RESISTANCE BOXES

SINGLE AND MULTIPLE DIALS

MINALPHA COILS
ACCURACY 0·1 PER CENT
SELF-CLEANING CONTACTS
OF SPECIAL MATERIALS
NEGLIGIBLE CONTACT RESISTANCE

Made by:

THE STANDARD SCIENTIFIC INSTRUMENTS CO.

115 BRODIES ROAD, MADRAS 28

Gram: 'MAYBLOOM' Phone: 55-5032

ASSOCIATED SUPPLY AGENCY

4B NOYAN SAHA LANE
CALCUTTA 3

★

Stockists for

- 'PYREX' LABORATORY GLASSWARES
- 'JENA' GRADUATED & VOLUMETRIC GLASSWARES
- PORCELAIN & SILICA WARES
- SCIENTIFIC INSTRUMENTS

&

- E. MERCK'S PURE, EXTRA PURE G.R. CHEMICALS

Reliable house for

* LABORATORY GLASSWARES
(PLAIN & GRADUATED)

* THERMOMETERS & HYDROMETERS

* PORCELAIN & SILICAWARES

* PLATINUM & NICKELWARES

* FILTER PAPERS & PRODUCTS

* SCIENTIFIC INSTRUMENTS, etc. etc.

CONTACT:

UNIQUE TRADING CORPORATION

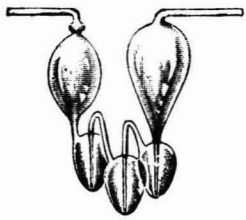
221 SHERIFF DEVJI STREET, BOMBAY 3

Gram: **UNILAB** Phone: **30011**

'SAMCO'

THE TRADE MARK OF
QUALITY & SERVICE
TO THE LABORATORY
INDUSTRY

Call at: 62761
Gram: 'GLASSCO'



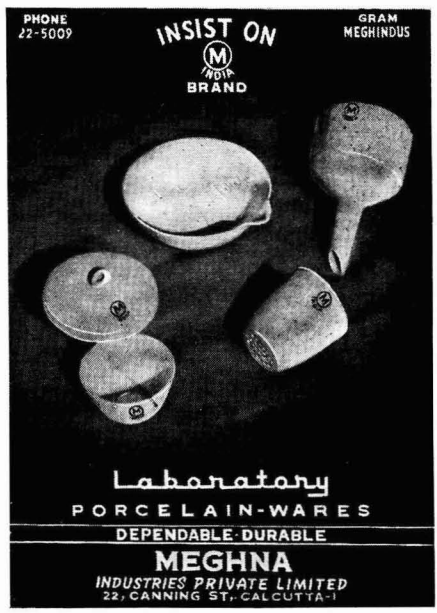
We specialize in manufacturing:

GROUND GLASS JOINTS, STOPCOCKS, STANDARD JOINT ASSEMBLIES, AUTOMATIC BURETTES & ANY OTHER APPARATUS MADE TO SPECIFICATIONS

SCIENTIFIC APPARATUS MANUFACTURING Co.
255/3-C MANGALDAS ROAD, BOMBAY 2

STOCKISTS OF
Physical, Chemical & Geographical Instruments
MANUFACTURED BY
POPULAR TRADERS, HILL ROAD, AMBALA CANTT.

SP/SAM/2



Sigcol

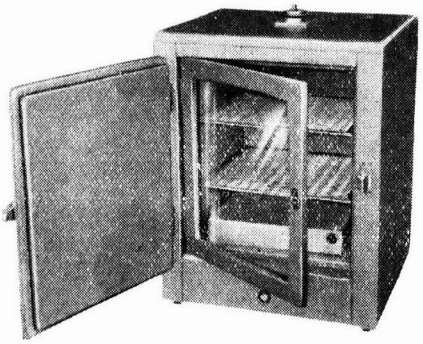
LABORATORY
GLASS
APPARATUS

•

Sole Selling Agents

GHARPURE & CO.
P-36 ROYAL EXCHANGE PLACE EXTN.
CALCUTTA 1
Gram : MEENAMO • Phone : 22-2061

TEMPO Laboratory Equipment



INCUBATOR,
BACTERIOLOGICAL

The Incubator Cabinet is double walled with two doors and is made of mild steel except for the inner door which is of wood with a glass panel for observation. It is operated electrically on 230 V. a.c. and the temperature is variable up to 60°C. The Pilot Lamp shows the working of the temperature control system.

Complete with a suitable length of three-core wire with socket and a three-pin plug.

Working Space: 14″ × 14″ × 14″
Shelves: Two

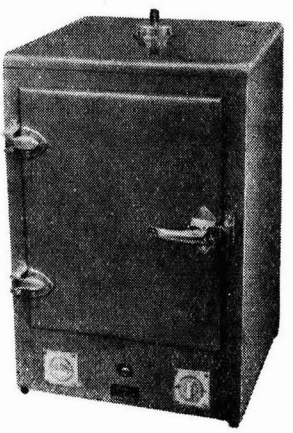
Construction — Double-walled mild steel construction with 2″ gap between the walls filled with fibre glass. Outside finished in silver-grey hammered tone synthetic enamel and inside painted with heat-resisting aluminium paint.

Size (working space) — 14″ × 14″ × 14″.

Heating — Electrically operated on 230 V., 50 cycle, A.C.

Maximum temperature — 250°C.

Temperature control — By means of a bimetallic thermostat. Variation not more than ±1°C.



HOT AIR OVEN

***Manufactured by*:**

TEMPO
INDUSTRIAL CORPORATION (PRIVATE) Ltd.

SONARI ROAD, PARANJPE 'B' SCHEME
BOMBAY 24

We manufacture

IONONE 100 PER CENT, IONONE ALPHA & BETA, GERANIOL & CITRONELLOL PURE, METHYL IONONE, HYDROXYCITRONELLAL 100 PER CENT, EUGENOL, CITRAL, GERANYL ACETATE, GUM STYRAX

and other

Aromatic Chemicals, Essential Oils, Resinoids and various perfume compounds useful for soap and other toilet articles

S. H. KELKAR & CO. (PRIVATE) LTD.

DEVAKARAN MANSION, 36 MANGALDAS ROAD
BOMBAY 2

Branch:
Opposite City Post Office
BANGALORE CITY

Gram:
'SACHEWORKS'
BOMBAY-DADAR

GS Gas PLANTS

CHEAP & SIMPLE source for GAS for all type of HEATING

AVAILABLE IN VARIOUS CAPACITIES

Also Manufacture

BURNERS FOR INDUSTRY, LABORATORY, KITCHEN

LABORATORY FITTINGS, OVENS, BATHS, STILLS, ETC.

ATOMIC ENERGY EQUIPMENT, REMOTE CONTROL TONGS,

ORE DRESSING EQUIPMENT, ETC. ETC.

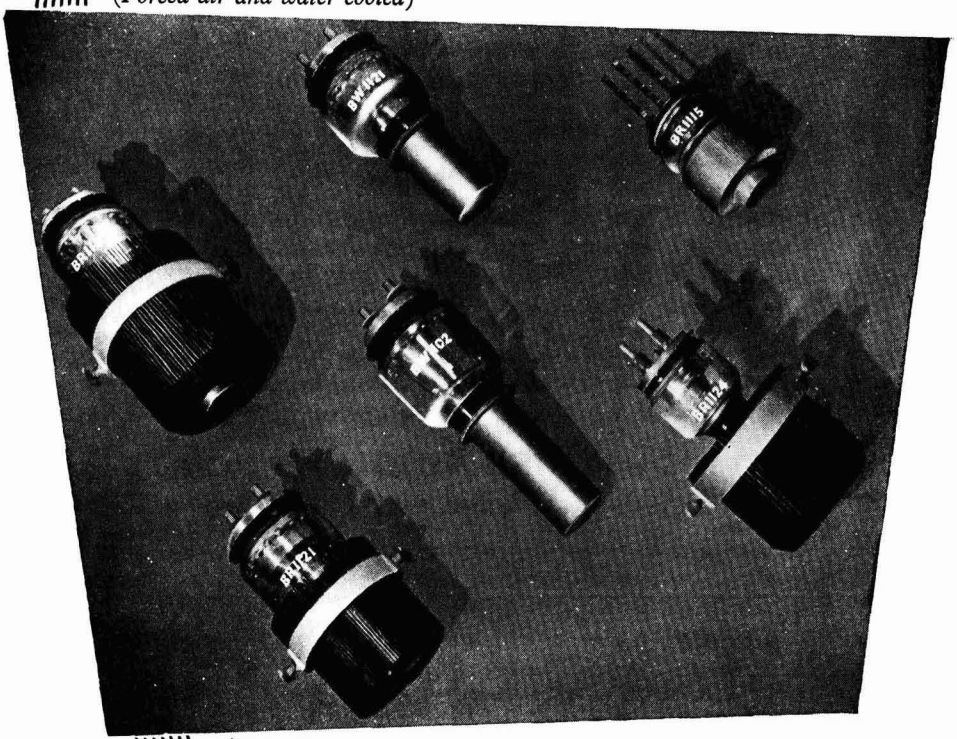
Stainless Steel Plant and Equipment Fabricators

GANSONS PRIVATE LTD., P.O.B. 5576, BOMBAY 14

* *New range of*

POWER OSCILLATORS *for* R.F. HEATING

(Forced air and water cooled)



* High Perveance
Rugged
Specially designed for arduous factory use.

Forced Air Cooled		Water Cooled	
BR 1124	Power Output 20 kW	BW 1102	Power Output 55 kW
BR 1102	Power Output 55 kW	BW 1121	Power Output 40 kW
BR 1115	Power Output 7 kW		
BR 1121	Power Output 40 kW		

Full technical data available on request

ASSOCIATED INSTRUMENT MANUFACTURERS

(INDIA) PRIVATE LTD.

B5, GILLANDER HOUSE,
P.O. Box 2136
CALCUTTA.

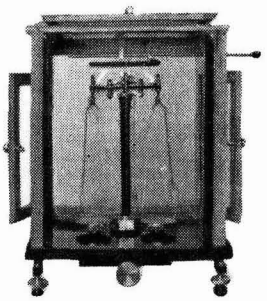
INDIA HOUSE,
FORT ST.,
BOMBAY.

SUNLIGHT INSURANCE BUILDING,
26/27 ASAF ALI ROAD,
N. DELHI.

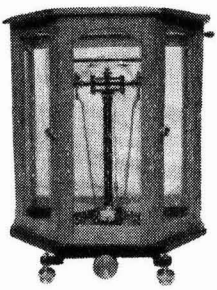
ENGLISH ELECTRIC VALVE CO. LTD. *Chelmsford, England*
Telephone: Chelmsford 3491

AP169

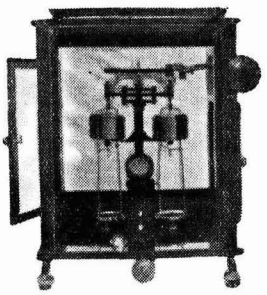
BALANCES *for* SCHOOLS, COLLEGES, INDUSTRIAL LABORATORIES & RESEARCH INSTITUTES



No. 5x



No. 6



No. 2

CATALOGUES SENT ON REQUEST

MANUFACTURED BY:

SCIENTIA INDUSTRIES (INDIA) PRIVATE Ltd.

34 BANERJI BAGAN LANE, SALKIA, HOWRAH

Estd. 1944

ASHA SCIENTIFIC COMPANY

Lotlikar Mansion, 503 Girgaum Road
BOMBAY 2

Telegrams: ASHACOM

DIRECT IMPORTERS
OF
LABORATORY APPARATUS, INSTRUMENTS & EQUIPMENT

AUTHORIZED DEALERS OF

"PYREX"

LABORATORY & SCIENTIFIC GLASSWARE

[Made in England]

Your orders and enquiries — Please

for

SCIENTIFIC | INSTRUMENTS
APPARATUS
APPLIANCES

AND

LABORATORY CHEMICALS

Please contact:

INDSALES
Corporation

11 HORNIMAN CIRCLE
BOMBAY 1

Call: 252762 Gram: ' ANALYTICAL '

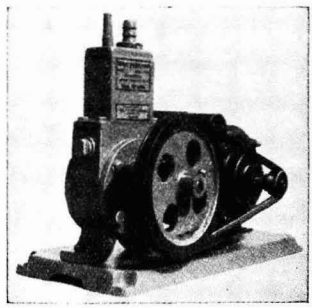
Indian skill can make

THE MAKERS OF RENOWNED "**BASYNTH**" BRAND A.R. ACIDS AND CHEMICALS HAVE THE PLEASURE TO OFFER TO THE SCIENTIFIC RESEARCH WORKERS OF INDIA A NEW PRODUCT OF THE ENGINEERING SECTION :

ROTARY VACUUM PUMP

Laboratory Model

- ALL INDIAN MATERIALS & CONSTRUCTION
- DRY MODEL: SINGLE STAGE, FOR ROUGH VACUUM



BASIC & SYNTHETIC CHEMICALS PRIVATE Ltd.

P.O. JADAVPUR UNIVERSITY, CALCUTTA 32

Use Swadeshi and help to keep employed Indian Technical Skill in industries

INDEX TO ADVERTISERS

Asha Scientific Co., Bombay A22
Associated Instrument Manufacturers (India) Private Ltd., Calcutta ... A21
Associated Scientific Corporation, Calcutta A32
Associated Supply Agency, Calcutta ... A17
B. Babulal & Co., Bombay A16
Basic & Synthetic Chemicals Private Ltd., Calcutta A23
Bengal Immunity Co. Ltd., Calcutta ... A7
Blue Star Engineering Co. (Bombay) Private Ltd., Bombay A31
Bombay Scientific Glass Works, Bombay ... A28
B. Patel & Co., Bombay A12
Central Scientific Supplies Co. Ltd., Tambaram A34
Craftsman Electronic Corporation Private Ltd., Bombay A35
C.S.I.R., New Delhi A25
Eastern Electric & Engineering Co. Private Ltd., Bombay A24
Frederick Herbert, Bombay A8
Gansons Private Ltd., Bombay ... A20
Gharpure & Co., Calcutta A18
Gordhandas Desai Private Ltd., Bombay A11
H. Reeve Angel & Co. Ltd., London ... A26
Indsales Corporation, Bombay ... A22
Industrial & Engineering Apparatus Co. Private Ltd., Bombay A16
Instruments & Equipments, Calcutta ... A12
Instrument Research Laboratory Ltd., Calcutta A30
International Agencies, Bombay ... A14
International Chemical Industries, Calcutta A28
James A. Jobling & Co. Ltd., Sunderland, England A33
J. T. Jagtiani, Bombay A8
Keroy (Private) Ltd., Calcutta ... A30
Laboratory Chemical Co., Bombay ... A32
Laboratory Furnishers, Bombay ... A14
Martin & Harris (Private) Ltd., Bombay A5, 36
Meghna Industries Private Ltd., Calcutta A18
M. Ramchandra & Sons, Bombay ... A16
Mysore Industrial & Testing Laboratory Ltd., Bangalore A28
Oster Chemical & Pharmaceutical Works Private Ltd., Calcutta A6
Pharma Trust, Bombay A6
Pioneer Equipment Co. Private Ltd., Bombay A27
Raj-Der-Kar & Co., Bombay A13, 29
Ravindra & Co. (Platinum), Bombay ... A9
Scientia Industries (India) Private Ltd., Howrah A22
Scientific Apparatus Mfg. Co., Bombay ... A18
Scientific Equipment Works, Delhi ... A14
Scientific Instrument Co. Ltd., Allahabad A2
S. H. Kelkar & Co. (Private) Ltd., Bombay A20
S. Mathuradas & Co., Bombay ... A8
Standard Metal Co., Calcutta ... A32
Standard Scientific Instruments Co., Madras A17
Tempo Industrial Corporation (Private) Ltd., Bombay A19
Toshniwal Bros. Private Ltd., Bombay ... A6
Uday Scientific Industries Private Ltd., Calcutta A34
Unique Trading Corporation, Bombay ... A17
Veb Carl Zeiss, Jena A15
Zill & Co., Bombay A10

THE WORLD'S BEST INSTRUMENTS

General Radio Co., U.S.A.

Electronic Apparatus for Science and Industry. Stroboscopes, Variacs, Sound and Vibration Meters, Amplifiers, Impedance Bridges, Signal and Pulse Generators, Oscillators, Wave Analyzers, Distortion Meters, R-L-C Standards, Voltmeters, Megohmmeters, Coaxial Equipment, Voltage Regulators, Sweep Drives, Frequency Standards and Meters, TV and Broadcast Monitors, Parts and Accessories.

BAIRD ATOMIC

Nuclear Measurement Apparatus, Scalers, Linear Amplifiers, High Voltage Power Supplies, Coincidence Analyzers, Scintillation Counters, Counting Rate-Survey Meters, Differential Pulse Height Analyzers, Analog-Digital Dataprinters, Gamma Radiation Detectors, Flow Counters, Counting Tubes, Calibrated Reference Sources, Timers, Reset Registers, etc.

LABORATORY WESTON

Voltmeters, Ammeters, Frequency Meters, Wattmeters, Galvanometers of Panel, Switchboard and Portable Patterns; Precision and Laboratory Standards, Portable and Uncased Current Transformers, Magnetic Contact and Moving Coil Relays, Photronic Cells, Photometers, Standard Cells, Instrument Rectifiers, Radio Test Sets and House Service Meters, etc.

SPERRY

"Microline" Microwave Measurement and Test Equipment, Wavemeters, Frequency Meters, F.M. Test Sets, Radar Range Calibrators, Wattmeter Bridges, Impedance Meters, Attenuators, Microwave Receivers, etc., and Accessories and "Klystron" Tubes, Oscillators, Amplifiers, Multipliers, Tuners, etc.

DUMONT

Cathode-Ray Oscillographs, Cathode-Ray Tubes, Gaseous Discharge Tubes, etc., Oscillograph Recording Cameras and Ancillary Equipment, Television Transmitting Equipment, etc.

ESTERLINE—ANGUS

Graphic Chart Recorders for Current, Voltage, Conductivity, Frequency, Wattage, Long Distance (telemeters), Operation, Power, Power Factor, Pressure, RKVA, Speed, Vaccum, etc., Current Transformers, Potential Transformers, etc.

AVO

Electrical and Electronic Test Instruments, Avometers, Multimirors, Valve Testers, Signal Generators, Bridges, Lightmeters, Douglas and Macadie Automatic Coil Winders.

Boonton Radio Corporation, U.S.A.

Electronic Instruments: Q-Meters and QX Checkers, RX Meters, FM-AM Crystal Monitored and Glide Slope Signal Generators, Metal Film Gauge, and Accessories.

GURLEY

Water Current Meters, Anemometers, Paper and Textile Testing Instruments and Survey Instruments

Distributors:

MOTWANE PRIVATE LIMITED

Incorporating:

EASTERN ELECTRIC & ENGINEERING COMPANY PRIVATE LIMITED

and

CHICAGO TELEPHONE & RADIO COMPANY PRIVATE LIMITED

127 Mahatma Gandhi Road, P.O. Box No. 459, Bombay 1. Telegrams: 'EASLEKTRIK' Bombay. Phone: 252337 (3 lines)

Bombay, Calcutta, New Delhi, Lucknow, Madras, Bangalore, Secunderabad. *Telegrams: "CHIPHONE" all offices*

SISTA'S-EE-71

Current Topics

THE INDIAN INSTITUTE OF SCIENCE: GOLDEN JUBILEE CELEBRATIONS

THE INDIAN INSTITUTE OF SCIENCE, BANGALORE, celebrated its Golden Jubilee from 2 to 8 February 1959. The event marks fifty years of inspiring and devoted service of the institution to the cause of scientific and technological progress in the country. The President of the Indian Union, Dr Rajendra Prasad, who is the Visitor of the Institute, inaugurated the celebrations in the presence of a distinguished gathering which included the Duke of Edinburgh, as the special representative of the British Association for the Advancement of Science and many prominent scientists. Besides lectures on scientific and technological topics of current interest by eminent world authorities, an exhibition depicting the major scientific contributions and the present-day activities of the different departments of the Institute was organized as part of the celebrations. On the occasion, honorary fellowships of the Institute were awarded to Shri Jawaharlal Nehru, Dr C. V. Raman and Shri M. Visweswaraya.

Founded and endowed by the late Jamsetji Nusserwanji Tata and actively aided and supported by the Central and State Governments, the Institute came into existence in 1909. The first batch of students was admitted in 1911 to the Departments of General and Applied Chemistry and Electrical Technology. At present over a dozen departments for advanced research and training in pure and applied sciences are functioning with 157 research and teaching staff, and nearly 500 students and research scholars. The total expenditure so far both on buildings and equipment exceeds Rs 1·5 crores and the recurring budget is nearly Rs 67 lakhs a year. By a recent notification of the Union Government, the Institute has been given the status of a full university and powers to confer postgraduate degrees in the various disciplines of science and engineering. Facilities are available in the Institute for research in all branches of Chemistry, Physics and Mathematics and for research and postgraduate instruction in Aeronautical, Mechanical, Civil, Electrical, High Voltage, Hydraulic, Electrical Communication, Internal Combustion, Automobile, Foundry, Chemical, Metallurgical and Industrial Engineering. The important position its past students, numbering over 3000, are occupying in government departments, research institutions and universities is an ample testimony to the work of the Institute during the past five decades.

The Institute had the enlightened guidance of Dr Morris W. Travers, its first director. In later years, many eminent men of science have guided its destiny. The most illustrious among them is Dr C. V. Raman. Other distinguished men of science associated with the Institute in various capacities include Dr J. C. Ghosh, Prof. M. S. Thacker, Dr H. E. Watson, Prof. J. L. Simonsen and Sir M. O. Forster, and its present director Dr S. Bhagavantam.

To list the achievements of the Institute is a stupendous task. The Institute is a pioneer in providing facilities for advanced instruction, post-graduate training and research in science and engineering in India, and the work carried out in the Institute has been instrumental in the establishment and development of several industries in the country. In the context of the importance that is being given to scientific research in the development plans of the nation, the Institute has a vital role to play by nurturing in its laboratories skilled scientists and technologists.

FORTY-SIXTH INDIAN SCIENCE CONGRESS SESSION, DELHI

THE FORTY-SIXTH SESSION OF THE INDIAN SCIENCE Congress Association held during 21-28 January 1959 at Delhi was one of the largely attended sessions in the history of the Congress. Over 3000 delegates, including a record number of 85 foreign delegates representing many learned societies and international organizations, participated in the deliberations of the Congress. Among the distinguished foreign delegates were the Duke of Edinburgh and Sir Alexander Fleck representing the British Association for the Advancement of Science, Prof. Arne Tiselius, the Nobel Prize winner from the Upsala University, Sweden, and

Dr E. W. R. Steacie, President, National Research Council, Canada. Dr A. L. Mudaliar, Vice-Chancellor, Madras University, presided over the session which was inaugurated by the Prime Minister, Shri Jawaharlal Nehru.

Over a thousand technical papers were presented at the 13 sections of the Congress. Forty symposia were organized under the various sections. The subjects discussed included: Social implications of technological advance in India; Role of operational research in planning; 1961 population census; Training of technical personnel; Teaching problems in chemical terminology; Trends in zoological research in India; Nutrition requirements of crops; Recent developments in plant breeding methods; Carbohydrate metabolism in plants; Proteins; Recent developments in plant diseases and pest control; Future of cinchona industry in India; Solid state physics; Magneto-hydrodynamics; Crystal structure analysis; IGY data; Present position, planning, and prospect of power generation, long distance transmission and distribution; Clay minerals; etc. Three joint discussions were held on (1) The effect of chemicals on cell division; (2) Laboratory animals; and (3) Planktonological studies in Indian waters.

Of the eleven special technical lectures delivered by the foreign delegates mention may be made of the following: Reactivity of free radicals (Dr E. W. R. Steacie); Analysis of macromolecular systems (Prof. Arne Tiselius); High vacuum techniques (Prof. J. Groszkowski); Magnetic amplifiers (Prof. P. H. Craig); Some results and problems of theoretical and applied mutation research (Dr L. C. Hans Stubbe); and Origin of maize (Prof. L. F. Randolph). Seven popular lectures were arranged which included: Atomic power development in India (Dr H. J. Bhabha); Science and engineering education in U.S.A. (Prof. P. H. Craig); Some chemical aspects of blood group specificity in man (Dr W. T. J. Morgan); Obligations and limitations of science (Prof. E. C. Stakman); Oil exploration (Prof. W. B. Mefre); Organization of science in Canada (Dr E. W. R. Steacie); and the Nobel Foundation and its activities (Prof. Arne Tiselius).

A special feature of this session was the organization, for the first time, of an exhibition of scientific and technical books and periodicals published in Indian languages. Organized by the Delhi University, the exhibits comprised 5000 books and 85 periodicals in 14 languages. The Science and Technology Exhibition arranged on the occasion was different from its predecessors in its content. In addition to the display of scientific instruments and appliances, there was special emphasis on display of scientific and technical books. The United States Information Services exhibited some of the advances made in the utilization of solar energy and the British Information Services had on display an exhibit on the development of atomic energy in the United Kingdom.

UNITED STATES SCIENCE INFORMATION SERVICE

ACTING UPON THE RECOMMENDATION OF HIS SCIENCE Advisory Committee, President Eisenhower has directed the National Science Foundation to take necessary steps for the establishment of a Science Information Service designed to help in meeting the critical needs of scientists and engineers in U.S.A., for better access to the rapidly mounting volume of scientific publication.

The proposed Science Information Service would help the scientist to find solutions to such problems as how to publish research results promptly, how to find out what is being published in a particular field, and how to locate and obtain the information needed. In the area of primary publication, the Service will provide financial assistance, where needed, for the publication of journals and monographs. It would encourage scientific societies and publishers to experiment with new methods of publication designed to increase efficiency, improve services and decrease costs. It will provide the answer to ' what is being published now ' by sponsoring, and if necessary supporting, the preparation of worldwide lists of both primary and secondary scientific research publications, classified subject-wise and indexed. It would perform a similar task with reference to a union list of scientific and technical periodicals and provide a clearing house of information on abstracting and indexing throughout the world. It will review the newly developing field of data centres, compiling information on the existing ones, analysing overlaps and duplications and defining areas where new centres are needed. It would seek to expand and improve inter-library exchange agreements throughout the world, photocopying processes and other ways of bringing to the scientist copies of items unobtainable through normal channels. On a long-term basis the Service will support a continuing programme of research and development, looking to the widespread application of machine techniques to such problems as storage, retrieval, indexing and to such problems as translation and abstracting. It will also encourage co-operation among the United States, foreign and international scientific information organizations.

Role of Physical & Biological Sciences in the Progress of Medicine*

I AM beholden to my colleagues of the Indian Science Congress for giving me this unique privilege of presiding over its 46th Session. During these several years many distinguished scientists have adorned this chair and it is with no sense of false modesty that I confess that this honour is one which I did not look forward to nor did I ever anticipate. I have ventured to accept your invitation, however, because of the conviction that the honour is one that is meant more to my profession, the medical profession, which it has been my great privilege to practise for the last fifty years. From another point of view, I felt that it gave me an opportunity to pay my humble tribute to the great part that science has played in the progress of medicine within the last fifty years and to place before you the picture of how medical science has been influenced and guided by the great discoveries in the fields of the physical sciences, the biological sciences and the technical and technological sciences. Never has this influence been more dominant than during the past quarter of a century when phenomenal and significant progress has been achieved in every branch of medical science, thanks to the achievements of scientists in the sister sciences to which I have referred.

It is, therefore, with feelings of profound gratitude that, as a representative of the field of medical science, I pay my tribute to the great scientists who have made significant contributions in advancing the fields of knowledge of the basic sciences. I venture to express the hope that the medical sciences have also played some little part in stimulating those working in the fields of the allied sciences. It cannot but be otherwise. Discoveries in one field of science lead to repercussions in other fields of science and the problems of one scientific discipline always stimulate research in other disciplines of science. Today, therefore, one is forced to the conclusion that science is indivisible, that no compartmentalism can possibly be conceived that, every new research in any field of the physical, biological or technological sciences has its effect on the others and that, therefore, the reactions in the minds of those who are investigating problems in any one of these sciences are considerable. At the same time, so enormous are the widening fields of research in these sciences that one may well be lost in the contemplation of the amount of knowledge that is being made available every year and which cannot possibly be comprehended by any single individual unless opportunities are given to realize at least the fundamentals of the great discoveries in the several branches of science. From this point of view, therefore, it seems to me a very happy idea of the originators of the proposal to hold a Science Congress that they conceived the possibility of scientists interested in every branch of science meeting at a common session and exchanging thoughts and experiences. The platform for science, if it is to be utilized effectively and for good purpose, must in the main be a platform not only for recording new experiences, new discoveries and new trends in scientific thought but, what is equally important, it should be a platform for disseminating the knowledge that has been gained in the different branches thereof, alike to the votaries of the respective science as also in a large measure to everyone with a scientific bent and in the pursuit of scientific knowledge. It is thus that scientists will be able, with greater amount of success, to realize the way in which scientific discoveries could best be utilized and the manner in which problems in their own special fields could better be tackled with confidence. This will be made more obvious when I refer to the advances of medical sciences and the debt medical sciences owe to the discoveries in other fields, in the fields of physical sciences, biological sciences and technological sciences.

Progress in the twentieth century

The twentieth century has witnessed remarkable scientific discoveries, so much so that science has for the first time come into its own. It may be asserted with confidence that far more scientific work has been done in the last 50 years than in the whole period of the previous history of humanity. Although many epoch-making discoveries have been made in the past, their application for practical purposes and the rapid development of the associated sciences have become a phenomenon of the twentieth century, more than that of any other period. In the past, science was thought of as an accessory factor — interesting, occasionally exciting, but

*Presidential address of Dr A. L. Mudaliar, Forty-sixth Session of the Indian Science Congress, Delhi, 21 January 1959.

perhaps not of much practical value. Few were prepared to consider that it had a direct bearing on the main stream of human endeavour and on the progress of historical events. The danger at present is the opposite, that of giving science too much credit, whether for good or evil, in the tremendous, vastly disturbing kaleidoscopic changes that are taking place consequent upon wars and revolutions, so unfortunately frequent in this half century. The power of science to affect the life of man for good or evil is no longer seriously in doubt. The problem now is rather that of finding the means by which science can be directed to constructive and not to destructive ends.

Perhaps in no field of science could the constructive use of scientific discoveries be more clearly demonstrated than in the field of medical science. And it may be stated that it is only in this century that the influence of science on medical practice, derived from the nineteenth century pioneer work of Pasteur and others, began to make itself felt on a large scale. Medicine has increasingly become dependent on the important chemical and instrument industries. Pharmacy, far from being a collection of simple herbs or the combination of drastic mineral salts, has become a scientific industry and one of no small importance even from the purely commercial point of view.

Prevention of diseases

The outstanding development in medicine of the nineteenth century centres round the prevention of diseases. The discovery of bacteria in relation to the causation of diseases has naturally led to a large number of investigations as to the best methods of preventing the growth and development of bacteria in the human system. This in turn led to better methods of treatment and to the surgical skill which was made possible by the use of anaesthetics. The health of the individual and of the community has been improved beyond all expectation by the adoption of numerous laws enforcing public health measures and the twentieth century opened its medical practice ready to co-operate with other branches of knowledge in the new role that science was destined to take in society.

One of the first responsibilities of a society is care for the health of its members. As has been already pointed out, during the opening decades of the twentieth century, medical practice has made progress comparable with that achieved in other branches and, in the realm of public health, science has extended its interest to embrace every aspect of social life. Radium, X-ray and many electric treatments are witness to the influence of the new physics on medicine. The skill in surgery has been increased beyond all expectation and chemistry has added to the efficiency of antiseptic measures while one branch has produced important drugs capable of destroying some of the most harmful bacteria which took a heavy toll of life before.

Medicine and war

Paradoxical as it may seem, it is the urgency for certain definite discoveries during a war that has led to a greater scientific effort in preventive and palliative medicine than had been possible during any period of peace. It was during the World War that methods of creating blood banks and serum banks were first initiated and tried. Today, lives of many thousands of persons have been spared because of these blood banks established in many a town in all civilized countries and largely contributed by voluntary donors. But the most spectacular event of World War II was the demonstration of the great potentialities of new drugs like penicillin and insecticides like DDT. It was in 1928 that Fleming made the observation that some of his bacterial cultures were being eaten away at various spots in the petri dishes in which they were prepared and noted that this was due to a mould which had grown there and which seemed to be giving out some substance which killed the bacteria. It was not, however, till ten years later that Florey and Chain started a systematic search for natural antibiotics, when Fleming's observation was put to use. By the time the clinical value of penicillin was proved, the war came and gave a great impetus to further investigations. It was a concentrated effort in the fields of chemistry, biology and medicine that led to the great use of this wonder drug, as it was called, to save literally thousands of lives.

The discovery of penicillin is often quoted as an example that important discoveries come by chance. It is no doubt true that some great discoveries do come by chance. But chance is multiplied by providing opportunities for discovery in the first place and for development by interested people in the second. Once penicillin was discovered, it was relatively easy to search through nature for other substances which might have the same or better effects. Thus a whole new field of antibiotics was opened — streptomycin, aureomycin, chloromycetin, synermycin, tetracycline — a bewildering array of antibiotics sometimes confusing and confounding to the medical practitioner.

During World War II, it was clearly realized that disease had played a much greater part in the previous wars than any of the destructive weapons of warfare and that, therefore, the most paramount

consideration should be to protect the forces against disease, especially in the tropical regions where war was waged, as well as the realization that the consequences of wounds should be minimized as far as possible. This led to an all-round advance in sanitational medicine and surgery.

Nutrition

It was realized early in the twentieth century that one of the most neglected aspects of medicine was that of dietetics. And as the science of nutrition leapt into prominence, the study of the problems of nutrition and of nutritional disorders led to major scientific discoveries of the aecessory food factors, the vitamins. This naturally led to further investigation as to what kind of food people needed and how much to keep them healthy and alive. This in turn had a direct influence on the largest and most ancient industry, agriculture, and on the newly established food industries. Agriculture, far from being the major human traditional occupation, is rapidly being transformed into an industry which is becoming more and more scientific in character: while in the field of medicine, an attempt at a scientific control of human conditions is being undertaken so that, in future, health and not disease will be the chief concern. In view of the large concentration of the population in urban areas, it will be easily realized that the food needed for them can no longer come straight from the farm to the table. There is also the danger that adulterated foods and improperly prepared foodstuffs may result in great calamities on account of food poisoning. It has, therefore, become necessary in most countries to have stringent laws passed to observe rigid control over the production and distribution of foodstuffs. This has led to research and development in the science of preparing and preserving food; thus artificial refrigeration, hermetically sealed food production, pasteurization, sterilization and other scientific methods have now become the common means of ensuring supply of safe foodstuffs.

Role of vitamins

In the past, many diseases were attributed, and quite rightly, to deficiencies in diet. Of these perhaps the most important was scurvy, the dreaded disease of sailors. But the study of those accessory factors so essential in food, the vitamins, gave an immediate impetus to the study of biochemistry and at last chemicals, that could be used and issued immediately for curative purposes in the shape of vitamins, were discovered. Some of them are simple, as vitamin C, but others like vitamin B are found to contain several different substances, each needed for carrying out some different function in the body. Science thus enabled us to possess the means of ensuring a healthy life as far as food could do it for the population of the whole world if only the will to take advantage of the discoveries of science were there. Yet it is unfortunate that even today diseases due to vitamin deficiency such as rickets, scurvy, beri-beri and pellagra are common in different parts of the world, either due to ignorance or poverty. And it is here that international organizations such as the Food and Agricultural Organization of the United Nations are doing much and can do a good deal more in this direction. It may be of interest to know that paradoxically enough the civilian population of many European countries, which were in the grip of the Great War, were actually kept in better health during the war in spite of reduced gross diet because of a scientific approach to the qualitative contents of such diet, ignoring the quantitative factor. It is needless to say that the health and activity of the armies in the field were likewise ensured by attention to these nutritive factors.

Role of hormones

Of equal importance for the maintenance of health were minute quantities of substances produced inside the body itself by organs such as ductless glands. These were known as the hormones. And today a study of hormones is a most entrancing study and promises to lead to great results. Prominent among these hormones are the aestrogenic and other ovarian hormones, thyroxin and insulin. Recent advances have shown the possibility of producing synthetic hormones or substitutes as in the case of diabetes. The original impetus to biochemical research came from medicine. Ever since Pasteur discovered bacteria, there was always the hope that some chemical substances could be found that would kill the bacteria without adversely affecting the patient. The first success was arrived at by trying to see if chemicals that would colour bacteria for recognition purposes could also be used to destroy them. This was how the group of chemical substances known as sulphonamides was produced in 1932 by Domagk who was awarded the Nobel Prize but was not permitted to accept it.

Medicine and the physical sciences

Medicine owes a great deal to the physical sciences as well. The developments in physics led to the invention of a number of new instruments. For a long time, the ordinary microscope was the only instrument powerful enough to view some of the animalcules which would not be seen by the naked eye. The use of the electron microscope was

a great advance in the field of microbiology. It enables us to see and reproduce on photographs the whole range of structure from those clearly visible in an ordinary microscope down to those of practically atomic dimensions. In the electron microscope, viruses and bacteriophages become visible and distinguishable for the first time and the finer nature of such tissues as muscle and skin begins to show something of why they have the peculiar and useful properties that they show in living organisms. The electron microscope can magnify up to one million times and thus a whole new biology is coming into existence by the use of this instrument. Besides the electron microscope, some new modifications of the ordinary microscope have been made, stimulated by the competition of the electron microscope. The most important of these modifications are the phase and interference microscopes which enable cells to be studied alive when previously they had to be killed and stained. Next came the new ultraviolet and infrared reflecting microscopes which brought out details not otherwise visible and which could also be used to study the chemical composition of cell structure.

The progress of medical science has always depended on the perfection of precision instruments of observation and control. Until very recently, these were not developed for the immediate needs of biology. The most recent and most powerful adjuncts to biological study have also come from physics — the valve amplifier to measure the minute currents and potentials in living system, the electron microscope referred to already and the use of isotopes and tracer elements which promises an interpretation of the actual process of transformation of chemicals in living systems. These and the electroencephalograph for registering the drug reactions of the human brain have led to the coming of age of biophysics. This does not mean that biochemistry has become less important. In fact, the post-war period is witnessing a multiplication of antibiotic drugs and a rational approach to that large field of hormone therapy and pharmacology.

Radioisotopes have been used in the fields of industry, biology, biochemistry and medicine. Leaks in water mains and pressurized cables can be located by adding small amounts of radioactive materials which can be detected when they escape. Radioisotopes are proving indispensable in biochemistry, for example, penicillin has been made active and its movement observed in the body of animals. Great progress has also been made in the treatment of surface cancers. Such examples make us realize that we are only at the beginning of the development of the utilization of radioisotopes.

When Roentgen, then an obscure Professor at Wurzberg, first discovered X-rays in 1895, he little realized that this was a scientific discovery of great potentiality. The use of X-rays in the field of medicine is well known today, whether in the diagnostic or therapeutic processes, and consequently the medical profession has studied for long the dangerous ill-effects of radiation and the remedial measures by which people working in such plants should be protected. In the twentieth century, however, a great figure — one of the greatest figures of the twentieth century physical science — emerged in the person of Lord Rutherford. His discovery has, as is now known, been rapidly followed up in various fields by a large number of scientific workers in all parts of the globe.

Progress of science in India

Although sporadic attempts were made now and then to establish institutes of science for the fostering of research in some fields, yet it must be confessed that very little was accomplished owing to the great lack of well-equipped laboratories and incentives for scientific workers. The whole picture has changed, however, after the dawn of independence in this country. The Council of Scientific & Industrial Research was the spearhead to promote the starting of a large number of national laboratories for various scientific disciplines. The first of these laboratories were the National Physical Laboratory and the National Chemical Laboratory but separate laboratories have since been established for researches, both basic and applied, in several fields of scientific knowledge. Today, there are a large number of these laboratories spread over the length and breadth of this country. The work of these national laboratories covers a very wide field indeed. The laboratories afford excellent facilities for research with the most modern techniques and every attempt is being made to link up research with the problems of industry, so vital for the progress of our country. Besides the establishment of these national laboratories, a great step has been taken forward to encourage young men with scientific talents to pursue a career in science, untrammelled by any considerations of other avenues of employment. Many have been awarded foreign scholarships through Government and through various organizations to acquire modern techniques in the fields where such techniques have not yet been fully developed in our own country. Yet the attractions of other services like the administrative services, wherein a very large number of posts have been created, draw away some of the best among the graduates in science who thus are lost to science for ever. It may be

interesting to know that in ancient days Roman engineering ranked with Roman law in importance. The Emperor Constantine wrote in the fourth century: "We need as many engineers as possible. As there is a lack of them, invite to this study persons of about 18 years who have already studied the necessary sciences. Relieve the parents of taxes and grant the scholars sufficient means." The appropriateness of similar measures being adopted in India need hardly be emphasized.

The institution of National Professorships for the first time has been hailed with approval by all interested in the future of this country. We are happy that the first National Professor to be appointed was none other than our esteemed countryman, Dr C. V. Raman, who is so actively engaged in his research work today. It is a matter of considerable satisfaction to all that two more eminent sons of India, Dr K. S. Krishnan and Dr S. N. Bose, past Presidents of the Indian Science Congress, have been recently appointed National Professors. The worth of a great scientist can never be measured in terms of the market place. Speaking of Faraday, Tyndal says that he might, with ease, have realized an income of £ 10,000 a year during the last 30 years of his life when he earned almost nothing by professional services. "Taking the duration of his life into account, this son of a blacksmith and apprentice to a bookbinder had to decide between a fortune of £ 150,000 on the one hand and his undowered science on the other. He chose the latter and died a poor man. But his was the glory of holding aloft among the nations the scientific name of England for a period of 40 years." Lives of such great scientists as Faraday's are for ever a beacon-light for the succeeding generations of scientific workers.

Technology and science in the planning concept

Technology and science have been given a pride of place in the planning concept of modern India. Simultaneously with the development of the national laboratories, steps have been taken to provide greater facilities in the universities for carrying on research, both fundamental and applied, and the generous grants recently given by the University Grants Commission — which it is hoped will be given in a larger measure in future — have been greatly appreciated by the universities. Thus the universities have, for the first time, been enabled to plan ahead and to organize research departments in many scientific disciplines and in other spheres of higher learning. All this, however, needs a much greater amount of emphasis in the educational pattern which must be adopted in conformity with the growing needs of a global concept of scientific advance. It is here perhaps that a greater amount of leeway has yet to be made and if India were to progress and to keep abreast of the times, if it is to be independent not merely in the political field but, what is equally if not more important, in the scientific and creative fields of human endeavour, it is obvious that urgent measures have to be taken to provide for the right type of education, scientific and otherwise, to train the young men in such a way that their creative talents will be stimulated and that the opportunities for their acquiring the knowledge so plentifully available today are not diminished by any limited idea of parochial or provincial patriotism.

The language of science

The language that science speaks is international and one must recognize that whatever may be the vehicle through which scientific thought can be conveyed, the use of this international language is absolutely essential if progress in science in any country is to be speeded up. And so it is that a plea is made, to those who hold a different viewpoint, that under present circumstances and taking into consideration the urgent needs of the country, nothing should be done to hamper, delay or embarrass the development of scientific education whatever may be the vehicle through which such education may be possible at present; what that vehicle should be, there could be no doubt in the minds of scientists.

Research in fundamental and applied sciences

It is hardly necessary to emphasize the fact that research both in fundamental and applied sciences should be encouraged in every manner possible. Occasionally there is a great deal of emphasis laid upon applied research to produce quick results: and, while it is conceded that science in its larger and more comprehensive sense is to be considered in relation to what it can do for human welfare, nothing should be done to impede the progress of pure science as well. It was J. J. Thomson who said: "Research in applied science leads to reforms; research in pure science leads to revolution". This fact has been demonstrated over and over again in all the great discoveries of science. It is not always wise to emphasize the utilitarian point of view in any piece of research for, if that had been the main consideration, some of the greatest discoveries of the age which have stimulated many of the researches in applied science would never have been possible. When Archimedes ran through the streets of Syracuse

shouting in Greek, "Eureka, Eureka", "I have found it, I have found it", he described the principle that every solid body lighter than a liquid in which it floats sinks so deep that the mass of liquid, which has the same volume with the submerged part, weighs just as much as the floating body. It might have meant nothing to that generation but we realize today that it is this principle of hydrostatics that is the basis of all problems of flotation and naval architecture. Likewise when Professor Faraday demonstrated his famous experiment that when a magnet is brought suddenly near a coil of wire, a slight current of electricity is produced in the wire, even such a great scholar and statesman as Mr Gladstone asked him the question: "After all, what use is it?" "Why, sir", replied Faraday, "there is every probability that you will soon be able to tax it."

The plea, 'science for its own sake', has been put forward clearly and forcibly by Sir Edward Appleton in his Presidential Address to the British Association for the Advancement of Science in September 1953. "I have long held the belief", said Sir Edward, "that the cost of scientific research is the price we must pay for our industrial progress. But we should be misleading the public as well as ourselves if we based our case for the general support of the pursuit of science on its utilitarian aspects alone. I know that we can claim that many discoveries in pure science, which in their time had no obviously practical import, have later proved to be the foundation of major improvements in every material civilization. But even that is an argument of profit and loss and, to my mind, does not bring us entirely to the heart of the matter. I should like to go back beyond the achievements to the example of the scientist, be he amateur or professional — who is impelled solely by a passionate desire to explore and understand. That is what I mean by science for its own sake — when knowledge and insight are sufficient rewards in themselves." A clearer exposition of the principle 'science for its own sake' cannot be made.

It is well also to realize that great discoveries of science may sometimes be made in unexpected quarters and by persons who may not be necessarily in the forefront of scientific workers. Men and women of different races, walks of life, temperaments and professions have become famous scientists. Leonardo da Vinci was an artist, Sir William Herschell, a band leader, Lavoisier, a tax collector and Priestley, a clergyman, Marie Curie, a political exile, Joule, a brewer, Edison, a telegraph operator, Einstein, a Patent Office clerk, Faraday, a bookbinder, Halley, a gourmet and Newton, a recluse. Many are the names of persons in diverse avocations who could be cited as great scientific discoverers of all ages. In our own country, the great genius Ramanujam, the mathematical prodigy next perhaps only to Newton, was a clerk in the Port Trust of Madras. So lie buried amidst anonymity some of the great scientists who have made their names immortal. These men and women had in common a passionate devotion to science. It has been aptly stated that genius flashes forth like a meteor unproduced and unpredictable. It is not limited to any race of people or to any particular latitude or longitude. It has often come up from obscurity and has flourished under poverty and persecution as well as under the smiles of fortune. At present, we can only hope and pray that it will come often in our country. Fortunately genius has a way of asserting itself in every age. We may feel confident that there will be future Aristotles, Galileos, Newtons, Faradays, Pasteurs, Freuds, Ramanujams and Einsteins to provide new insight into the eternal mystery of the universe.

Science and society

The relations of science to society in health, in industry and in thought have been full of promise; but it is a humiliating admission that the five decades of the present century have witnessed the catastrophe of two World Wars and of many smaller conflicts. Even the period following the cessation of hostilities in 1945 has been marked by conflict or international friction in many parts of the world — Europe, Africa and Asia. Yet during this time, scientific achievements have been so outstanding and so full of promise for the greater possibilities of human welfare than ever before.

The social need of the period requires scientific planning. The advances of biochemistry and chemotherapy have shown that on this side, science is going to be more effective in human affairs than it has ever been in the past. The whole world can be changed more quickly now by some chemical discovery such as that of paludrin for malaria. And today the World Health Organization, taking note of these significant advances, has launched boldly and wisely on a programme of eradication of diseases rather than of control of diseases. The eradication of malaria is no longer a theoretical problem for it has been effectively proved that by modern methods of scientific investigation and application it could be accomplished. This naturally necessitates scientific planning so that individual scientists, often working in ignorance of the wider implication of their efforts to develop this or that field, may be guided to the more urgent needs of society so that the time lag may be saved with the saving of millions

of human lives. The implication is not so much that scientists should be directed to this or that particular purpose but rather that a better system of scientific education should be adopted to a society consciously aimed at securing the maximum human welfare.

But the application of scientific remedies is not altogether easy in an atmosphere where ignorance and prejudice prevail. In science as in politics, a break with tradition has always meant a liberation of human inquiry into hitherto closed fields. If science does not progress as rapidly as it ought to and its beneficent influences do not reach the masses, it is more often than not due to ancient customs and beliefs and to a certain extent, very naturally, to hesitation to discard such beliefs. The greatest difficulty of discovery is not so much to make the necessary observation but to break away from traditional ideas in interpreting them. From the time when Copernicus established the movement of the earth and Harvey the circulation of blood down to when Einstein abolished the ether, the real struggle has been less to penetrate the secrets of nature than to overthrow established ideas even though in their time they might have helped in some way the advancement of human knowledge.

War, however, produced the most outstanding example of the conscious use of science in the twentieth century industry, agriculture, medicine: and even science itself began to be planned instead of being left to the chance of economic forces. This growing consciousness of the function of science was one of the most characteristic features of the twentieth century social relations. Science became fully, consciously and immediately what it had long been unconsciously considered, an essential part of production. It was something worth investing in, directly by setting up of research laboratories connected with various industries or indirectly by subsidizing universities where the workers for these laboratories could be trained and where basic research could be carried out. The number of research laboratories established in various large-scale industries and the many research projects which universities are being asked to undertake in connection with industrial advances are proof positive, if such proof were indeed necessary, that science can pay its way if it is properly utilized.

Science knows no frontiers. Perhaps the best example of this is the observance of the International Geophysical Year which is noteworthy not only because of its intrinsic value and the popular interest evinced throughout the world in this venture but also because it is a supreme example of scientific co-operation among all nations when, in other fields, unfortunately, ideologies of a conflicting nature are so clearly manifest. It is becoming more and more appreciated that no discovery of science can be hidden for long. At the International Conference on the Peaceful Uses of Atomic Energy held at Geneva in August 1955, the President of the Conference, Dr Bhabha, said: " Knowledge once given cannot be taken back "— a significant statement coming from an outstanding scientist of the day. In the light of this fact, the feverish heat with which nations are trying to compete with each other in the race for some scientific discovery not necessarily of a nature that will be productive of good but unfortunately of a type that is more designed to destroy than to create or preserve seems indeed a tragedy too deep for words to describe.

Science for the welfare of humanity

In another sense, all the secrecy and the mystery that surround some of our scientific works would, on a correct appreciation of the position, seem to be love's labour lost. The scientist today is unfortunately between two compelling forces, one trying to utilize the basis of the discoveries for the good of humanity and the other equally concerned and equally eager to utilize the great discoveries of science to uses which can only lead to the destruction of humanity with consequences too staggering even for the imagination to dwell upon. It was a realization of this factor that led to scientists protesting, in season and out of season, against the abuse of scientific discoveries for destructive purposes. The biological warfare, that was once threatened, led to a protest from scientists and, at the International Congress of Microbiologists held in Rome in 1953, the following resolution was passed: " The Sixth International Congress for Microbiology, confident of interpreting the thought of all microbiologists, expresses its view that the science of microbiology should have as its sole aim the welfare and progress of humanity; that all microbiological research should be directed to this end; and that all countries should adhere to the 1925 Geneva Protocol." May we not hope that in the sphere of atomic science as well, a similar declaration would be made: that all atomic energy would be used only for peaceful purposes and that every discovery would be turned to endeavours for the improvement of conditions of living of human society; that the psychological warfare, which has unfortunately been continued for too long a period, would end and that the Commissions now in conference to concentrate upon how best to lessen international tensions would be given divine guidance such that humanity may be spared the horrors of world conflicts and the consequent deprivation

of precious lives and the degradation of human society.

Spectacular as these great discoveries have been, yet every day witnesses a new epoch-making event which stuns the imagination of millions of people. It would almost appear as if this is just the beginning of a new era of unimaginable discoveries. As we scan the skies and behold the great doors of the secrets of nature unfolding, we are struck dumb with amazement and with humility. In Jean Paul Richter's beautiful dream, a man was called up into the vestibule of heaven and carried to universe upon universe in endless space, until his mind reeled before the transcendental distances which were still before him. Then the man sighed and stopped, shuddered and wept. His overladen heart uttered itself in tears and he said: " Angel, I will go no further; for the spirit of man acheth with this infinity. Insufferable is the Glory of God. Let me lie down in the grave and hide me from the persecution of the Infinite, for end I see there is none." Then the Angel lifted up his glorious hands to the heaven of heavens, saying: " End is there none to the universe of God. Lo ! also is there no beginning."

Domestic Solar Water Heater

K. N. MATHUR, M. L. KHANNA, T. N. DAVEY & S. P. SURI
National Physical Laboratory, New Delhi

Manuscript received 17 *July* 1958

An arrangement for heating water with solar energy for supplying the domestic needs of a small family at Delhi, using easily available and inexpensive construction materials (galvanized iron sheets), has been described. The heat collector unit consists of a wooden box, insulated at the bottom, in which are formed the flow channels for water by one corrugated and one plane galvanized iron sheet. The upper side of the box is glazed with one or more layers of $\frac{1}{8}$ in. thick window glass sheets to reduce heat losses, keeping a 2 in. gap between the glass sheets and the water flow channels.

As the length of the day is short and water requirements large during the winter, the heating unit is set up at an angle of 45° to the horizontal to make the best use of sunlight. Flow rates of water, through the collector unit, in the range 4-21 gal./hr have been used and a rate of 7-10 gal./hr has been found to be optimum under the experimental conditions employed. The efficiency of heat transfer on a clear day is about 70 per cent which is more than that for the usual types of heat collector units using copper pipes soldered to flat copper sheets.

IN a previous paper[1] the results of some experiments on a solar water heater intended to supply the domestic needs of a small family were presented. The heat collector unit was made of thin copper sheets separated by a space of half an inch and provided with longitudinal ribs for stiffening the unit as well as for channelling water to avoid cross-currents. In the present communication two new types of collectors, both made out of cheap and readily available material, namely galvanized iron sheets, are described.

Details of construction

In one type of the solar water heater two corrugated galvanized iron sheets are put one upon the other in 'mirror image' position in a manner somewhat similar to Heywood's[2] as illustrated in Fig. 1 (type D). This sandwich arrangement forms nearly circular channels for the flow of water. The two sheets are secured by riveting at a few points along the lines of contact. The end edges are soldered to circular header pipes made from galvanized sheet of a thicker gauge. Cold water is let in at the lower end and flows up the double channels (ten in number) into the upper header.

In the second type (Fig. 1, type S), a corrugated sheet and a plane sheet are used, the rest of the arrangement as well as the dimensions of the sheets being exactly the same. This form of heater reduces the volume of water in the channels to nearly one-half. The upper surface of the assembly in either case is thinly coated with carbon black dispersed in shellac-spirit solution. The complete assembly is encased in a wooden box large enough to allow 4 in. of sawdust insulation at the back and a similar thickness around the sides. In order to prevent shadows an extra space of 4 in. is allowed on the two sides and wooden planks painted white are fixed at an angle of 45° with the sides. The upper face of the

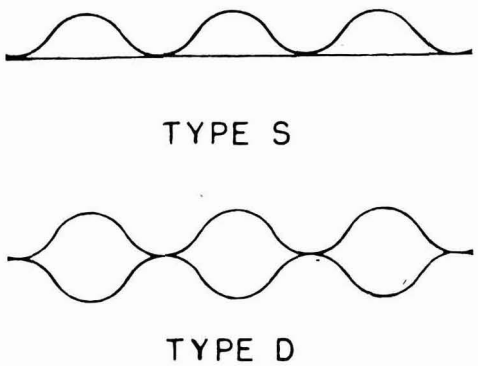


FIG. 1 — SECTION THROUGH HEAT COLLECTOR UNITS [Type S with one corrugated and one plane sheet, and type D with two corrugated sheets]

box is glazed with large sheets of $\frac{1}{8}$ in. thick window glass, keeping an air gap of about 2 in. between the glass sheets and the metal heater surface. The heater unit thus formed has a glazed surface area of 22·4 sq. ft and a blackened metal heat collector area of 19·0 sq. ft. Arrangement is provided for inserting thermometers at the inlet and outlet ends and a constant head arrangement is used to give a uniform rate of flow of water. A bib-cock on the outlet side enables the rate of discharge of water to be controlled.

In order to get maximum advantage of sunlight, a moving arrangement is necessary by which the collector can be made to face the sun so that at any instant the rays of the sun strike the surface at normal incidence. An elaborate arrangement of this type will be expensive and, therefore, a compromise had been made to fix the collector in a position of maximum advantage. This can be secured in the northern hemisphere by facing the collector due south and inclining the surface by the same angle to the horizontal as the latitude of the place. This will ensure normal incidence at noontime at the periods of the equinoxes, with the sun too low in winter and too high in summer. However, in order to make the best use of the winter sun, when the length of the day is short and the hot water requirements are large, it was decided to set up the collector at an angle of inclination of 45° to the horizontal (latitude of Delhi, 28°35′). This ensures a larger measure of solar intensity during the winter months.

In most of the types of the flat plate collectors[2-6] tried in U.S.A. and other countries water is made to flow through a copper tube bent in a zigzag pattern, which is soldered on the under surface of a blackened copper plate absorber. In this pattern, the heat absorbed by the copper plate, when exposed to the sun, goes to heat the circulating water via the copper pipe. This method suffers from the following disadvantages:

1. Since a large length of copper pipe is used (roughly 60 ft for an 8 × 3 ft plate collector and diameter about $\frac{1}{2}$ in.), there is considerable loss of 'head' and this loss is increased further by the presence of large number of bends.

2. On account of the resistance to flow offered by the pipe, thermo-siphon circulation is considerably reduced and if a reservoir is used for storing hot water, the use of a pump for circulating water becomes necessary. This adds considerably to the installation cost of the absorber.

3. The heat transfer from the absorber sheet to the copper pipe is not very efficient since it takes place through a narrow limited region of contact between the curved surface of the pipe and the flat surface of the plate across a thin layer of soft solder.

4. Since the copper pipes are usually separated by 3 in. or more of space, midway between two adjacent copper pipes the temperature must be several degrees higher than the temperature of the pipes. Thus the temperature distribution on the surface of the copper absorber will go through an undulating curve along the width of the plate. Since the heat losses from the absorber will depend on the difference of temperature between the absorber and surrounding air, more losses will take place from points of higher temperature difference.

It would thus appear that compared with the sandwich type of water heater discussed here, the tube type collectors will invariably show higher losses which may be offset to a limited extent by increasing the number of cover glasses. The use of more than one layer of glass, on the other hand, makes the unit expensive and cumbersome. There is the further disadvantage that a larger area of glass surface will have to be kept clean. Further, deposition of moisture between the two glass covers is frequent and results in considerable loss of energy through scattering, particularly in the early morning hours when the sun's altitude is low. Keeping these points in view, a cheap flat plate heat collector has been built and data have been obtained for working such a unit under the conditions of the North Indian winter, which is characterized by clear bright sunny days. The complete set-up of a single unit is shown in Fig. 2 and the details of construction in Fig. 3.

Observations

Observations using a heat collector unit with a single layer of glass taken on a number of days during October and November 1955 are presented in Table 1. The observations were made at hourly intervals from 1030 to 1630 hrs IST. Observations were also made for different rates of flow of water ranging from 4 to 21 gal./hr corresponding to rates of flow from 1·8 to 9·4 lb. of water per hour per sq. ft of insulation area, i.e. the effective glazed area. The average rate of flow of water was considered since it was not possible to maintain a strictly constant rate for any length of time and the values given are thus nominal and are subject to slight variation.

The values of intensity of solar radiation have been calculated from measurements of the total intensity of incident solar radiation and of the scattered radiation made with a simplified type of pyrheliometer (Table 1). The measurements were made at the beginning and end of each observation period and an average value was taken.

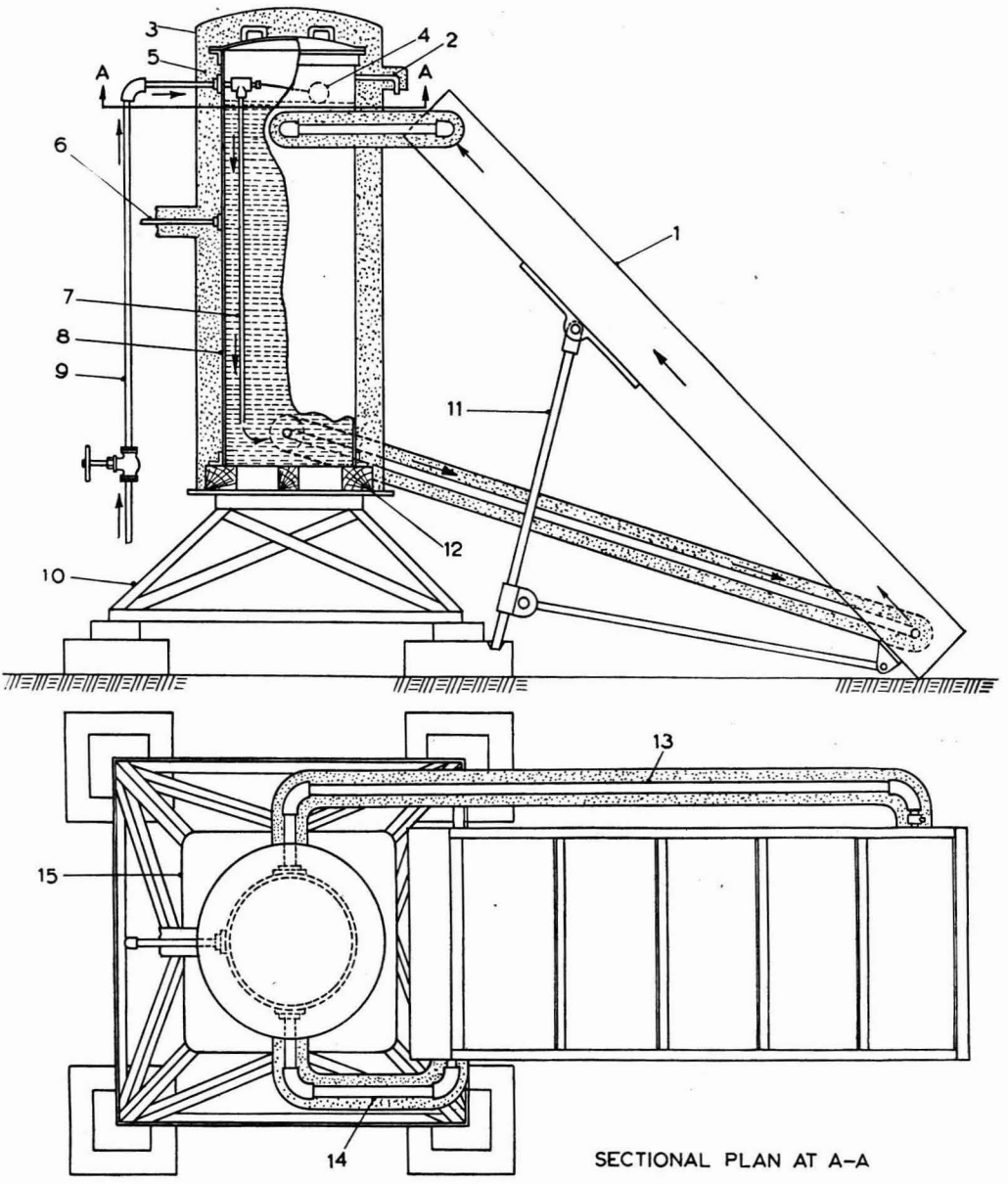


FIG. 2 — COMPLETE SET-UP OF THE SINGLE SOLAR WATER HEATER UNIT [1, glass cover; 2, overflow; 3, outer cover of water reservoir; 4, float; 5, rockwool insulation; 6, hot water outlet; 7, cold water inlet; 8, wall of water reservoir; 9, connection to water supply; 10, angle iron stand; 11, support for water heater; 12, wooden base for reservoir; 13, cold water inlet pipe; 14, hot water outlet pipe; and 15, outer frame of the reservoir]

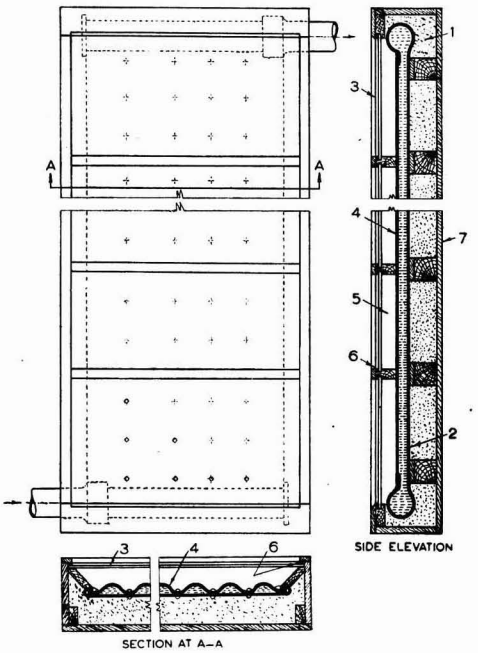


FIG. 3 — DETAILS OF CONSTRUCTION OF THE SINGLE SOLAR WATER HEATER UNIT [1, rockwool insulation; 2, bottom plane G.I. sheet; 3, glass sheet cover; 4, top G.I. corrugated sheet; 5, air gap; 6, felt padding; and 7, wooden casing]

From the rate of flow of water, its specific heat and the rise in its temperature, the quantity of heat, Q_w, absorbed by water per hour per sq. ft of the exposed glass surface of the heater was calculated (Table 1). The ratio of this energy, Q_w, to the amount of total solar radiation, I, falling on the exposed glass surface gives the overall efficiency of the flat plate absorber. The total solar radiation, I, was obtained from the observed value of I_s, the intensity of scattered radiations, and the normal component, I_c, of direct solar radiation I_d. The component I_c is calculated from the observed value I_d of direct solar intensity making use of the following equations.

$$I=I_c+I_s \quad \ldots\ldots\ldots\ldots (1)$$

where I_c is obtained from the following equation:

$$I_c=I_d(\sin a.\cos\theta+\cos A.\cos a.\sin\theta) \quad \ldots (2)$$

in which A is obtained from the relation:

$$\sin A=\frac{\cos\delta\times\sin h}{\cos a} \quad \ldots\ldots\ldots (3)$$

where h is hour angle, i.e. the apparent rotation of the celestial sphere about the earth's axis, measured westward in degrees from the south meridian (1 hr = 15°); δ, the solar declination on the particular day, i.e. the angle of sun measured above or below the celestial equator (obtained from solar almanac); a, the solar altitude above horizon; θ, the angle of the absorbing surface on the horizontal; I_d, direct solar energy, B.t.u./hr/sq. ft; I_s, scattered radiations, B.t.u./hr/sq. ft; and I_c, normal component of direct solar radiation falling on the glass surface.

As a result of the incidence of the quantity I of solar energy, the water in the heater will be heated up and there will be a difference in temperature of incoming and outflowing water. Let θ_i be the temperature of incoming and θ_o, the temperature of outflowing water. Then if W is the mass of water flowing through the absorber per hour per sq. ft of the glazed (i.e. exposed) surface and S its specific heat, then $Q_w=W.S.(\theta_o-\theta_i)$ will give the amount of heat absorbed by water. This should be equal to the amount of total solar radiation, I, falling on the exposed glass surface of the collector provided there is no loss of heat due to any cause. However, there is loss of heat not only due to radiation from surface of top glasses as well as from the blackened surface of the collector but also by conduction through the back surface of the heater plate in contact with the insulating material and by convection through air blowing over glass surfaces. These losses depend upon factors like ambient temperature, wind velocity, presence of clouds, etc. If the overall heat transfer coefficient, k, is expressed in B.t.u./hr/sq. ft/°F., then the total quantity of heat lost to the surroundings, to a first approximation, will be given by:

$$k\left(\frac{\theta_o+\theta_i}{2}-\theta_A\right)$$

where θ_A is the temperature of the surrounding air. If we take the temperature of incoming water θ_i to be the same as the ambient air temperature θ_A, then the heat balance equation can be expressed as:

$$I=k\left(\frac{\theta_o+\theta_i}{2}-\theta_A\right)+W.S.(\theta_o-\theta_i)$$

$$=k\left(\frac{\theta_o}{2}-\frac{\theta_i}{2}\right)+W.S.(\theta_o-\theta_i)$$

$$=\frac{k}{2}(\theta_o-\theta_i)+W.S.(\theta_o-\theta_i)$$

$$=(K+W.S)\Delta\theta \quad \ldots\ldots\ldots\ldots (4)$$

where $K=k/2$ and $\Delta\theta=(\theta_o-\theta_i)$, the rise in temperature of water. It is apparent from the above that heat utilization will be maximum when $K=0$.

TABLE 1 — EFFICIENCY OF SOLAR WATER HEATER WITH A SINGLE CORRUGATED SHEET WITH DIFFERENT RATES OF FLOW OF WATER

Date of observation and weather conditions during 1955	Av. rate of water flow *gal./hr*	Time *hrs IST*	$I^*_{av.}$ *B.t.u./sq. ft*	$\Delta\theta$ °F.	Q_w *B.t.u./sq. ft*	Eff. %	K
10 Nov.; clear day	21·0	1030-1130	264	24·3	229	87	1·5
		1130-1230	280	26·1	246	88	1·3
		1230-1330	271	25·2	237	87	1·4
		1330-1430	250	20·7	195	78	2·7
		1430-1530	210	18·0	169	81	2·2
		1530-1630	144	10·7	110	78	3·8
9 Nov.; windy and intermittently cloudy	19·0	1030-1130	305	26·1	218	72	3·2
		1130-1230	300	28·8	244	82	2·0
		1230-1330	280	27·0	229	82	1·9
		1330-1430	238	24·3	206	87	1·3
		1430-1530	185	18·9	160	87	1·3
		1530-1630	125	10·8	91	73	3·1
3 Nov.; clear day	13·0	1030-1130	275	36·0	204	75	1·9
		1130-1230	303	39·6	222	74	1·9
		1230-1330	304	36·0	208	69	2·7
		1330-1430	270	33·3	192	71	2·4
		1430-1530	219	26·1	150	69	2·6
		1530-1630	146	16·2	93	64	3·2
4 Nov.; clear day	10·0	1030-1130	254	46·8	212	84	0·8
		1130-1230	275	45·0	206	75	1·5
		1230-1330	274	44·1	198	72	1·6
		1330-1430	238	41·4	191	80	1·1
		1430-1530	186	30·6	142	77	1·4
		1530-1630	126	20·7	96	76	1·4
13 Nov.; hazy and partly cloudy	9·0	1000-1100	192	45·0	180	93	0·2
		1100-1200	197	39·6	163	83	1·0
		1200-1300	170	21·6	89	52	3·8
		1300-1400	140	27·0	110	79	1·2
		1400-1500	116	21·6	89	76	1·2
11 Oct.; clear day	7·0	1030-1130	256	50·4	185	72	2·0
		1130-1230	265	57·6	176	67	1·6
		1230-1330	276	59·4	195	71	1·6
		1330-1430	246	54·9	177	72	1·4
		1430-1530	191	50·4	159	83	0·6
		1530-1630	127	27·0	83	65	1·7
18 Oct.; clear day	7·0	1030-1130	268	53·1	181	68	1·9
		1130-1230	285	59·4	202	71	1·7
		1230-1330	287	61·2	202	71	1·6
		1330-1430	248	58·5	179	72	1·1
		1430-1530	193	47·7	140	73	0·9
		1530-1630	126	36·9	100	79	0·3
12 Oct.; clear day	6·0	1000-1100	203	27·9	88	44	4·6
		1100-1200	215	44·1	135	63	2·2
		1200-1300	234	61·2	173	74	0·7
		1300-1400	219	60·3	163	74	1·0
		1400-1500	183	55·8	105	57	0·6
		1500-1600	139	64·8	160	—	—
10 Oct.; clear day and hazy afternoon	4·0	1130-1230	280	47·0	98	35	4·2
		1230-1330	271	72·0	134	49	2·0
		1330-1430	241	83·0	139	58	1·2
		1430-1530	194	79·0	105	54	0·8
		1530-1630	134	63·0	88	66	0·4

*The value of $I_{av.}$ is the average value during the given time interval.

TABLE 2 — WORKING EFFICIENCY OF SOLAR WATER HEATERS WITH MORE THAN ONE GLASS LAYER

Date of observation and weather conditions	Av. rate of water flow *gal./hr*	Time *hrs IST*	Two glass layers					Three glass layers			
			$I^*_{av.}$ *B.t.u./sq. ft*	Δθ °F.	Q_w *B.t.u./sq. ft*	Eff. %	K	Δθ °F.	Q_w *B.t.u./sq. ft*	Eff. %	K
30 Dec. 1955; clear day	7	1030-1130	202	40·5	128	63	1·9	41·4	126	62	1·8
		1130-1230	228	50·4	158	68	1·4	50·4	153	67	1·5
		1230-1330	251	57·6	163	65	1·2	54·0	153	61	1·6
		1330-1430	240	60·3	145	61	0·9	56·7	149	62	1·2
		1430-1530	200	50·4	149	54	0·8	44·1	111	56	1·5
		1530-1630	131	45·0	87	67	—	36·9	93	62	0·5
2 Jan. 1956; clear day	10	1030-1130	—	—	—	—	—	—	—	—	—
		1130-1230	229	38·7	174	76	1·5	38·7	172	75	1·5
		1230-1330	246	40·5	182	74	1·6	38·7	172	70	1·9
		1330-1430	244	36·9	165	68	2·1	36·0	160	66	2·3
		1430-1530	207	32·4	145	70	1·9	32·4	143	69	2·0
		1530-1630	145	23·4	104	72	1·7	23·4	97	67	1·8
3 Jan. 1956; clear day	10	1030-1130	205	33·3	147	73	1·7	31·5	141	69	2·0
		1130-1230	250	36·0	160	64	2·5	36·0	161	65	2·5
		1230-1330	262	37·8	180	69	2·5	34·2	169	65	3·2
		1330-1430	233	36·0	173	75	2·0	34·2	163	70	2·4
		1430-1530	219	30·6	142	65	2·7	29·7	140	64	2·9
		1530-1630	190	22·5	105	55	4·0	22·5	106	56	4·0
4 Jan. 1956; windy and scattered clouds in the forenoon	5	1030-1130	111	13·5	32	29	5·9	13·5	32	29	5·9
		1130-1230	196	44·1	102	52	2·2	47·7	111	57	1·9
		1230-1330	254	63·0	132	52	1·8	63·0	169	67	1·8
		1330-1430	219	70·2	112	51	0·9	59·4	134	61	1·5
		1430-1530	205	68·4	121	59	0·8	55·8	125	61	1·5
		1530-1630	153	59·4	91	60	0·4	45·0	92	60	1·2·

*The value of $I_{av.}$ is the average value during the given time interval.

The efficiency of solar heat utilization as given in Tables 1 and 2 is calculated from the following relation:

Percentage efficiency (Eff. %)=

$$\frac{Q_w}{I}\times 100=\frac{W.S.\Delta\theta}{(K+W.S)\Delta\theta}\times 100=\frac{100\,W.S}{(K+W.S)} \quad \ldots (5)$$

For water, where $S=1$, the equation further simplifies to:

$$\text{Eff. }\%=\frac{W}{K+W}\times 100 \quad \ldots\ldots (6)$$

Experiments were also carried out with two and three layers of glass sheets to see if there was any improvement in heat utilization. The results are given in Table 2.

Discussion

The performance of flat plate collectors has been the subject of much detailed theoretical and experimental study by several workers, notably Heywood[2], Hottel[3], Kirpicher and Baum[4,5], Ward[6], and others[7]. Ward[6] has distinguished between four possible conditions of heat flow in a flat plate collector, viz. (i) steady state condition with no fluid flow, (ii) unsteady state with no fluid flow, (iii) steady state with fluid flow and (iv) unsteady state with constant rate of fluid flow. Of these, (i) relates to the steady state condition when the energy increase due to solar radiation incident on the collector surface is exactly balanced by the heat losses through absorption in and reflection from the glass plates, conduction from the back of the apparatus, and convection and radiation outwards from the collector; (ii) relates to the initial conditions when heat is just allowed to fall and temperature begins to rise but no flow is yet established; (iii) and (iv) are the most important conditions from a practical standpoint.

In the present set of experiments we have tried to approximate to condition (iii), namely steady state with fluid flow. It is apparent that during the early hours of morning this is far from the case and it takes some time for the system to reach a somewhat steady condition of working. In the experiments the rate of water flow through the collector has been varied from 21 gal./hr to 4 gal./hr. At the higher rates of flow it is obvious that the rise in the water temperature, Δθ, will be less and reference to the data in column 5 of Table 1 shows that the maximum increase in temperature with a flow of 21 gal./hr is 25°F. only. With the flow rate of 13 gal./hr, this goes up to 40°F., with 7 gal. to 60°F. and with 4 gal. to 83°F. When the

rise in temperature is large, i.e. with slower rates of water flow, the losses due to radiation, conduction and convection increase considerably. On the other hand, with higher rates of flow the temperature rise is less and the losses are correspondingly reduced. This aspect is brought out clearly in Table 3 where the total quantity of heat absorbed by water during the entire working day, i.e. the sum of Q_w (ΣQ_w) over 6 hr of working day is given along with the rate of flow of water and maximum rise in temperature over the ambient temperature.

It will be seen from the results presented in Table 3 that as the rate of flow is reduced the rise in temperature is greater, while the total amount of heat actually absorbed by the water during a day is reduced, the reduction being due to increased heat losses. Part of these losses can be reduced by (i) reducing radiation, conduction and convection losses from the glass surface by using two or more layers of glass and (ii) increasing the thickness of insulating material. The effect of increasing the number of glass layers was investigated (Table 2). The amount of heat absorbed by water at 7 and 10 gal./hr flow rate is recorded in Table 4.

The results show that for both the rates of flow the total amount of heat absorbed as also the increase in temperature is significantly less compared to the value with one layer of glass. This agrees with the observations made by Trombe[1] at Mount Louis, that while the multiple layers of glass undoubtedly help to reduce the heat losses, they also reduce the amount of heat energy reaching the heating surface through absorption in the glass. However, if the ambient temperature is very low, as may happen in the colder regions, where both low temperature and cold winds may be present, there may be some advantage in using two or three layers of glass. In Delhi most of the time during the winter months there is hardly any wind present.

TABLE 3 — HEAT ABSORBED AT DIFFERENT RATES OF FLOW OF WATER

Av. rate of water flow *gal./hr*	ΣQ_w *B.t.u./sq. ft*	Max. rise in temp. over ambient temp. °*F.*
21·0	1186	26·0
14·5	1093	34·0
13·0	1079	39·6
10·0	1045	47·0
7·0	1002*	61·0
6·0	824	65·0

*The value represents average value recorded over a period of 3 days and a working period of 6 hr; hazy and cloudy days have not been taken into account.

TABLE 4 — EFFECT OF GLASS LAYERS

Av. rate of flow of water *gal./hr*	ΣQ_w *B.t.u./sq. ft*		Max. rise in temp. over ambient temp. (°*F.*) with	
	2 layers	3 layers	2 glass layers	3 glass layers
7	830	785	60·3	56·7
10	924	882	40·5	38·7
10	907	880	37·8	36·0

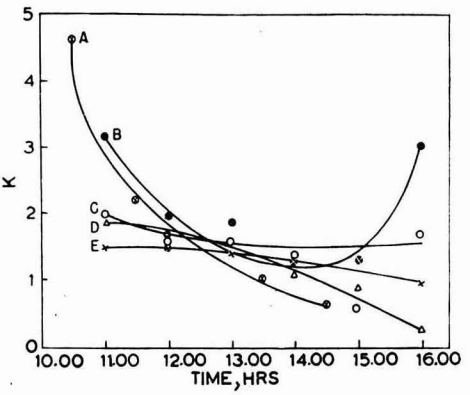


FIG. 4 — VARIATION OF OVERALL COEFFICIENT OF HEAT TRANSFER (K) ON DIFFERENT DAYS EMPLOYING DIFFERENT FLOW RATES OF WATER [A, 6 gal./hr; B, 19 gal./hr; C, D and E, 7 gal./hr on different days]

The value of the overall coefficient of heat transfer, $K = \frac{1}{2}k$, presented in Table 1 on reference to equation (6) shows that heat transferred to water will be maximum when $K = 0$. The variation in the value of K obtained at different hours of the day employing different flow rates of water is shown in Fig. 4. It is observed that both for higher rates of flow, i.e. 19 gal./hr, and for lower rates of flow, i.e. 6 gal./hr, the K values show large variations reaching in some cases a figure as high as 4·5 (Table 1). On the other hand, for the rate of 7 gal./hr, the variation in value of K is much less and lies between 0·3 and 2. This is more or less the case for the rates of 9 and 10 gal./hr also. It can be concluded from this that for the size of water heater described in this paper the optimum flow value is 7 to 10 gal./hr; the rate of 7 gal./hr should be preferred if the water is to be heated to higher temperatures.

Conclusion

From the results of these studies it is clear that the solar water heater is a practical proposition for obtaining a hot water supply for domestic purposes. For a total insulation area of 22 sq. ft the solar energy absorbed during a working day of 6 hr works out to roughly 22,500 B.t.u./hr corresponding to slightly over 1 kWh./hr. At the rate of electrical

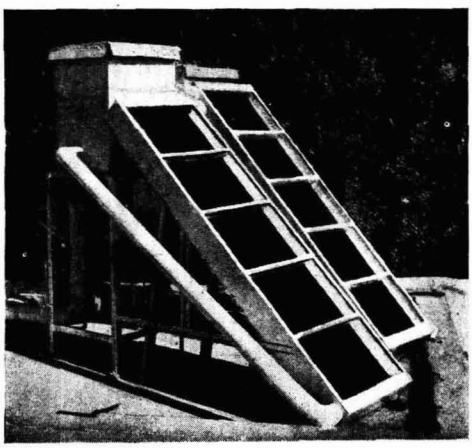


FIG. 5 — AN INSTALLATION CONSISTING OF TWO SOLAR WATER HEATER UNITS

domestic energy of 2 annas per unit, this works out to 12 annas or 75 naye paise per day or roughly Rs 22 per month.

In some recent trials we have used a single unit and a double unit (Fig. 5), the latter with a total insulation area of 55 sq. ft in conjunction with a water reservoir of 100 imperial gallons capacity, connected in such a manner that thermo-siphon action is possible and a temperature of between 120° and 140°F. could be reached during the day. With reasonably good insulation the fall in temperature during the night did not normally exceed 20°F. and thus it was possible to obtain running hot water supply at about the right temperature both for washing in the kitchen and for a shower in the early morning hours. The heat gain for 55 sq. ft unit will correspond to 2·5 kWh. or Rs 55 worth of electricity every month. The domestic solar unit will thus recover its initial cost in less than one year.

References

1. MATHUR, K. N. & KHANNA, M. L., *Proc. Symposium on Solar Energy & Wind Power, Unesco, Paris*, 1956, 202.
2. HEYWOOD, H., *J. Inst. Fuel*, **27** (1954), 334.
3. HOTTEL, H. C. & WOERTZ, B. B., *Trans. Amer. Soc. mech. Engrs*, **64** (1942), 91; *Space Heating with Solar Energy* by H. C. Mottel (Massachusetts Institute of Technology), 1954, 58.
4. KIRPICHER, N. V. & BAUM, V. A., *Nauka i Zhizua, Moskva*, No. 7 (1946), 1-6.
5. KIRPICHER, N. V. & BAUM, V. A., *Priroda, Moskva* (Jan. 1954), 45-53.
6. WARD, G. T., *Proc. Inst. mech. Engrs*, **169** (1955), 1091-1112.
7. MORSE, R. N., *Proc. World Symposium on Applied Solar Energy, Phoenix, Arizona*, 1956, 191; *Central Experimental Workshops Reports, E.D.* 1 *and* 3, *Melbourne*, April 1954 & July 1956.

Gelation Time Studies of Some Resorcinol Adhesives

A. G. GHOSH*

National Chemical Laboratory, Poona

Manuscript received 16 *June* 1958

The effect of *p*H, temperature and initial resorcinol-furfural ratio on the gelation time of some resorcinol-furfural adhesives, when hardened in the normal manner with paraform, has been investigated. The gelling time of the adhesives decreases when part of the resorcinol in them is replaced by phenol.

THIS investigation was undertaken with a view to developing an adhesive for bonding the skins of a sandwich panel to the paper honeycomb core, at temperatures close to room temperature, within a period commensurate with the allowable production costs. The practice generally followed in the production of such adhesives is to react resorcinol in molar ratios greater than 1 with formaldehyde or paraform[1,2]. To set the adhesive an additional quantity of paraform is subsequently added, the amount being sufficient to raise the aldehyde content to 1·5-2 moles per mole of resorcinol.

*At present with the British Paints (India) Ltd.

In this series of experiments, furfural was used in place of formaldehyde in the initial reaction, setting being achieved by paraform as usual. Furfural, being a solvent for phenolic bodies and resinous condensation products, ensures a homogeneous and uniform adhesive which, in practice, aids in stress distribution. On weight per weight basis, less water is liberated with furfural, making dehydration simpler. Also, the higher boiling point of furfural reduces aldehyde losses in the reaction.

In the present study, the gelling characteristics of a resorcinol-furfural-paraform system (series A) and a resorcinol-phenol-furfural-paraform system (series B) as a function of *p*H, temperature and initial resorcinol aldehyde ratio are reported.

Experimental procedure

Apparatus — The solutions were heated in a Pyrex beaker fitted with a solid brass heating jacket around it. The heating element was controlled by a thermistor-electronic control. Temperature was controlled within $\pm 0{\cdot}5$°C. The viscosities of the solutions have been determined with the help of a Techne industrial viscometer. Techne gelation timer was used for measuring the gelling time (in minutes) of the resin.

Resin series A — The resorcinol-furfural mixtures (resorcinol-furfural ratios 1: 0·6, 1: 0·7 and 1: 0·8; *p*H of 60 per cent solutions of the resins being 8·0, 8·0 and 8·2 respectively) together with the catalyst (sodium hydroxide) were heated to a temperature of 60°C. within 15 min. and kept at this temperature for 1-1½ hr until a 60 per cent solution attained a viscosity of approximately 100 cp. The resin was then dehydrated under vacuum and made up to a 60 per cent solution (w/w) with distilled industrial alcohol. The viscosities of the solutions varied between 95 and 120 cp. To gel the resin, paraform was added to the resin solution to raise the total aldehyde content to 1·5 moles per mole of resorcinol.

Resin series B — In this series, resorcinol was partially replaced by phenol. The total phenol-furfural molar ratio was 1: 0·6. The resins were prepared by reacting phenol for 30 min. at 85°-90°C. with enough furfural to keep the phenol-furfural ratio at 1: 0·6. The resin mixture was cooled to 50°C. and the rest of furfural together with resorcinol was added. The temperature of the reaction mixture was then brought up to 60°C. and maintained at that level for *c.* 2 hr or until the viscosity of a 60 per cent solution in distilled industrial alcohol approximated to 100 cp.

Results and discussion

Resin series A — The temperature-gelation time curves for this series of resins indicate that the original resorcinol-furfural ratio does not vary the setting properties significantly. These resins share the general characteristics of resorcinol-formaldehyde resins as regards *p*H, viz. that the gelation time decreases as the *p*H increases.

The viscosities of the three resin samples were measured up to 27 days of storage at 23°-26°C. A slight increase was noted in the resins 1 and 2 while the viscosity of resin 3 increased to 350 cp. in 12 days and thereafter became more or less constant. After 18 months of storage the resins were still soluble in alcohol and spread freely.

Resin series B — From Fig. 1 it can be seen that as the concentration of phenol is increased, the gelation time of the resin decreases. This effect is more striking below 60°C. (Fig. 2). According to Hancock[3], the addition of phenol to resorcinol increases the stability of the resin. Therefore, it is assumed that the decrease in gelation time with increasing concentration of phenol is mostly due to the fact that the order of the rates of transformation

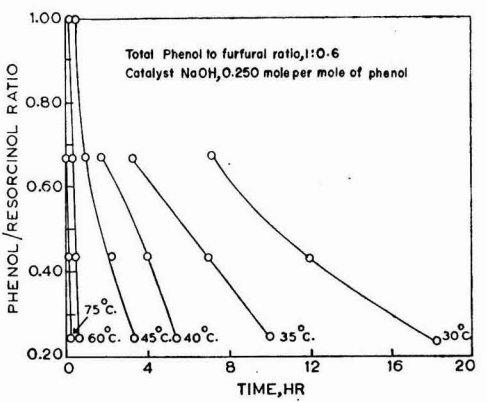


FIG. 1 — RELATION BETWEEN GELATION TIME AND PHENOL-RESORCINOL RATIO

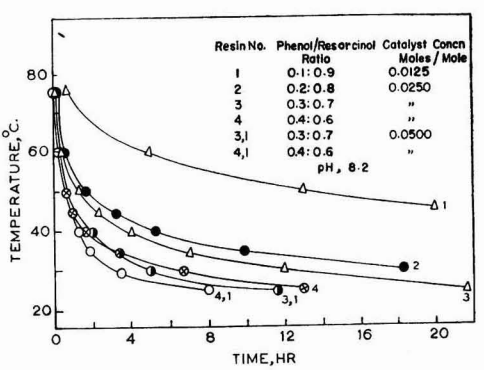


FIG. 2 — RELATION BETWEEN GELATION TIME AND TEMPERATURE

to a 'C' stage is in reverse to the order of initial reactivity[2,4] of different phenols as observed by Paisley and Megson[5]. These resins have been used successfully to bond sandwich skins to the honeycomb cores at room temperatures.

Conclusion

It is possible to obtain stable, smooth flowing, homogeneous adhesives setting at room temperatures by reacting together resorcinol and furfural and maintaining the ratio of resorcinol to furfural greater than 1. The setting time of these adhesives decreases if part of the resorcinol is replaced by phenol. The prospects for developing these adhesives on a commercial scale are good as furfural, the raw material required for these resins, can be manufactured from the plentiful agricultural wastes in India.

References

1. Little, G. E. & Pepper, K. W., *Brit. Plast.*, **19** (1947), 430-36.
2. Raff, R. A. F. *et al.*, *Industr. Engng Chem.*, **43** (1955), 1423-27.
3. Hancock, E. G., *J. Soc. chem. Inst. Lond.*, **66** (1947), 337-40.
4. Sprung, M. M., *J. Amer. chem. Soc.*, **63** (1941), 334-43.
5. Paisley, M. M. & Megson, N. J., *J. Soc. chem. Inst. Lond.*, (*Trans.*), **58** (1939), 213-15.

Measurement of the Electrical Resistance of Sized Powders at Different Bulk Densities: Part II—Graphite Powders

T. R. GOPALASWAMY, N. R. SUBRAMANIAN & G. D. JOGLEKAR
Division of Industrial Physics, National Physical Laboratory, New Delhi

Manuscript received 9 *May* 1958

Bulk electrical resistivity and bulk density of graphite powders from different sources have been determined with a view to establishing criteria for identifying the source of the graphite samples and for determining their suitability for specific industrial purposes. Measurements carried out with 20 samples have shown that bulk electrical resistivity and bulk density of the graphites decrease progressively as the particle becomes more and more flaky. Electrical resistivity increases with increase in the fineness and the ash content of the powders; surface films on the graphite particles also increase the resistivity. Bulk density decreases with increase in the fineness of the powders and increases with increase in ash content.

GRAPHITE samples of commerce, obtained from different sources, find specific applications in industry, and their identification is important. For example, in judging the suitability of graphites in the manufacture of graphite crucibles, dry cells, graphite brushes and pencils, information on the nature and source of the graphite sample is essential. Different methods of identification such as chemical analysis, differential thermal analysis, determination of surface area by nitrogen adsorption and by covering power, microscopical methods, and oxidation rates have been used by previous workers[1-4]. Most of these methods aim at arriving at characteristic constants or specific ranges of magnitude for different properties of the graphite samples which may be considered as a guide to the identification of graphite

samples and their suitability for specific industrial uses.

Similar work to specify the properties of graphites suitable for dry cells or brushes has not been hitherto attempted. The only property that has received consideration so far is the ash content[5] in the graphites. Croft, Skewes and Walkely[6] have, however, pointed out that the ash content of a graphite used in dry cells does not, to any appreciable extent, affect the performance of the cells; also there was some evidence that removal of interstitial gangue may actually be detrimental. They expressed the opinion that it is more important to grind the graphite very fine than to remove the last traces of inclusions. Therefore, it was considered that a more extensive study of the electrical characteristics of a graphite to be used for dry cell or brush manufacture will be useful in the processing of graphite for these industries.

Graphite is anisotropic in nature and the resistivity of graphite crystals in the direction parallel to the graphite plane is about 5×10^{-5} ohm cm. at room temperature[7]. The resistivity in the transverse direction is large and difficult to determine; it is of the order of 3 ohm cm. or more. In dry cells, carbon graphite and metal graphite brushes, the graphite particles are oriented in a random way.

The electrical resistances of a number of graphite samples, supplied by manufacturers of graphite articles as well as of samples prepared in the laboratory, have been determined and compared. The results are presented in this communication.

Experimental procedure

The experimental procedure followed is the same as described in an earlier paper[8]. Three or more readings of the electrical resistance of the powders, packed in a random manner, were taken at each specified number of tappings and the average resistance calculated. The particulars of the different samples investigated are given in Table 1. Although, in most cases, the experiments have been carried out up to 100 tappings, it was found that in several cases there was a tendency for the weight and resistance to remain constant and showed no abnormal behaviour after 50 tappings. Hence in all the experiments readings up to 50 tappings only have been taken into account.

Results and discussion

The results of a typical determination of the electrical resistance of a graphite sample given in Table 2 show that the method employed gives reproducible values. From the experimental data collected for the 20 samples of graphite, it was found that there is a linear relationship between the logarithm of the electrical resistance (ohms) and the weight (g.) of the material contained in the 2 in. cube. The equation of the most probable straight line representing this relationship is of the form $y = mx + b$, where y is the logarithm of the resistance; x, the weight of the material in the cube; m, the slope of the line; and b, the intercept of the line on the y axis. b was calculated from the experimental data for each sample and values of b are also included in Table 1.

TABLE 1 — CHARACTERISTICS OF GRAPHITES FROM DIFFERENT SOURCES

Sample No.	Particulars of sample*	Mesh size†	Ash %	Intercept on Y-axis b
1	Patna State No. 501	+100	8·0	2·8
2	do	−100+200	12·2	2·7
3	do	−200	22·0	3·8
4	Patna State No. 555	+100	7·6	2·3
5	do	−100+200	22·0	3·6
6	do	−200	40·0	3·6
7	Patna State No. 999	+100	26·4	4·9
8	do	−100+200	37·0	5·0
9	do	−200	40·0	5·8
10	Sample from a dry cell manufacturer	−80+150	11·3	3·4
11	do	−150	33·8	3·9
12	Madagascar	−20+28	11·3	2·4
13	do	−65+100	13·0	2·4
14	Norwegian	−200	11·2	2·7
15	Sample from a dry cell manufacturer	−200	9·0	1·9
16	Patna State No. 555; froth floated and dried to 110°C.	−150	4·6	1·6
17	Patna State No. 555 (heated for 3 hr at 400°C.)	—	4·6	1·3
18	Ceylon	−35+48	10·8	3·8
19	do	−65+100	16·0	3·9
20	Tailings from the flotation of Patna State No. 555	−200	53·0	6·7

*Samples 1-9 were obtained in lump form, hand crushed and further reduced in a ball mill.

†The mesh size of samples 12, 13, 18 and 19 is according to Tyler sieves and for the rest it is according to the I.M.M. sieves.

The results presented in various figures show the variation of the logarithm of the resistance with the weight of the sample. The number by which each curve is designated refers to the sample number as listed in Table 1.

Variation of resistance with the source of sample — The graphite samples 1, 4, 13 and 19 are more or less of the same particle size. It is seen from Fig. 1(a) that the curve for Madagascar graphite is on the left and that for Patna State (P.S.) graphites on the right. The curve for Ceylon graphite occupies an inter-

TABLE 2 — ELECTRICAL RESISTANCE OF PATNA STATE No. 555 GRAPHITE POWDER

[*Particle size of graphite*, 100 *mesh* (*I.M.M.*); *ash content*, 7·6%]

		No. of tappings					
		0	10	20	30	40	50
Resistance, ohms		2·70	0·70	0·75	0·70	0·60	0·60
		2·70	0·70	0·65	0·60	0·60	0·60
		2·50	0·70	0·65	0·60	0·60	0·60
	Av.	2·63	0·70	0·68	0·63	0·60	0·60
Wt of graphite, g.		96·80	118·50	122·10	124·60	126·10	126·60
		96·40	116·60	122·90	125·10	125·10	127·50
		97·60	117·70	123·20	124·90	124·20	127·00
	Av.	96·90	117·60	122·70	124·90	125·10	125·40

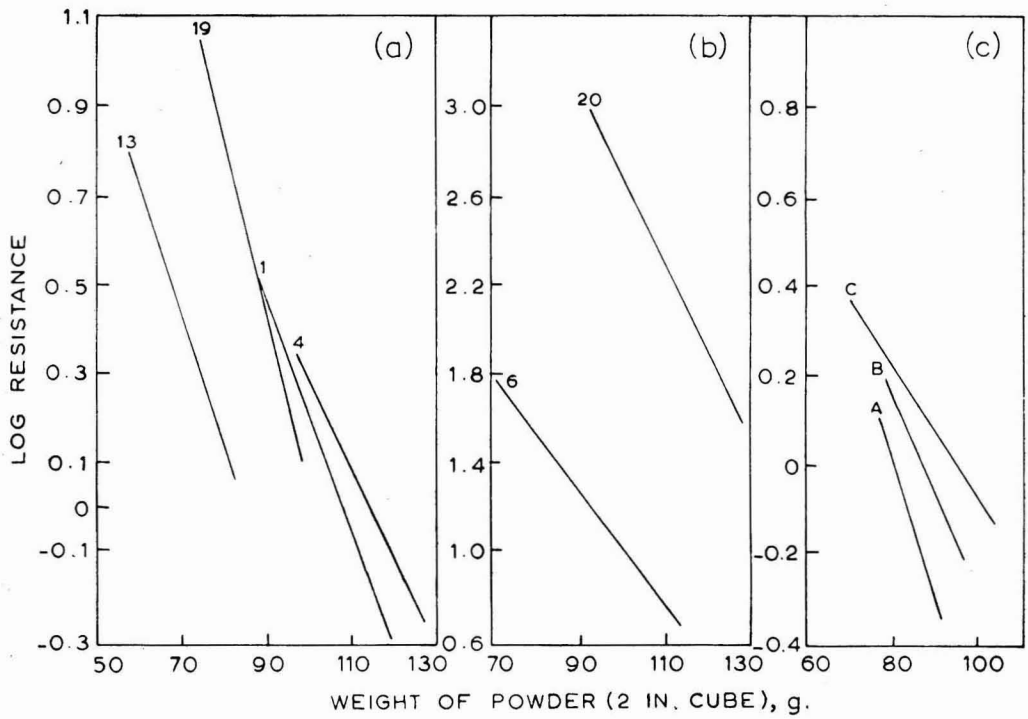


FIG. 1 — VARIATION OF RESISTANCE OF THE GRAPHITE SAMPLES WITH (a) SOURCE; (b) ASH CONTENT; AND (c) PARTICLE SIZE

mediate position. Madagascar graphite is the flakiest of all the samples whereas the Patna State graphite is the least flaky and Ceylon graphite is intermediate in the size range studied[2]. As the graphite becomes more and more flaky, the straight line graph shifts to the left, or, in other words, the resistivity of the sample decreases for a given bulk density. Chapiro and Vessolovski[9-11] have observed that the resistance of different graphites examined by them diminished progressively according to their crystalline state, the more crystalline the material the lower its resistance. Thus, it is seen that graphites from different sources behave differently when tested by the method followed. Graphite selected for the test should, more or less, be of the same size and ash content.

Variation of resistance with ash content — Fig. 1(b) shows the variation of the resistance of graphite

samples which are from the same source and of the same size, but of varying ash content. With increase in ash content, the curve shifts vertically and becomes steeper indicating that the resistance increases with ash content.

Variation of resistance with particle size — It is difficult to get natural graphite powders from the same source, varying in size but with the same ash content. This difficulty was overcome by taking a floated graphite (Patna State 555) with 1·3 per cent ash content. The graphite has so low an ash content that by grinding the floated sample no material variation in the ash content would occur. The graphite was ground to different finenesses to obtain fractions of −20+40, −40+80 and −80+150 I.M.M. mesh sizes and the electrical resistance of the powders (2 in. cube) was determined. The results presented in Fig. 1(c) (graphs marked A, B and C refer to the size fractions −20+40, −40+80 and −80+150 respectively) show that as the particle size of the sample is reduced, the curve shifts up vertically and to the left indicating that the resistivity of the samples increases as the powder becomes finer and finer.

Variation of resistance with size and ash content — The variation in the resistance characteristics of the graphites, when both the ash content and the particle size vary, is brought out in Fig. 2. As the

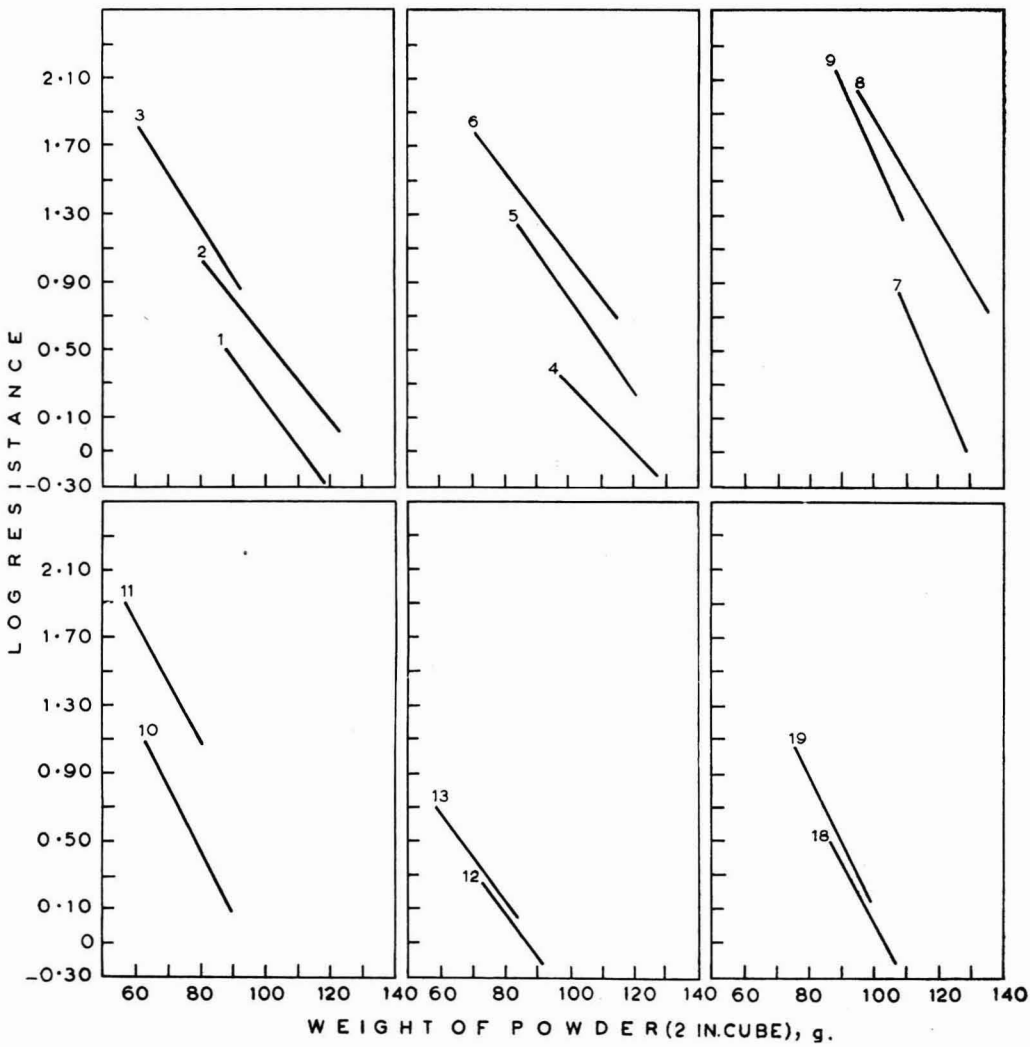


FIG. 2 — VARIATION OF RESISTANCE OF GRAPHITE SAMPLES WHEN BOTH ASH CONTENT AND PARTICLE SIZE VARY

material gets finer, it increases in its ash content (Table 2). The effect of increasing the ash content is to shift the curve up vertically and a little to the right. The curves show that as the particle size is reduced the curves shift upwards and to the left. Size reduction brings about a marked shift to the left. An anomaly is noticed, however, in the case of lines corresponding to samples 8 and 9. The ash content does not differ much for the two samples and as such this anomalous behaviour may be due to the nature of the ash and the nature of its association with the graphite particles.

Effect of surface films on resistance — The effect of surface films on the electrical resistance can be seen from Fig. 3, which shows the behaviour of a sample (16) of floated graphite and of the same sample after heating to 400°C. (17). From Fig. 3 it can be seen that the only change brought about by heating the sample is in its resistance. The lowering in the electrical resistance of the sample can be explained as due to the removal, as a result of heating, of the adsorbed flotation oils taken up by the particles. It was also observed that fall in the electrical resistance of the graphite powders depends upon its particle size. As the particle size is increased the variation in resistance is reduced.

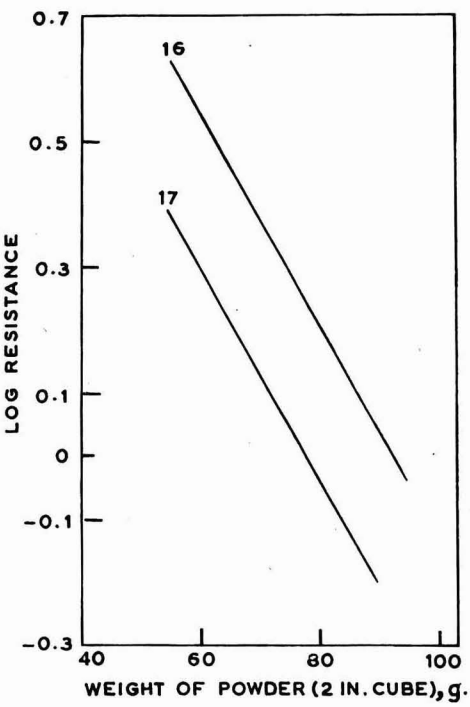


FIG. 3 — EFFECT OF SURFACE FILMS ON THE RESISTANCE OF THE GRAPHITE SAMPLE

Variation of bulk density with the source of graphite — The variation of the bulk density of the samples with the source, size and ash content is shown in Fig. 4(a, b and c respectively). The graphs show not only the differences in the resistance of the powders but also the differences in bulk density of the graphite samples. Samples 1, 4, 13 and 19 have more or less the same size and their ash content also does not vary much. It is seen from Fig. 4(a) that Madagascar graphite shows the least bulk density. Patna State graphites have high bulk densities, while Ceylon graphite has an intermediate value. This difference in bulk density is due to the difference in the shape of the particles of the different graphites. As the shape of the particles departs from a cubical one, the packing of the particles becomes less dense[12].

Variation of bulk density with size and ash content — It is known that the bulk density of powders decreases with decrease in their particle size provided no change occurs in the shape of the particles. This holds true of graphite powders also. Fig. 4(b) illustrates such a variation for samples 1, 2, 8, 9, 12, 13, 18 and 19. The ash content of these samples does not vary much, but there is a difference in their particle size. The bulk density increases with an increase in the ash content for powders having more or less the same size. This is clear from the graphs for samples 6 and 16 in Fig. 4(c).

Summary

From the results presented it is evident that graphites from different sources behave differently as regards their electrical resistance and bulk density. The electrical resistivity and bulk density decrease as the particles become more and more flaky. The electrical resistivity increases with increase in the fineness and the ash content of the powder. The effect of surface films is also to increase the resistivity of the powders. The bulk density of the graphite powders decreases with increase in the fineness of the powders and increases with increase in ash content. The results also show the usefulness of electrical resistance and bulk density measurements, not only for identifying graphite samples from different sources, but also for determining the suitability of a graphite sample for a specific purpose. These results also bring out the fact that the suitability of a graphite for a specific purpose should not be judged merely on the basis of its ash content. For the same bulk density, a low ash graphite does not necessarily have a lower resistance than the one with a higher ash content within certain limits. The resistivities of graphite powders depend upon their particle size, shape and ash content.

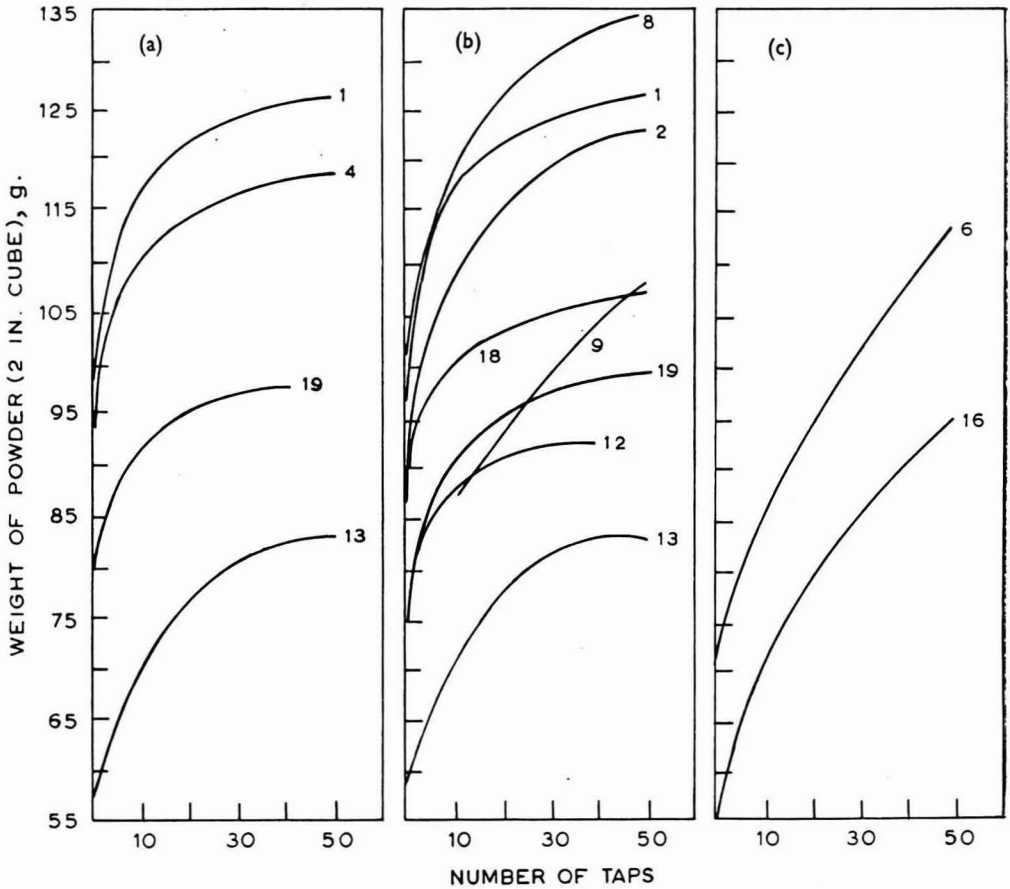


FIG. 4 — VARIATION OF BULK DENSITY OF THE GRAPHITE SAMPLE WITH (a) SOURCE; (b) PARTICLE SIZE; AND (c) ASH CONTENT

Acknowledgement

The authors are thankful to Shri A. N. Bulsara for his help in the experimental work.

References

1. MACKLES, L., HEINDL, R. A. & MONG, L. E., *J. Amer. Ceram. Soc.*, **36** (1953), 266-72.
2. MARATHE, B. R. & JOGLEKAR, G. D., *J. sci. industr. Res.*, **16A** (1957), 23-28.
3. HEINDL, R. A. & MOHLER, N. F., *J. Amer. Ceram. Soc.*, **38** (1955), 89-94.
4. HEINDL, R. A. & MOHLER, N. F., *Tech. News Bull. U.S. Bur. Stand.*, **39** (1955), 85-86.
5. JOGLEKAR, G. D. & GOPALASWAMY, T. R., *Utilization of Indian Graphite, Bulletin No. V, Mineral Raw Materials and Their Byproducts* (National Institute of Sciences, India), 66-71.
6. CROFT, R. C., SKEWES, H. R. & WALKELY, A. I., *Austr. J. appl. Sci.*, **3** (1952), 338-54.
7. KRISHNAN, K. S. & GANGULI, *Nature, Lond.*, **144** (1939), 667.
8. JOGLEKAR, G. D., SEN, D. & GOPALASWAMY, T. R., *J. sci. industr. Res.*, **18A** (1959), 21.
9. CHAPIRO & VESSOLOVSKI, *Miner. Syre*, **6** (1931), 265-74.
10. CHAPIRO & VESSOLOVSKI, *Chim. et Industr.*, **26** (1931), 1131.
11. *Refractories Bibliography* 291 (American Iron & Steel Institute & American Ceramic Society), 1950.
12. JOGLEKAR, G. D. & SUBRAMANIAN, N. R., *J. sci. industr. Res.*, **13B** (1954), 682-91.

Studies on Indigenous Cottonseed: Part VI—Delinting & Hulling

K. S. CHARI, V. R. HARWALKAR, S. A. SALETORE & S. H. ZAHEER

Regional Research Laboratory, Hyderabad

Manuscript received 1 *September* 1958

The yields of linters, hulls and meats from a commercial variety of cottonseed subject to ' mill-run ' cut and two-stage cut are presented ; both the operations are followed by hulling and separation. The quality of linters under the two processing conditions has been assessed. The power consumed for delinting and hulling operations has been determined.

The yield of linters is higher in ' mill-run ' cut although the quality of linters obtained by first cut in the two-stage cutting is superior. The power consumption for cutting linters by ' mill-run ' is lower than that for two-stage cutting.

STUDIES on the production of linters from a commercial sample of cottonseed were previously reported[1]. In the work presented here the same type of cottonseed has been used to study the yields of linters, hulls and meats, the power consumed for each step of processing and the capacity of the units under various operating conditions. The commercial cottonseed used was a mixture of high and low lintered varieties in the proportion of 78: 22 (estimated by manual segregation). The lint contents of the mixture and its separated components on 8 per cent moisture basis were: mixture, 10·86; high lintered component, 13·15; and low lintered component, 4·31 per cent.

The arrangement of the units in the processing of cottonseed is shown in Fig. 1. The cottonseed containing varying amounts of foreign matter such as locks of cotton, sand, earth, twigs, etc., is fed by a bucket elevator to a 6 in. conveyer which drops the seed to a safety shaker; here, the ' oversize ' foreign matter is separated on one side, sand and fine dust on the other, and the cleaned seed is conveyed with the help of a conveyer and an elevator to the delinter chute. The material passes through the feeder at controlled rates, through a permanent magnet to the 141 saw delinter. During delinting, some dust and hulls fall to the bottom due to ' moting ' and the linters are collected on a rotating condenser.

The delinted seeds are fed by a drag elevator to a 24 in. bar type huller, which is so adjusted that 80 per cent of the seed is cut. The cut seeds fall on to a shaker separator for purifying. The larger hulls and some of the uncut seeds from the top deck of the separator are delivered through a conveyer to a hull and seed separator. The meats, some hulls and smaller uncut seeds pass through the perforations to the lower deck, through the smaller holes of which

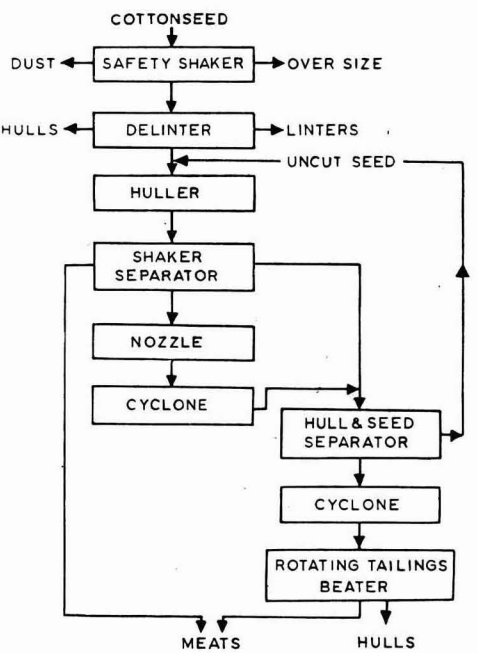


FIG. 1 — FLOWSHEET: ARRANGEMENT OF UNITS IN THE PROCESSING OF COTTONSEED

TABLE 1 — YIELD OF PRODUCTS AND POWER CONSUMED FOR MILL-RUN ADJUSTMENT PROCESS

(*Adjustments*: *middle stud*; *index*, 0; 1*T*)

Run No.	Wt of seeds *lb.*	Time taken *hr*	Power for delinting *kWh.*	Power for delinting per ton *kWh.*	Linters *lb.*	Dust *lb.*	Oversize *lb.*	Hulls below linter *lb.*	Hulls *lb.*	Meat *lb.*	Power for hulling *kWh.*	Power for hulling per ton *kWh.*
60	1082	3·8	28·5	59·0	65·0 (6·0)	47·0 (4·3)	6·0 (0·6)	23·0 (2·1)	139·0 (12·8)	802·0 (74·1)	16·5	34·2
61	1187	3·5	28·0	52·8	62·5 (5·3)	27·0 (2·3)	3·0 (0·3)	35·5 (3·0)	171·5 (14·1)	877·5 (73·9)	17·0	32·1
62	1253	3·8	30·0	53·7	62·0 (5·0)	26·0 (2·1)	5·5 (0·4)	39·5 (3·2)	154·0 (12·3)	916·0 (73·2)	18·0	32·2
Av.	1174	3·7	28·8	55·2	63·2 (5·4)	33·0 (2·8)	4·9 (0·4)	32·3 (2·8)	154·8 (13·2)	865·2 (75·5)	17·2	32·8

Percentage yields are indicated in parentheses.

TABLE 2 — YIELD OF PRODUCTS AND POWER CONSUMED FOR FIRST CUT IN THE DOUBLE CUT PROCESS

(*Adjustments*: *outermost stud*; *index*, 6; 2*T*)

Run No.	Wt of seeds *lb.*	Time *hr*	Power *kWh.*	Power per ton *kWh.*	Linters *lb.*	Dust *lb.*	Oversize *lb.*	Hulls below linters *lb.*	Delinted seeds *lb.*
66	3920	6·7	43·0	24·6	118·0 (3·1)	84·0 (2·1)	8·0 (0·2)	121·0 (3·1)	3590·0 (91·7)
67	1960	3·3	20·0	22·9	45·0 (2·3)	39·5 (2·0)	3·5 (0·2)	46·0 (2·4)	1820·0 (93·0)
Av.	2940	5·0	31·5	23·8	82·0 (2·7)	61·8 (2·1)	5·8 (0·2)	84·0 (2·8)	2705·0 (92·4)

Percentage yields are indicated in parentheses.

the fine meats pass to a conveyer which carries them to storage. Due to reciprocating movement of the shaker separator, the meats form a lower layer below the uncut seeds and hulls, on the intermediate deck. The nozzle is so adjusted as to pick up the uncut seeds and hulls which are delivered to the conveyer carrying similar material from the top deck, while the lower meats layer joins other meats passing to the storage.

The hulls and the uncut seeds are elevated and conveyed to a hull and seed separator, where the lighter hulls are carried away in a current of air, while the heavier uncut seeds drop to the bottom of the separator and are passed back to the huller. The hulls are beaten in a perforated rotating drum tailings beater to free them of adhering particles of meats, and the hulls and meats are conveyed to storage.

Experimental procedure

'Mill-run' adjustment — With 'mill-run' adjustment, which yields maximum linters in one delinting operation, the yields and power requirements were determined during three runs of complete processing, viz. delinting, hulling and separation. The results are presented in Table 1.

Adjustment for two cuts — In Table 2 are recorded the results of two runs so adjusted that in the first instance about 2·5 per cent of linters were cut. The partly delinted seeds were then subjected to a second cut, such that the maximum amount of linters is obtained without damaging the seeds. The data are presented in Table 3.

Evaluation of data

The average percentage yields of various products obtained in both adjustments are recorded in Table 4. It is seen that the yield of linters is higher using the 'mill-run' adjustment, although the quality of linters by first cut (ash content 2·9 per cent) is superior to that of the 'mill-run' (ash content 4·27 per cent). It is also seen that the yield of linters is only 5·4 per cent by mill-run and about 4·0 per cent by double cut, though the linter content of the original seed is 10·86 per cent. The low yield is due to the fact that the adjustments made are such that the seed is not damaged during delinting and the linters are not contaminated with hull-pepper. The

TABLE 3 — YIELD OF PRODUCTS AND POWER CONSUMED FOR SECOND CUT AND HULLING IN THE DOUBLE CUT PROCESS

(*Adjustments*: *middle stud*; *index*, 0; 1*T*)

Run No.	Wt of seeds *lb.*	Time taken *hr*	Power for second cut *kWh.*	Power per ton *kWh.*	Linter *lb.*	Dust *lb.*	Over-size *lb.*	Hulls below linter *lb.*	Hulls *lb.*	Meats *lb.*	Power for hulling *kWh.*
68	3590	9·4	61	38·0	46·5 (1·2)	31·0 (0·8)	4·0 (0·1)	19·0 (0·5)	529·0 (13·5)	2960·0 (75·5)	33·5
70	1820	3·2	32	39·4	27·5 (1·4)	16·0 (0·8)	2·0 (0·1)	12·0 (0·6)	278·0 (14·2)	1470·0 (75·0)	14·0
Av.	2705	6·3	47	38·7	37·0 (1·3)	23·5 (0·8)	3·0 (0·1)	15·5 (0·6)	404·0 (13·8)	2215·0 (75·3)	23·8

Percentage yields are given in parentheses.

TABLE 4 — YIELD OF PRODUCTS BY MILL RUN AND DOUBLE CUT PROCESSES

Process	Yield of products						Total
	Linters %	Dust %	Oversize %	Hulls below linter %	Hulls %	Meats %	
Mill run	5·4	2·8	0·4	2·8	13·2	75·5	100·1
Double cut							
First cut	2·7	2·1	0·2	2·8	—	—	99·7
Second cut	1·3	0·8	0·1	0·6	13·8	75·3	

TABLE 5 — POWER CONSUMPTION FOR CUTTING LINTERS

Process	Wt of seeds *lb.*	Linter yield			Power			Power per lb. of linter *kWh.*
		First cut *lb.*	Second cut *lb.*	Total *lb.*	First cut *kWh.*	Second cut *kWh.*	Total *kWh.*	
Mill run	1174	63·2	—	63·2	28·8	—	28·8	0·456
Double cut	2940	82·0	37·0	119·0	31·5	47·0	78·5	0·660

yield compares favourably with those obtained by Murti *et al.*[2], who obtained an average yield of 4·4 per cent of linters during the 'mill-run' of American type of seed containing an average lint content of 9·7 per cent calculated on 10 per cent moisture basis.

Normally the American practice is to cut about 1·5-3·0 per cent during first cut in a total of about 8 per cent recovery of linters. In the present set of experiments on double cut, the yield of linters by the first cut is more than that by the second cut. This is not a common industrial practice.

The average power consumption for cutting linters by 'mill-run' and by double cut is shown in Table 5, which indicates that the power is lower for 'mill-run' than for the other. The high power consumption in the latter is compensated by obtaining a part of the linters of superior quality. If there is a good demand for first-cut linters at a price which will compensate for the extra power consumed, it is advantageous to produce linters in two cuts.

Acknowledgement

Our sincere thanks are due to Shri G. S. Chowdhury for assistance during the erection of the pilot plant and to Messrs The Aryan Industries (Private) Ltd, Secunderabad, for supplying the raw materials.

References

1. Chari, K. S. *et al.*, *J. sci. industr. Res.*, **17A** (1958), 371.
2. Murti, K. S. *et al.*, Papers presented at the Technical Symposium of the Vanaspati Manufacturers' Association of India held on 18 February 1958 in Bombay.

The Corrosion of Metals in Synthetic Atmospheres Containing Sulphur Dioxide

B. SANYAL & D. V. BHADWAR
Defence Research Laboratory (Stores), Kanpur

Manuscript received 27 *February* 1958

The mechanism of atmospheric corrosion of metals has been investigated by measuring the rates of corrosion of aluminium, copper, nickel, zinc and mild steel in humid synthetic atmospheres containing sulphur dioxide. The effects of varying humidity, temperature, sulphur dioxide concentration, duration of exposure of the metals, singly or in combinations, on the rates of corrosion have also been investigated.

It has been observed that each metal requires a minimum humidity for the initiation of corrosion. Aluminium exhibits a critical humidity (80 per cent R.H.) at which the rate of corrosion is accelerated; mild steel exhibits critical humidities at 60 and 75 per cent R.H., and copper and zinc do not exhibit any. The rates of corrosion of the metals depend on the temperature of the atmosphere, the thickness of the moisture film on the metal surface, the nature of the corrosion products and the permeability of the films of these products to moisture and acid. Rise in temperature increases the rate of corrosion as a result of acceleration of the chemical reaction between the metal and the acid, up to a point, beyond which it falls due to lower solubility of sulphur dioxide in water vapour which does not get condensed on the metal surface.

HUMIDITY, temperature and gaseous as well as solid pollution are the principal factors contributing to the corrosion of metals exposed to natural atmospheres. The behaviour of certain metals on exposure to several types of outdoor and sheltered conditions has been studied by a number of workers[1-4]. While field work of this nature has been extensive, studies on corrosion under strictly defined conditions in the laboratory have been few[5-9].

In the present investigation the corrosion of some common metals and metallic couples exposed under laboratory conditions to one or more of the specific corrosive factors, viz. relative humidity and composition of the atmosphere, temperature and duration of exposure, have been investigated, and the results are presented in this paper.

Materials and methods

Samples — Panels (2 × 1 in.) of mild steel (Si, 0·07; S, 0·044; P, 0·049; Mn, 0·023; C, 0·07 per cent), copper (Cu, 99·8 per cent), zinc (Zn, 99·6; Pb, 0·009 per cent) and aluminium (Al, 99·5; Si, 0·12; Fe, 0·3; Cu, 0·08 per cent) cut from 18 gauge sheets were used in the tests. The panels were freed from mill scale, where present, and cleaned with toluene and methanol before exposure.

Exposure tests — The specimens were kept in glass bottles containing sulphuric acid of densities corresponding to relative humidities of the atmosphere desired. The specimens were hung on glass hooks suspended from rubber bungs used to seal the bottles. Requisite amount of sulphur dioxide was liberated by adding calculated amount of a strong solution of sodium thiosulphate to the sulphuric acid in the bottles. The change in the relative humidity of the atmosphere as a result of the addition of thiosulphate solution was negligible. The bottles were kept in incubators maintained at definite temperatures. The rate of corrosion of the metal panels was followed by weighing them at intervals and noting the weight gain due to corrosion; the specimens were finally derusted to determine the loss in weight of metal due to corrosion (expressed as loss of metal). Mild steel was derusted by cathodic treatment in 5 per cent sulphuric acid (wt/vol.) containing an inhibitor; copper, brass and nickel by dipping them in 5 per cent sulphuric acid at room temperature; zinc by treatment with 10 per cent cold chromic

acid solution; and aluminium by immersion in cold concentrated nitric acid. Unless otherwise stated, the conditions under which the experiments were carried out were as follows: sulphur dioxide concentration, 0·3 per cent; duration of exposure, 7 days; and temperature, 40°C.

Results

Influence of humidity — The results of tests on the influence of humidity on the corrosion of different metals exposed to an atmosphere containing 0·3 per cent by volume of sulphur dioxide are presented in Fig. 1. It is seen from Fig. 1 that in the case of mild steel, there are two critical humidities (the primary one at 60 per cent R.H. and the secondary at 75 per cent R.H.) at which there is considerable increase in corrosion rates. Above 75 per cent R.H., the corrosion rate (loss of metal) curve is almost linear up to the maximum humidity (99 per cent). In the case of copper a continuous increase in the corrosion rate is observed with increasing humidity and no critical humidity is noticeable. Corrosion of zinc starts at 50 per cent R.H. and the curves are more or less linear. There is a distinct fall in corrosion rate of zinc at maximum humidity (99 per cent), which is probably due to the influence of products of condensation. No critical humidity is noticed for zinc, whereas the critical humidity for aluminium is 80 per cent R.H. and the rate of corrosion rises markedly up to 99 per cent R.H.

The corrodibility of the metals in an atmosphere containing 0·3 per cent sulphur dioxide and at 40°C. and 89 per cent R.H. is in the following decreasing order: mild steel, zinc, copper and aluminium.

Influence of sulphur dioxide concentration — The influence of sulphur dioxide concentration on the rate of corrosion of different metals is shown in Fig. 2. There is a steep rise in the rate of corrosion (weight gain) of mild steel beginning with a sulphur dioxide concentration 0·3 per cent which is maintained up to 0·9 per cent. Thereafter, the curve tends to flatten up to 1·9 per cent and then falls. The curve for loss in weight after derusting shows a rapid fall. In the case of zinc, within the entire range of concentration studied, the rate of corrosion is approximately proportional to the concentration of sulphur dioxide. There is a very slow rise in the rate of corrosion of copper with increase in the concentration of sulphur dioxide. In the case of aluminium the curve for weight gain shows rapid rise with sulphur dioxide concentration, whereas the curve for loss in weight shows a very slow rise.

Comparative rates of corrosion of different metals — The comparative rates of corrosion of mild steel, aluminium, copper and zinc are presented in Fig. 3. Mild steel is the most corrodible metal, followed by copper; corrosion of zinc and aluminium is of a smaller order. The influence of varying sulphur dioxide concentration is most marked in the case of mild steel.

Effect of temperature — The rate of corrosion of copper and mild steel at 10°, 30°, 40° and 60°C. and at 89 per cent R.H. was studied. The corrosion [loss of metal (in mg.) in a 2×1 in. specimen] in the case of the metals at different temperatures was respectively: copper — 1·9, 7·5, 27 and 27 and mild steel — 65, 135, 175 and 130. These values show that the corrosion rates increase with temperature up to 40°C., after which there is no further change in the case of copper but a slight fall in the case of mild steel. For zinc and aluminium, the corrosion rates do not increase with temperature.

Influence of sulphur dioxide available per unit area of metal — One, two and three mild steel panels,

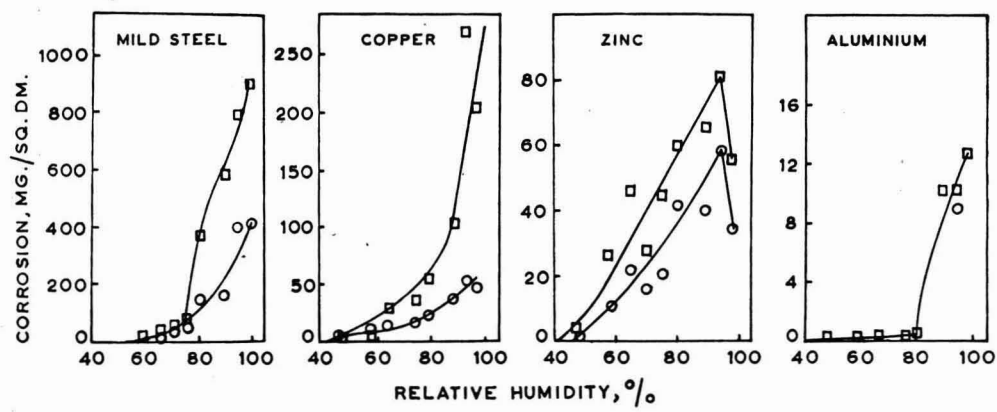


FIG. 1 — INFLUENCE OF VARYING HUMIDITY ON THE CORROSION OF METALS BY SULPHUR DIOXIDE [O—O—O, weight gain; □—□—□, loss of metal; concentration of SO_2, 0·3 per cent]

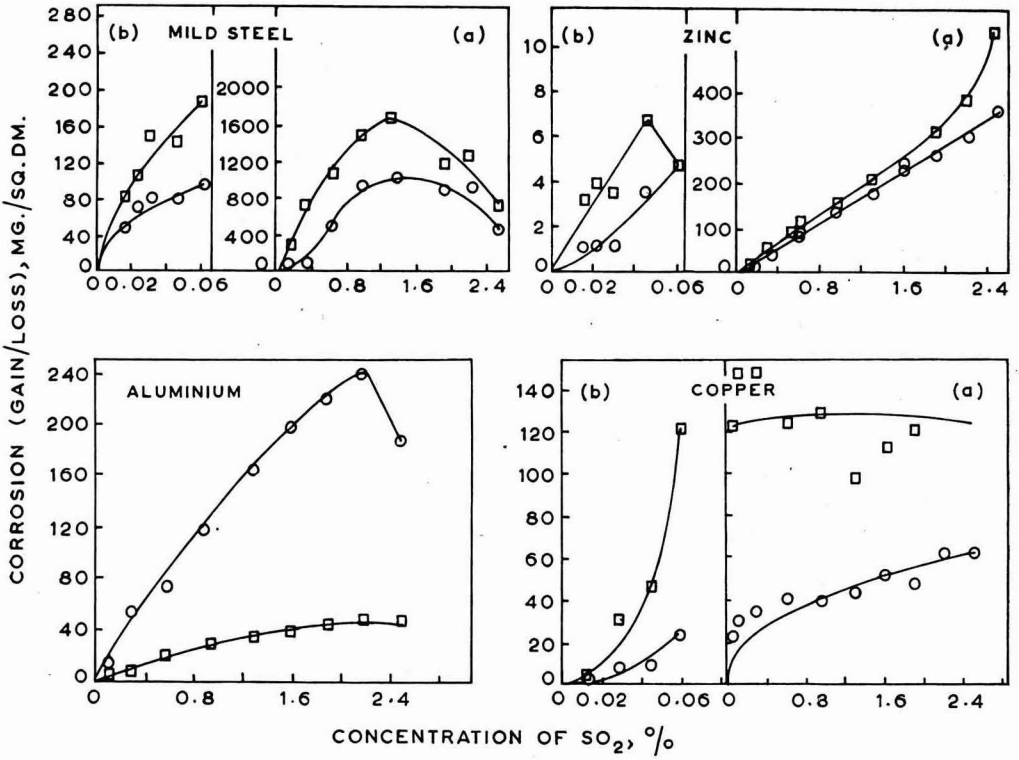


FIG. 2 — INFLUENCE OF VARYING SULPHUR DIOXIDE CONCENTRATION ON THE CORROSION OF METALS [O—O—O, weight gain; □—□—□, loss of metal; R.H., 89 per cent]

representing 4, 8 and 12 sq. in. of area, were exposed to an atmosphere containing the same amount of sulphur dioxide. The R.H. of the atmosphere was maintained at 80 per cent. The loss in weight of the panels was 35, 25 and 14 mg. respectively which indicates that the rate of corrosion increases with the quantity of sulphur dioxide available per unit area of the metal, though it is not strictly proportional to the increase in area.

Effect of intermittent exposure to sulphur dioxide

In these experiments sulphur dioxide was introduced into the bottles containing the specimens every third day.

Influence of duration of exposure — Corrosion rate-time curves for different metals at increasing concentrations of sulphur dioxide and for varying periods of exposure (Fig. 3) are mostly exponential over the first part and flatten towards the time axis which shows that corrosion is rapid in the initial stages.

Influence of concentration of sulphur dioxide — The final corrosion values for the metals (Fig. 3) have been plotted against sulphur dioxide concentrations in Fig. 3 which also shows the sulphur dioxide to metal ratio in the corrosion products. In the case of mild steel there is an increase in corrosion with increasing sulphur dioxide concentration up to about 0·9 per cent after which there is a fall up to 3·8 per cent. This is followed by a slight rise at 9·9 per cent. It is interesting to note that the fall in corrosion rate after about 1 per cent concentration of sulphur dioxide was also observed in the earlier experiment in which sulphur dioxide was introduced initially and the panels were exposed for 7 days. A close similarity is observed between the corrosion rates and the sulphate-iron ratio (Fig. 4), indicating that there is a change in the composition of the products of corrosion with increase in the rate of corrosion.

Corrosion of zinc increases rapidly with increase in sulphur dioxide concentration but no maximal value is obtained as in the case of mild steel. The sulphate content of the corrosion product increases up to a sulphur dioxide concentration of 1 per cent (Fig. 4). This is followed by a fall in sulphate content and thereafter there is no further change in the composition of the corrosion product up to the maximum concentration of sulphur dioxide employed.

In the case of copper the rate of corrosion increases rapidly up to a concentration of 1·5 per cent sulphur dioxide and thereafter it goes on increasing slowly. There is a close parallelism between the corrosion value (weight increment) and sulphate-copper ratio (Fig. 4) which shows that the composition of the corrosion product changes with the concentration of sulphur dioxide.

Corrosion of metals in proximity with one another — Panels of mild steel, aluminium, nickel and zinc were exposed to an atmosphere of sulphur dioxide (concentration of SO_2, 0·6 per cent; R.H., 89 per cent). The panels were in close proximity to one another, but not in actual contact. The results presented

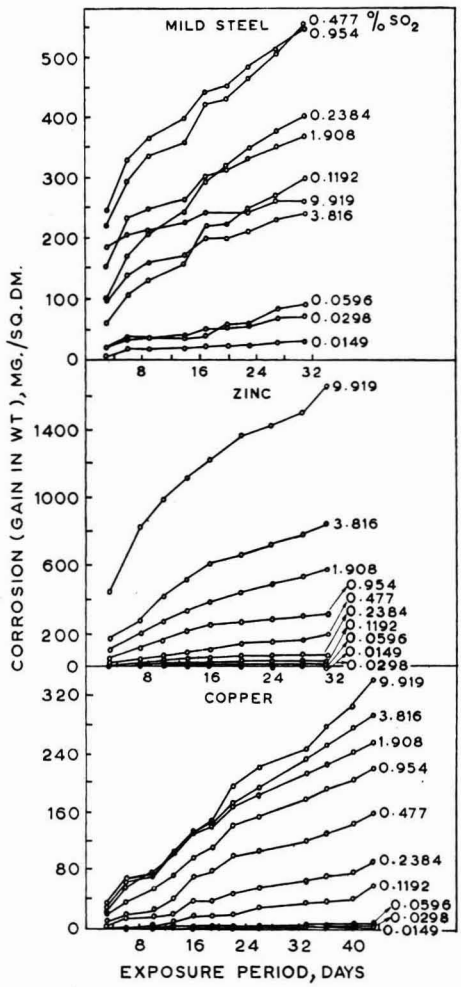


FIG. 3 — INFLUENCE OF VARYING THE PERIOD OF EXPOSURE ON THE CORROSION OF METALS [SO_2 added every third day to the system; R.H., 75 per cent]

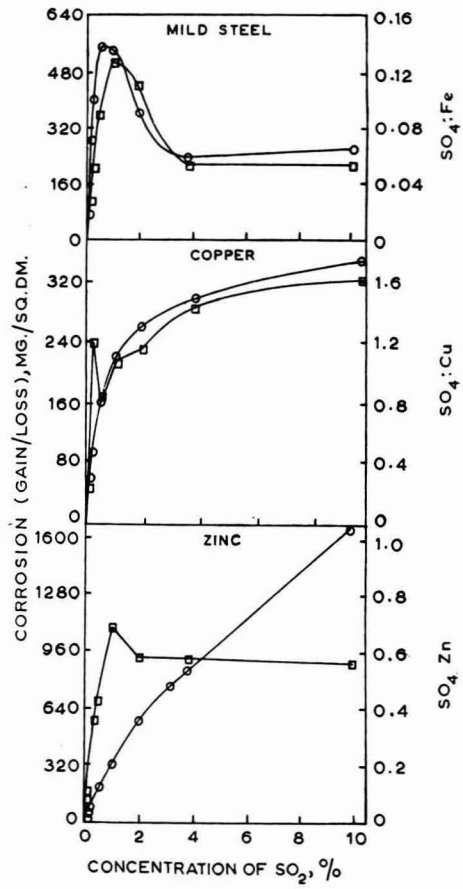


FIG. 4 — SULPHATE-METAL RATIO IN THE CORROSION PRODUCT AND CORROSION OF METALS AT DIFFERENT CONCENTRATIONS OF SULPHUR DIOXIDE [O—O—O, weight gain; □—□—□, weight loss]

in Table 1 show that when panels of the same metal are exposed together the corrosion of the panels decreases with increase in the number of panels exposed. The extent of corrosion of nickel and mild steel panels when they are exposed together remains the same as when they are individually exposed. When panels of mild steel, nickel and zinc are exposed together, the corrosion of mild steel and nickel is reduced and that of zinc increases.

Rates of reaction of metals with sulphur dioxide — The rates of reaction between different metals and sulphur dioxide, measured in terms of the gain in weight of the panels after exposure for different intervals, are presented in Table 2.

Taking the final maximum corrosion values (metal loss) from Table 2 for each metal as 100 per cent, the corrosion values for the respective metals at

TABLE 1 — CORROSION OF METALS EXPOSED INDIVIDUALLY OR WITH OTHER METALS

(*R.H.*, 89%; *temp.*, 40°C.; *conc. of* SO_2, 0·6%; *exposure period*, 7 *days*)

Panel exposed	No. of panels	Corrosion/ panel *mg.*
Mild steel	1	294
do	2	239*
do	3	187†
Zinc	1	38
do	2	23*
do	3	18†
Nickel	1	45
do	2	28*
do	3	18†
Mild steel	1	255
Nickel	1	28
Mild steel	1	187
Zinc	1	31
Nickel	1	20
Zinc	1	33
Mild steel	1	152
Nickel	1	8
Zinc	1	31

*Average of 2 values.
†Average of 3 values.

TABLE 2 — RATE OF REACTION BETWEEN METALS AND SULPHUR DIOXIDE

(*Conc. of* SO_2, 0·6%; *R.H.*, 89%; *temp.* 40°C.)

Period of exposure *hr*	Mild steel		Zinc		Nickel	
	Wt increment *mg.*	Metal loss *mg.*	Wt increment *mg.*	Metal loss *mg.*	Wt increment *mg.*	Metal loss *mg.*
2	4·6	5·4	7·4	13·5	4·7	2·8
4	10·4	8·8	11·4	20·8	7·4	4·5
7	11·9	12·7	14·0	24·6	9·2	5·1
24	84·7	117·6	15·4	24·7	25·0	16·1
72	157·1	267·7	18·1	27·9	33·1	27·2
168	163·6	366·2	20·8	34·3	53·9	50·9

intermediate stages have been calculated and plotted against the period of exposure in Fig. 5. It is observed that during the first 7 hr of exposure mild steel corrodes a little more than 3 per cent; after 24 hr it rises to 32 per cent and in 2 days it is more than 70 per cent. Nickel shows a similar behaviour but the corrosion is more than that in mild steel after the first 7 hr; after 24 hr the value is nearly the same as that for mild steel and thereafter the rise is steady up to the maximum value. Zinc behaves differently. During the first 7 hr, it is corroded to the extent of *c.* 72 per cent of the maximum value, and thereafter it rises steadily reaching 100 per cent over a period of

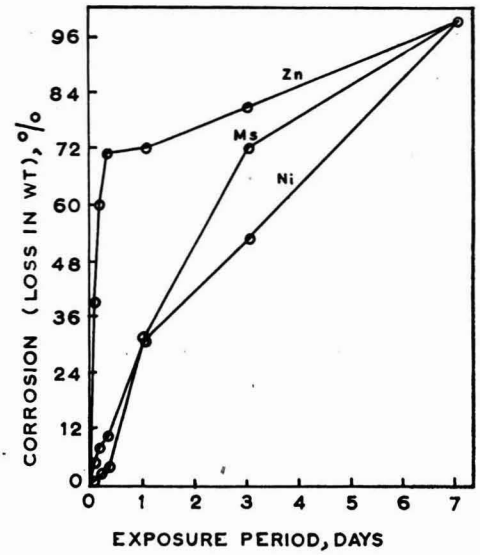


FIG. 5 — COMPARATIVE RATES OF CORROSION OF METALS BY SULPHUR DIOXIDE ON EXPOSURE FOR DIFFERENT PERIODS [Concentration of SO_2, 0·6 per cent; R.H., 89 per cent; and temperature, 40°C.]

7 days. These results suggest that when these metals are exposed together as in the previous experiment, zinc would react with sulphur dioxide faster than other metals which would thus be 'starved' due to depletion of sulphur dioxide from the system.

Corrosion of galvanic couples — Couples made by clamping pairs of panels of different metals with insulated nuts and bolts were exposed for 7 days to an atmosphere of R.H. 89 per cent and containing 0·6 per cent (vol./vol.) sulphur dioxide. Non-galvanic couples were run simultaneously to serve as controls.

The corrosion of mild steel was reduced in contact with zinc, the loss in weight per panel being about 220 mg. in the control and 137 mg. in contact with zinc. The loss in weight of zinc, on the other hand, increases from 33 to 44 mg. This trend, however, was not so marked in other galvanic couples. In the case of copper and mild steel, and copper and zinc couples, all the metals showed slightly enhanced corrosion as compared to the controls.

Discussion

In a system consisting of the metal surface, water vapour and sulphur dioxide, water vapour is distributed between the gas phase and the surface of the metal, a film of water being formed on the metal surface. Sulphur dioxide is distributed between the gas phase and the film of water present on the metal

surface, a solution of sulphur dioxide being formed on the latter, initiating corrosion. Thus, the amount of sulphur dioxide and the humidity, on which the thickness of the moisture film formed on metal surface depends, influence the rate of corrosion (Figs. 1 and 2). The nature of the products of corrosion, the permeability of the metal oxide, hydroxide and sulphate films produced as a result of corrosion, to moisture and acid, and the breakdown of the films determine the rates of corrosion of metals. Thus, in the case of iron, an oxide film is formed at lower humidities which grows and gets strengthened with time and confers resistance to corrosion under low humidity conditions. At higher humidities, moisture may be absorbed by the oxide, encouraging the formation of a film of ferrous or ferric hydroxide. This enhances the rate of corrosion and corresponds to the primary critical humidity for mild steel at about 60 per cent (Fig. 1). At still higher humidities there is a breakdown of the hydroxide film and further attack on new centres, opened up on the metal surfaces, takes place, accelerating the rate of corrosion of the metal. This corresponds to the second critical humidity (75 per cent; Fig. 1). Aluminium exhibits only one critical humidity at *c.* 80 per cent, whereas copper and zinc do not show any critical humidity. A minimum humidity (R.H. 40 per cent) is, however, required for the formation of the corrosion product (Fig. 1).

In the presence of sulphur dioxide, oxidation of sulphur dioxide to sulphur trioxide takes place on the metal surface, which, in the presence of moisture, forms sulphuric acid leading to increase in corrosion. The acid formed has a more pronounced penetrating effect on the films of the products of corrosion, which are reacted upon, exposing fresh metal surface to corrosive attack. The amount of acid formed depends on the quantity of sulphur dioxide present and the corrosion rates are thus influenced by the latter (Fig. 2).

At low temperatures and high humidities, the metal surface is covered with a film of moisture. At higher temperatures less condensation takes place and the film of moisture on the metal surface is discontinuous. As the temperature rises there is also a diminution in the solubility of sulphur dioxide in water. Consequently, temperature has a dual effect: up to a certain point it increases corrosion by accelerating the chemical reaction between metal and sulphur dioxide, but at higher temperatures, corrosion rates fall due to the above reasons.

The moisture content of the atmosphere, the amount of sulphur dioxide, temperature, the nature of corrosion product formed by each metal are, therefore, the initiating and controlling factors for corrosion.

The oxide/hydroxide films formed on mild steel are less compact and non-continuous and are easily susceptible to penetration by moisture, gases and electrolytes, whereas in the case of zinc, copper and aluminium, the films are more continuous, compact and stronger, and their breakdown does not take place easily. The corrosion rates of the latter metals are, therefore, less influenced by changes in environmental conditions.

Close proximity of dissimilar metals influences their corrosion rate in two ways: (1) the metal which reacts with sulphur dioxide more readily is corroded more than the one which does not so readily react with sulphur dioxide, and (2) a galvanic couple is formed whereby the baser metal gets corroded more rapidly than the nobler metal.

Acknowledgement

The authors are grateful to Dr T. S. Subramanian, Shri J. J. Bagchi and Shri N. K. Mukerji for their assistance in the course of this work. The paper is published with the kind permission of the Director of Research and Development, Ministry of Defence.

References

1. Hudson, J. C. & Stanners, J. F., *J. appl. Chem.*, **3** (1953), 86.
2. Ambler, H. R. & Bain, A. A. J., *J. appl. Chem.*, **5** (1955), 437.
3. *A.S.T.M. Symposium on the Outdoor Weathering of Metals & Metallic Coatings, Washington*, 1934.
4. Sanyal, B. & Singhania, G. K., *J. sci. industr. Res.*, **15B** (1956), 448.
5. Vernon, W. H. J., *Trans. Faraday Soc.*, **23** (1927), 159.
6. Evans, U. R., *Corrosion — Passivity & Protection* (Edward Arnold, London), 1948.
7. Sanyal, B. & Preston, R., *Chem. Ind.*, **37** (1952), 1126; **38** (1953), 995.
8. Vernon, W. H. J., *Trans. Faraday Soc.*, **31** (1935), 1678.
9. Preston, R. St J. & Sanyal, B., *J. appl. Chem.*, **6** (1956), 26.

Anodic Stripping Method for the Determination of Local Thickness of Electroplates: Part I—Design of Electronic Relay & Its Application to Measurement of Thickness of Chromium Electrodeposits

S. SATYANARAYANA & D. L. ROY
Central Electrochemical Research Institute, Karaikudi

Manuscript received 20 *September* 1958

A method based on anodic stripping has been developed for the determination of the local thickness of electrodeposits. An improved stripping cell of simple design, a simple low-cost and efficient stainless steel gasket and an electronic relay circuit constructed for the purpose are described.

A small spot on the surface of the test piece is anodically dissolved using a large stainless steel cathode which is designed to serve as a container for the electrolyte. At the moment of completion of anodic dissolution of the electrodeposit, the change in the anode potential (due to the basis metal coming in contact with the electrolyte) is fed to a two-stage d.c. amplifier, and is made to actuate a relay which stops aneelectric timer and indicates the stripping time automatically. The stripping time is directly related to the thickness of the electrodeposit.

The accuracy of the technique and its applicability to the measurement of the thickness of thin chromium deposits on industrial basis metals like steel, nickel, brass and copper have been examined. The method is comparable with the microscopic method in its accuracy and is particularly suitable for measuring the thickness of very thin electrodeposits.

THE corrosion resistance and wear resistance of electrodeposited metals are mostly determined by the thickness of the coating[1]. As such, determination of the thickness of electroplates, particularly the thickness at the significant surface regions on the specimen, is of prime importance as a quality control measure. Specifications in electroplating[2] involve the minimum thickness of the coated metal or alloy on such significant surfaces, depending on the type of use which the article is put to.

Most important of the destructive methods is the optical microscopic test at the desired spot. The equipment used is expensive and requires a skilled operator, considerable time and labour. Further, the tests are at highly localized points and the results are, therefore, inaccurate for thin coatings[3].

Among the non-destructive methods, the magnetic[3] and electromagnetic methods are applicable only for magnetic basis metals and relatively non-magnetic coatings. These methods have many other limitations and the accuracy may not be more than ± 10 per cent. Other (at present) less useful methods are the ultrasonic[4], X-ray[5], eddy current[6] and thermoelectric[7] methods.

Mesle's chord method[8], a semi-destructive one, is not as widely and as easily applied as the chemical jet test method[9]. In the B.N.F. jet test, a uniform jet of a suitable corroding solution is impinged on the surface of the specimen under carefully standardized conditions, and the time of penetration of the coating is empirically correlated with its thickness. While the method is relatively quick, it has the following disadvantages: (i) high temperature coefficient, (ii) difficulty in detecting the end point and (iii) considerable error due to subjective factors. The average deviation in thickness measurement may be ± 15 per cent. In an attempt to increase the ease of

detection of end point, Glazunov[10], Britton[11], Lindsay[12] and Gentry[13] attempted to correlate the change in voltage or current at the completion of stripping when initially a voltage was applied across the jet or the solution.

In addition to the above methods, there is one based on anodic stripping. The main advantages of the anodic stripping method for thickness evaluation are: (i) it can be made independent of subjective errors; (ii) it is not based on the study of a highly localized region as in the microscopic test, and, therefore, gives a better idea of local thickness; (iii) it is applicable both to magnetic as well as non-magnetic coatings; (iv) only a very small quantity of the electrolyte solution (about 1-2 ml.) is required; (v) the tested spot can be easily refinished because of the small, clearly defined, circular stripped spot; and (vi) the accuracy of the method can be high as it is not highly temperature dependent (because of the low temperature coefficient of electrochemical processes), and potential changes can be quite sharp in suitable electrolytes, so that the end point is accurately registered by the instrument.

Anderson and Manuel[14] described the anodic spot stripping method for the measurement of the thickness of chromium electrodeposits, and obtained values with an accuracy of ± 2 per cent by visually observing the change in current at the end point. Francis[15] described a thyratron-operated relay circuit which stopped a timer at the end of anodic stripping, and proved the general applicability and high accuracy of this method of measuring local thickness of electroplates. At least one firm in the U.S.A.[16] has placed on the market a handy electronic instrument with automatic cut-off at the end point and direct reading of thickness, based on the anodic spot analysis method.

Since the Francis circuit is 90 V. and 4·5 V. battery operated and uses a relatively complicated gasket design, and since the details of the commercial Kocour instrument are not available, an attempt has been made here (1) to design an electronic relay amplifier and end point detector, (2) to design an easily replaceable gasket sealing arrangement, (3) to evolve suitable electrolytes for different systems and (4) to establish the degree of accuracy of the method under the experimental conditions employed.

Experimental procedure

Apparatus (Fig. 1) — The rectified and filtered d.c. output (about 420 V.) from the rectifier tube, 5Y3, is used to supply proper plate voltages to 6AC7 and 6SJ7 sharp cut-off pentodes. To operate these pentodes as sharp cut-off tubes, and thereby ensuring proper amplifier response, it was found necessary to maintain the screen voltages constant. This was done by using voltage regulator tubes, VR150 and VR75. The VR150 was chosen (to operate at 150 V.), because the grid and cathode of the second stage are already at 75 V. with respect to ground. The d.c. supply for electrolysis is obtained from the VR75 through the potentiometer P_1.

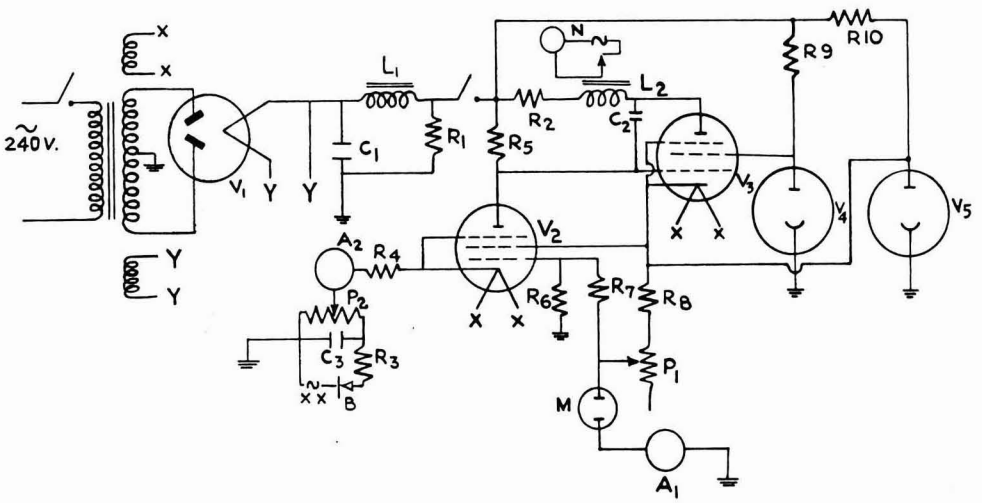


FIG. 1 — CIRCUIT DIAGRAM OF THE ELECTRONIC SYSTEM [$R_1 = 100$ KΩ; $R_2 = 100$ KΩ; $R_3 = 100$ Ω; $R_4 = 200$ Ω; $R_5 = 80$ KΩ; $R_6 = 500$ KΩ; $R_7 = 200$ KΩ; $R_8 = 10$ KΩ; $R_9 = 10$ KΩ; $R_{10} = 22$ KΩ; $P_1 = 100$ KΩ; $P_2 = 1$ KΩ; $C_1 = 32$ μF; $C_2 = 0{\cdot}01$ μF; $C_3 = 32$ μF; $L_1 = 15$H; $L_2 = 2$ KΩ (2 ma. relay); $V_1 = 5Y3$; $V_2 = 6AC7$; $V_3 = 6SJ7$; $V_4 = VR150$; $V_5 = VR75$; X-X = 6·3 V. a.c.; Y-Y = 5·0 V. a.c.; $A_1 = 0$-5 ma. d.c.; $A_2 = 0$-10 ma. d.c.; M = anodic stripping cell; N = electric stop watch; B = 100 ma. crystal rectifier]

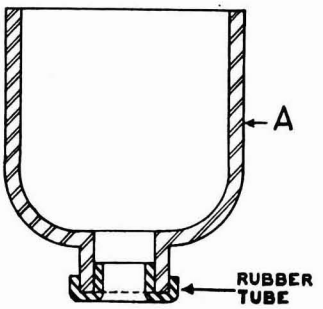


FIG. 2 — STRIPPING CELL

Procedure — In the first stage, the grid bias is obtained by rectifying the a.c. output from the 6·3 V. heater winding, using a crystal diode. For a given cell system, consisting of a particular basis metal, electroplate and electrolyte, the initial anode potential being fed to the grid must be compensated so that only further variations in the potential will actuate the relay after amplification. This compensation is carried out by setting potentiometer P_2. Ammeter A_2 furnishes a visual indication of the setting.

To calculate the thickness, it is necessary to ensure constancy of the electrolysis current with time, constancy of the stripped area in different thickness determinations, and to choose such an electrolyte as to have 100 per cent anode efficiency. A suitable electrolysis current, indicated in ammeter A_1, is obtained by adjusting P_1. This current is kept constant during electrolysis, by having in series with the cell a resistance R_8 large enough to make the changes in cell resistance relatively inappreciable.

When the stripping is complete, the anode potential changes, and the relay is actuated and stops an electric stop-watch. The cathode potential remains constant because of the large area. A signal lamp can also be made to light up. The instrument thus automatically measures the stripping time and, therefore, the coating thickness.

The operating point of the relay is determined by the setting of P_2. The sensitivity of the instrument is such that a minimum anode potential change (at M) of 100 mV. fed to the grid circuit of the first stage will actuate the relay. For chromium and most other electroplates, this sensitivity is quite adequate.

To get a reproducible stripping area, different designs involving rubber gaskets with precision perforation have been employed[14-16]. These gaskets are not easily and cheaply replaced. A simple, low-cost and efficient gasket design for stripping has been evolved in the present work.

The stripping cell (Fig. 2) consists of a stainless steel vessel (A) of about 10 ml. capacity. At the base, the vessel has a constriction, i.d., $\frac{1}{8}$ in., o.d., $\frac{3}{16}$ in. and about $\frac{1}{8}$ in. long. Thin rubber tubing (about $\frac{1}{4}$ in. length), of the type used for cycle tube valves, is slipped inside the bore to $\frac{1}{8}$ in. and the rest of the rubber tube is doubled up on the outside of the constriction. This defines a definite area on the surface of contact, and this area is not appreciably altered by slight changes in clamping pressure. The vessel is held by a clamp and is simply pressed on to the test specimen at the chosen spot and the top of the constriction (covered with rubber) effectively prevents any liquid leakage.

The electrolyte (1·0-2·0 ml.) is poured into the cell, and any air bubble is removed by momentarily lifting the gasket from the specimen, and the liquid that has leaked out is removed by absorbent paper. Electrolysis is now started at the required current (2-3 milliamperes, in the case of chromium electroplates) by adjusting P_1. A_2 is quickly adjusted to the proper (predetermined) value by setting potentiometer P_2. After stripping is complete, the time indicated by the electric timer is directly related to the thickness, since the area of the anode spot can be measured. The stripped area was found to be constant within $\pm$0·5 per cent at constant current density, but it is a function of c.d., decreasing if the c.d. is increased, which is presumably due to an edge effect. It is, therefore, necessary to use the same stripping current density for all tests.

Results

The applicability of the electronic relay and the gasket design was first studied with reference to the determination of local thickness of thin chromium electrodeposits on the industrial basis metals, viz. copper, brass, nickel and steel. The electrolyte used was 3*N* NaOH, the c.d. used was 8 amp./dm.^{2}. The electrode potentials measured before and after stripping are given below:

	Anode potential *V.* (*NHE*)				Cathode potential *V.* (*NHE*)
	Cr over Cu	Cr over brass	Cr over Ni	Cr on steel	Stainless steel
Before stripping	1·09	1·09	1·09	1·09	1·10
After stripping	1·45	1·40	1·35	1·30	1·10

It can be inferred from the above data that the large stainless steel cathode does not change its potential while the minimum anode potential change by stripping of the chromium layer is 0·2 V. (in case of steel base) which is enough to actuate the relay when P_2 is initially set.

TABLE 1 — THICKNESS OF ELECTRODEPOSIT AND ANODIC STRIPPING TIME

Thickness of electrodeposit μ	Anodic stripping time (*sec.*) of spot				
	No. 1	No. 2	No. 3	No. 4	No. 5
1·7	267	266	264	265	265
2·5	383	380	385	386	—
3·2	508	505	509	512	—

The instrument was calibrated in the following manner. Chromium was electroplated on a flat, polished copper cathode, held parallel to a flat lead sheet anode. The sides of the two electrodes, which were not facing each other, were coated with paraffin and pressed against the wall of the perspex cell. Under these conditions the central region of the cathode is known[17] to get a uniformly thick coating. The thickness of the electroplate at different places in the central region was measured. The results are recorded in Table 1. It is to be pointed out that increasing deviations in stripped area are observed at thicknesses greater than about 2·5 μ even at constant c.d. These deviations can be minimized by using a suitable stirrer to reduce concentration polarization. Since the majority of industrial chromium plate is in the range of 1·0 μ no stirring is necessary under these conditions.

The mean deviation of the stripping times (Table 1) is ±2 per cent which is possibly due to the variations in the thickness itself.

Sections were cut at different thickness regions and the chromium thickness measured with an optical microscope and compared with the values calculated from the anodic stripping time. The values obtained for chromium plate thickness by the two methods for two sections were: 1·8 and 2·6 and 1·7 and 2·5 microns respectively.

These results show that the thickness values for the electroplate obtained with the instrument developed by us are in agreement with those obtained by the microscopic method within the limits of accuracy of the latter method. The thickness calculated from the stripping time is thus accurate to within ±5 per cent.

The method is particularly useful for measuring the thickness of very thin coatings (few millionths to hundred thousandths of an inch) for which other methods are not reliable. The test takes only *c.* 5 min. for completion and requires 1 to 2 ml. of the electrolyte solution; the tested spot can be easily refinished (for example, by brush plating) since it is small and well defined. Further, the method greatly minimizes errors arising from subjective factors. The amplifier is assembled from easily available radio parts. The rubber seal for the gasket is easily and inexpensively renewed. It can, therefore, be concluded that this method for the determination of the local thickness of electrodeposits has many advantages over other methods. Work on the extension of the method for quantitative data on composition of solutions and potential changes involved for other single metal and alloy coatings is in progress.

Acknowledgement

The authors wish to record their sincere thanks to Dr K. S. G. Doss, Director, and to Dr H. V. K. Udupa, Assistant Director, for their keen interest in the course of this work.

References

1. Blum, W. & Hogaboom, G. B., *Electroplating and Electroforming* (McGraw-Hill Book Co. Inc., New York), 1949, 102.
2. *Specifications and Tests for Electrodeposited Metallic Coatings* (American Society for Testing Materials, Philadelphia), 1958, 8.
3. Howells, G., *Corros. Technol.*, (1953), 233.
4. Erwin, W. S. & Rassweiler, G. M., *Rev. sci. Instrum.*, **18** (1947), 750.
5. Behr, F. A., *Non-destr. Test.*, **7** (1953), 33.
6. Brenner, A. & Gracia-Rivera, *J. Plating*, **40** (1953), 1238.
7. Heath, A. R., *Metal Finish.*, (April 1955).
8. Mesle, F. C., *Metal Ind., Lond.*, **33** (1935), 282.
9. Clarke, S. G., *J. Electrodep. tech. Soc.*, **12** (1936-37), 1, 157.
10. Glazunov, A., *Chim. et Industr.*, **29** (1933), 688.
11. Britton, S. C., *J. Inst. Met.*, **58** (1936), 211.
12. Lindsay, A. J. *et al.*, *J. Soc. chem. Ind.*, **58** (1939), 288.
13. Gentry, C. H. R., *Analyst*, **73** (1948), 157.
14. Anderson, S. & Mannuel, R. W., *J. electrochem. Soc.*, **78** (1940), 373.
15. Francis, H. T., *J. electrochem. Soc.*, **93** (1948), 79.
16. Kocour Co., Chicago, U.S.A.
17. Blum, W. & Hogaboom, G. B., *Electroplating & Electroforming* (McGraw-Hill Book Co. Inc., New York), 1949, 113.

REVIEWS

THE SOURCES OF INVENTION by John Jewkes, David Sawers & Richard Stillerman (Macmillan & Co. Ltd, London), 1958. Pp. xii + 428. Price 31*s.* 6*d.*

In these days it is generally taken for granted that research must necessarily be on a very large scale if it is at all to meet modern requirements. As a result, research is getting more and more institutionalized. It is becoming concentrated in large laboratories backed up by an elaborate research organization whether in the government sector, in large industrial establishments or at the universities. It is this powerful trend which the authors of this book have sought to assess from an impartial angle.

They have tried to emphasize that the modern system of research organization has some inherent drawbacks. The disincentives which large organizations may create for the research worker with an independent bent of mind have been pin-pointed in the book. For instance, the natural tendency of such an organization is to direct research from the top. Organizational rules and procedure tend to create an atmosphere where behaviour according to a set pattern is at a premium. In such surroundings people who can toe the line with other members of a large research group are likely to succeed more easily than the independent minded man, particularly the talented man at the bottom, who might find it impossible to have his way in a heirarchical structure, with its unavoidable screenings and interferences by executives at different levels. Modern large-scale research is, therefore, confronted with the most difficult task of organizing originality without diminishing its power.

By a searching analysis of a typical compilation of the most important inventive contributions of the twentieth century, the authors bring out the startling fact that even during this century, which is popularly believed to be the age marking the eclipse of the independent inventor, the contribution of the independent inventor is at least as significant, if not more important than that of large-scale organized research. Large laboratories can claim to have originated outstanding successes such as acrylic fibres, cellophane tape, continuous hot-strip rolling, crease resisting, DDT, diesel-electric locomotive, duco lacquers, fluorescent lighting, freon refrigerants, krilium, methyl methacrylate polymers, modern artificial lighting, neoprene, nylon, polyethylene, silicones, synthetic detergents, terylene, tetraethyl lead terylene and transistor. But an even more impressive list of cases can be ranked as individual invention in the sense that much of the pioneering work was carried out by men working on their own without the backing of research institutions and usually with limited resources and assistance, or, where the inventors were employed in institutions, these institutions, as in the case of universities, are such a kind that individuals were autonomous, free to follow their own ideas without hindrances. Under this latter group the authors mention air-conditioning, automatic transmissions, bakelite, ball-point pen, catalytic cracking of petroleum, cellophane, chromium plating, cinerama, cotton picker, cyclotron, domestic gas refrigeration, electric precipitation, electron microscope, gyro-compass, hardening of liquid fats, helicopter, insulin, jet engine, kodachrome, magnetic recording, penicillin, 'polaroid' hand camera, power steering, quick freezing, radio, safety razor, self-winding wrist-watch, streptomycin, sulzer loom, synthetic light polarizer, titanium, xerography, and the zip fastener.

The authors have devoted careful attention to the problem of making things easier for the small inventor. They stress the important role which the patent system can play in affording much-needed protection to the small inventor working on his own. While they also favour a system of direct monetary awards to meritorious inventors, they readily recognize the numerous complications which will have to be faced in introducing any practicable and effective system of awards. Such a system of awards must be broad based to be effective. Apart from awards to a few inventors who may produce outstanding works of genius, a scheme of assistance and encouragement must embrace talented inventors, who may not all be geniuses. Just as a vast amount of money and resources are invested in the organized sector of research, a liberal amount should be set apart for promoting and helping the efforts of the small inventor; this in spite of the genuine risk that some of the resources would inevitably get into the hands of imposters and mere cranks, and the risk of sinking money in some impractical schemes sponsored by crazy inventors. The authors make a strong plea for creating conditions under which the independent inventor can thrive and prosper, and point out that in this matter, the social attitude towards such inventions should also be reorientated. The independent inventor must not be treated as a

misfit in the modern set up, but given his proper place.

Various other factors affecting modern industrial innovation have been carefully studied, and the comprehensive evidence which the authors have collected throws light upon many questions under discussion today.

A valuable part of the book consists of summaries of case histories of the twentieth century inventions which according to the authors constitute (with certain exceptions such as recent developments in space travel, atomic energy, and the electronic devices employed in 'automation') a representative cross-section of the technical progress of this century. Part II of the book which contains these highly informative and interesting summaries can be said to constitute a book by itself.

To sum up, the book is an admirable study of the causes and consequences of industrial innovation, a subject which has received little systematic attention during the first half of this century. Industrial innovation is one spring, if not the mainspring, of economic progress, and all who are interested in this very important subject will, no doubt, read the book with interest and profit.

R. B. PAI

RECENT ADVANCES IN GELATIN AND GLUE RESEARCH: Proceedings of a Conference Sponsored by the British Gelatin & Glue Research Association. Edited by G. Stainsby (Pergamon Press, London), 1958. Pp. 277. Price 70s.

This monograph is a compilation of the authoritative accounts of the recent progress in the origin, structure, physical and chemical properties of gelatin, and their relation to commercial preparation and uses of gelatin. With the increasing attention given in recent times to collagen and gelatin, this volume will be warmly welcomed by researchers in this field.

The general editor has achieved a considerable measure of success in editing and compiling the papers covering a wide range of topics presented at the International Conference at Cambridge in 1957 under five sessions.

The volume opens with the Conference Lecture by Pauling on the recent progress on the origin and structure of collagen.

The problems connected with the structure, genesis and properties of connective tissue have been critically analysed and introduced by Gustavson in Session I. The stability of its structure is attributed to hydrogen bonding (Burge *et al.*) and to the aldehydes present (Landucci *et al.*). The mechanical properties and macro-structure of collagen have been discussed by Harkness. Robb-Smith has clarified the position of reticulin as a member of the collagen family. The biogenesis of collagen has been reviewed by Jackson who favours Schwann-Virchow hypothesis. Ramachandran, from his novel X-ray data, has suggested the formation of collagen from an elastin-like substance; this demands further evidence according to Jackson and Smith.

Session II deals with soluble collagens, shape, structure and molecular weights of gelatin with an introduction by Pouradier. Bowes *et al.* have shown that alkaline extracts of skins contain two or more non-collagenous proteins as well as an acidic polysaccharide.

The products obtained by controlled degradation have been reported by Gallop *et al.*, and Astrup *et al.* have suggested that acid-soluble ichthyocol is the initial step in the degradation of collagen to gelatin. Courts and Stainsby have presented evidence for multi-chain gelatin molecules by measuring their average chain lengths and molecular weights. Doty and Nishihara have determined the molecular weights of soluble collagen by different methods and refinements in these calculations have been suggested by Williams.

A part of this session relates to synthetic polypeptides. The structural aspects of polypeptides have been well summarized by Bamford. The physical and chemical properties of poly L-proline have been compared with those of collagen and gelatin by Blout. Kurtz *et al.* describe the synthesis of poly L-hydroxy-proline and copolymers of proline and hydroxy-proline that exhibit gelatin-like properties.

Ward introduces in Session III the problems connected with the conversion of collagen to gelatin. The possible types of pre-treatment and extraction and the factors such as species, age and type of tissues that give rise to the differences in the conversion of collagen into gelatin and in the products formed have been adequately discussed by Fysh and Kuntzel *et al.* The differences in the behaviour of acid and alkali processes gelatin have been well brought out in the paper of Veis *et al.* In modifying and converting collagen into gelatin, shortening of chains and breakdown of inter-chain linkages by heat or hydrogen bond breakers have been put forward by Courts, whereas Seifter *et al.* find that collagenase produces a number of unstable fragments with helical configuration that undergo thermal unfolding.

Bailey has summarized the recent developments on the use of ion-exchange resins. Eastol, Lench and Watson, comparing the recent results of amino acid composition for vertebrate and invertebrate collagen, have shown that chemical properties of collagen are not necessarily related to physical properties like shrinkage temperature.

The chemical and physical properties of gelatin have been discussed in Session IV with an excellent introduction by Ferry. The N- and C-terminal amino acids contents suggest the hydrolysis of peptide bonds during thermal conversion of collagen to gelatin (Heyns). Gelatin rigidities and melting points were shown to be not markedly affected by difference in *p*H, molecular weight (Ward) whereas James has shown that this property is affected by guanidino content. The molecular processes involved in pre-gelation studying birefringence, the viscosity and elasticity of gelatins with the use of ultrasonics have been discussed by Bourgina and Pryor *et al.* respectively. Kenchington has described the chemically modified cross-linked gelatin.

The relation between the properties of gelatin and its industrial use has been presented by Blake in an introduction to Session V. The contribution of guanidino chain to the protective colloidal action (Davis), the influence of impurities on gelatin in providing a diverse phase for oil/water emulsions (Kragh), and the polarographic method for the determination of the polypeptide impurity (Maren) have been discussed. The differences observed in the hardening of gelatin solution (Pouradier), monolayers (Tachibana *et al.*) by various tanning agents have been reported. Tourtellotte has discussed the chemical modification of gelatin for improved physiological functions.

The volume is concluded with a selection of contributions to the discussions on the various papers presented at the conference.

Y. NAYUDAMMA

SOME CATALYTIC GAS REACTIONS OF INDUSTRIAL IMPORTANCE by J. C. Ghosh, S. K. Bhattacharya & M. V. C. Sastri (M.S. University of Baroda, Baroda), 1958. Pp. xi + 356. Price Rs 13.50

This book is an outcome of a series of lectures delivered by Dr J. C. Ghosh at the University of Baroda under the Maharaja Sayyaji Rao Gaekwad Honorarium Lecture Series during 1948-49.

The book is divided into seven chapters. The first chapter deals with the fundamentals of adsorption and catalysis and incorporates some of the latest developments in the subject. The section on mixture adsorption by catalysts is particularly interesting. The second chapter gives an account of the synthesis of ammonia. A special feature of the chapter is a fairly detailed description of the processes followed at Sindri and at Travancore for the manufacture of ammonium sulphate. This information is not easily available. The third chapter on the synthesis of urea is important in view of its manufacture at Sindri. Chapter IV describes the synthesis of oil from coal by the Fischer-Tropsch and related processes. The Koppers-Totzek and the Lurgi gasification processes for the production of synthesis gas are exhaustively dealt with. Chapter V is a good review on the hydrogenation of coal and tar to oil. Chapter VI deals with the synthesis of methanol. The section on the differential thermal analysis of catalysts used in its preparation is quite interesting. The last chapter reviews the synthesis of higher alcohols.

There are a few mistakes in the book which may be rectified when it is revised. In the first chapter, in the section on multi-layer theory, credit has been given to Brunauer, Deming, Deming and Teller for the development of the theory. Actually, it was put forward by Brunauer, Emmett and Teller and extended by the above-mentioned authors.

While discussing the mechanism of the Fischer-Tropsch and Oxo processes in Chapter IV, no mention is made of the hydrocarbonyl concept proposed and still held by the U.S. Bureau of Mines workers.

The book is interesting and informative, and it should be welcomed not only by the research worker, but also by those engaged in industry. It should be a useful addition to all technical libraries.

A. KINI

SURFACE ACTIVE AGENTS AND DETERGENTS: Vol. II, by Anthony M. Schwartz, James W. Perry & Julian Berch (Interscience Publishers Inc., New York), 1958. Pp. xv + 839. Price $ 17.50

Schwartz and Perry's *Surface Active Agents: Their Chemistry and Technology* appeared in 1949 and was at the time the only book which gave a comprehensive account of the synthesis, manufacturing practices, physical chemistry and practical applications of surface active agents. Although other books on surface activity and surface active agents have appeared in the interval, Schwartz-Perry has continued to be the standard book on the subject. The physical chemistry of surface active agents, however, has been treated more fully and fundamentally in Moilliet and Collie's *Surface Activity* and in books on surface chemistry and physics. The modification of the title to *Surface Active Agents and Detergents* seems unnecessary since detergents are surely included in surface active agents. The book under review is a supplement to the earlier volume on surface activity and is mainly devoted to a coverage of developments during the period 1947-56. This arrangement obviously has both advantages and disadvantages. By excluding the material contained in the 1949 edition, which covered the literature up to 1947, space has been conserved and it has been possible to deal in great detail with the patents and publications of 1947-56. On the other hand, it has

made Vol. II somewhat difficult to read, and it is unsatisfactory for obtaining a clear and balanced picture of any aspect of the wide field of surface activity. Part IV on 'Practical Applications of Surfactants' might well have been shortened considerably and the parts dealing with the basic organic and physical chemistry of surfactants expanded. Little knowledge of real value is to be obtained by making a long list of practical applications of surfactants. A textile, cosmetic, paint or other technologist who has to choose a surface active agent suitable for a certain process or project will not get material assistance from reading the short section which deals, unavoidably, in a superficial manner with his particular branch of technology. Apart from these minor points of criticism, the book represents a most diligent and scholarly effort to survey recent progress on surfactants and is a necessary addition to every library concerned with chemical technology.

Following an introduction, which gives an all-too-brief account of general considerations, the book is divided into four parts: Part I — Processes for Synthesizing and Manufacturing Surfactants; Part II — Special Function Surfactants and Compositions; Part III — The Physical and Colloidal Chemistry of Surfactants in Theory and Practice; and Part IV — Practical Applications of Surfactants. The volume is a complete and dependable source of reference since practically no book, paper or patent on the subject of surface active agents appearing during the last ten years has been omitted.

K.V.

PROGRESS IN CRYSTAL PHYSICS: Vol. I — THERMAL, ELASTIC AND OPTICAL PROPERTIES by R. S. Krishnan (S. Viswanathan & Co., Madras), 1958. Pp. vi + 198. Price Rs 20.00 or 30*s*.

This monograph deals with thermal expansion, thermal conductivity, elastic constants, photoelastic effect and thermo-optic behaviour of crystals, Faraday effect in diamagnetic crystals and dielectric properties of ionic crystals.

In each chapter first the progress made in the theory of the particular property of the crystal and also in the technique used for experimental investigation has been summarized and the data available in the literature have been tabulated. Bibliography of the papers from which these data have been compiled has also been included at the end of each chapter. In the first chapter on thermal expansion emphasis has been laid on the variation of Gruneisen constant with temperature. In the chapter on thermal conductivity discussions on the temperature variation of thermal conductivity have been included. The data tabulated in this chapter include the ratios of thermal conductivities of a large number of crystals along different axes. The chapter on elastic constants includes a mathematical résumé and the constants required for the 32 classes of crystals have been tabulated. The experimental methods have also been summarized. In the chapter on photoelastic effect in crystals, the theoretical discussions are more exhaustive. An outline of Mueller's theory of photoelasticity has been included and tables showing particular constants required for the 32 classes of crystals have been given.

In the discussions on the effect of temperature on the dispersion of crystals, an expression for the temperature coefficient of refractive index has been deduced following Ramachandran and Radhakrishnan. Data for temperature variation of a large number of crystals have been tabulated in detail.

The chapter on Faraday effect in diamagnetic crystals deals with theoretical discussions on variation of magneto-optic rotation with wavelength and temperature, and with Faraday effect in crystals. Values of Verdet's constants and anomaly factor have been given for a large number of crystals. In the last chapter a résumé of the theory of dielectric constant of ionic crystals has been given and the values of dielectric constant, temperature coefficient of dielectric constant and low frequency dielectric loss have been tabulated for a few inorganic crystals.

It appears from the list of references that in each of these branches of crystal physics valuable contributions have been made by the author and his colleagues at the Indian Institute of Science, Bangalore. It also appears from the contents that the different chapters have been written by different sets of writers chosen from the workers at Bangalore, although in the text itself no mention has been made of these names below the titles of the chapters. It has, therefore, been possible to include in the monograph a masterly review of the work done in the different branches of crystal physics. Such a review will serve as a source of inspiration and will be extremely useful not only to workers in these lines but also to those workers in other lines who may be in need of the data reported in this monograph. The price of the volume may appear to be a little high but if the high cost of paper and printing be taken into consideration, the price is moderate.

S. C. SARKAR

NUCLEAR RADIATION IN FOOD & AGRICULTURE by W. Ralph Singleton (D. Van Nostrand Co. Inc., Toronto, New York, London), 1958. Pp. xii + 379. Price 64*s*.

This book is based on material presented before the International Conference on Peaceful Uses of Atomic

Energy held in Geneva in 1955, reports of which were published in sixteen volumes in 1956. It consists of eight parts dealing with the uses of radio-isotopes in agriculture; studies on photosynthesis; plant physiology, pathology and cytology; soils and fertilizers; genetic and biological hazards of nuclear radiation; genetic eradication of insect pests; crop improvement and food sterilization. A careful selection of topics out of a very large number of papers has made it a very useful publication. The presentation of complicated subjects has been very lucid and easy. Since the book is on a rapidly progressing science, the material presented three years back does not satisfy a specialist, who is anxious to know the latest developments. A scientist interested in this field certainly gets a very clear impression of the ideas upon which recent developments are based. This book can be recommended for students and research workers.

R. V. TAMHANE

THE INDIAN EPHEMERIS AND NAUTICAL ALMANAC FOR THE YEAR 1959 (India Meteorological Department, Ministry of Transport & Communications, Government of India, New Delhi), 1958. Pp. xxiv + 404. Price Rs 12.00

This is the second year of publication of this annual and it has appeared somewhat later than last year. The volume shows that efforts have been taken to take note of the criticisms made of the first volume and data have been presented in a more easily utilizable manner by our almanac makers. The calendar part includes, under the column 'Phenomena', the movements of Jupiter and Saturn which were not indicated in the first number. A change, which people in the southern part of the country may not accept, is the transit of the sun. What was *Mesadi* in 1958 becomes *Vaisakhadi* in the 1959 version. An addition is the movement of the moon in the different *rasis* indicated at the bottom of the calendar. The principal festivals section does not seem to have any place for either the Tamil New Year's Day or the Telugu New Year's Day. The dates for Ayudha Puja also differ from the dates accepted by the Madras Government. The data provided in the volume conform to the latter version and the almanac is incorrect. The current volume is better bound than the first volume.

S. V. ANANTAKRISHNAN

INDIGENOUS DRUGS OF INDIA by R. N. Chopra, I. C. Chopra, K. L. Handa & L. D. Kapur (U. N. Dhur & Sons Private Ltd, Calcutta), Second Edition, 1958. Pp. xxxii + 816. Price Rs 50.00 or 105*s*.

The first author of this book requires no introduction. He is well known for his extensive and long-standing work in the field of indigenous drugs. The present book will be warmly received by those interested in this field. The authors have taken into account the chemical and pharmacological data and have successfully integrated the same with the clinical and commercial aspects. It is interesting to note that the workers in this field are often likely to overlook the utilitarian value of indigenous drugs which the first author has constantly emphasized throughout his career. A certain overlapping in the data included in the various books the first author has published so far is inevitable. However, in certain details, this book should have completely included the previous works of the same author. The status of the first author, the size of the present book and the labours involved in its preparation are likely to tempt the reader to consult it as a reference guide. Such a reference guide, however, has to be complete.

The economic structure of India has considerably changed since the Second World War. It would have been very much instructive to learn the figures of production, export and import of various drugs during the post-war period.

The pressure from the extra-medical fields for conducting research on indigenous drugs has been continuously increasing in the last ten years. On the other hand, the advent of several specific synthetic drugs has apparently challenged their importance. The publication of the present work will certainly help to clarify this conflicting position.

R. B. AURORA

Publications Received

GENERAL AND INORGANIC CHEMISTRY FOR UNIVERSITY STUDENTS by J. R. Partington (Macmillan & Co. Ltd, London), Third Edition, 1958. Pp. xxiii + 927. Price 60*s*. net

NOMOGRAMS FOR CHEMICAL ENGINEERS by O. P. Kharbanda (Heywood & Co. Ltd, London), 1958. Pp. xii + 247 (103 illustrations). Price 80*s*. net

SCIENTIFIC ENCYCLOPEDIA (D. Van Nostrand Co. Inc., Toronto, New York, London), Third Edition, 1958. Pp. 1839 including 1400 illustrations and 12 colour plates. Price £ 11

THERMODYNAMICS by Virgil Moring Faires (The Macmillan Co., New York), Third Edition, 1957. Pp. xxi + 543. Price $ 7.50

STATISTICAL PHYSICS: Vol. 5 of Course of Theoretical Physics by L. D. Landau & E. M. Lifshitz (Pergamon Press Ltd, London, New York, Paris, Los Angeles), 1958. Pp. x + 484. Price 80*s*. net

MANAGEMENT — PRINCIPLES AND PRACTICES by Dalton E. McFarland (The Macmillan Co., New York), 1958. Pp. x + 612. Price $ 6.95

SURVEYS OF INDIAN INDUSTRIES: Vol. II, by B. S. Rao (Oxford University Press, Bombay), 1958. Price Rs 20.00

INTERNATIONAL GUIDE TO EUROPEAN SOURCES OF TECHNICAL INFORMATION. Edited by Gerard A. Dreyfus (European Productivity Agency of the Organization for European Economic Co-operation, Paris), 1957. Pp. 439. Price 16*s*.; $ 2.50; 800 Fr.

THE WORK OF WHO — 1957: Annual Report of the Director-General to the World Health Assembly and to the United Nations (World Health Organization, Geneva), 1958. Pp. vii + 183. Price 6*s*. 9*d*.; $ 1.25; Sw. Fr. 4

TECHNICAL DRAWING by Frederick E. Giesecke, Alva Mitchell & Henry Cecil Spencer (The Macmillan Co., New York), Fourth Edition, 1958. Pp. vii + 844. Price $ 10.00

THE FIRST TEN YEARS OF THE WORLD HEALTH ORGANIZATION (World Health Organization, Geneva), 1958. Pp. vii + 538

FOUR-AXES UNIVERSAL STAGE by P. R. J. Naidu (published by the author, University of Madras), 1958. Pp. x + 106

TRANSISTOR TECHNOLOGY: Vol. I — Bell Laboratories Series. Edited by H. E. Bridgers, J. H. Scaff & J. N. Shive (D. Van Nostrand Co. Inc., Toronto, New York, London), 1958. Pp. xxxvii + 661. Price 131*s*. 6*d*.

TRANSISTOR TECHNOLOGY: Vol. 2 — Bell Laboratories Series. Edited by F. J. Biondi (D. Van Nostrand Co. Inc., Toronto, New York, London), 1958. Pp. xiii + 701. Price 131*s*. 6*d*.

PHYSICAL ACOUSTICS AND THE PROPERTIES OF SOLIDS — Bell Laboratories Series by Warren P. Mason (D. Van Nostrand Co. Inc., Toronto, New York, London), 1958. Pp. xii + 402. Price 67*s*. 6*d*.

NUCLEAR REACTOR METALLURGY by Walter D. Wilkinson & William F. Murphy (D. Van Nostrand Co. Inc., Toronto, New York, London), 1958. Pp. ix + 382. Price 42*s*.

AVIATION MEDICINE — SELECTED REVIEWS, Agardograph 25. Edited by Clayton S. White, W. Randolph Lovelace II & Frederic G. Hirsch (Pergamon Press Ltd, London), 1958. Pp. vii + 305. Price 70*s*. net

PERKIN CENTENARY, LONDON — 100 YEARS OF SYNTHETIC DYESTUFFS (Pergamon Press Ltd, London), 1958. Pp. xii + 136. Price 42*s*. net

SOME PROBLEMS OF CHEMICAL KINETICS AND REACTIVITY: Vol. I, by N. N. Semenov (Pergamon Press Ltd, London), 1958. Pp. x + 305. Price 50*s*. net

MATHEMATICS FOR ENGINEERS — Part II, by W. N. Rose (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), Fifth Revised Edition, 1958. Pp. xii + 403. Price 25*s*. net

GAS TURBINES FOR AIRCRAFT by Arthur W. Judge (Chapman & Hall Ltd, London; *Distributors in India:* Asia Publishing House, Bombay), 1958. Pp. vii + 439. Price 60*s*. net

ACCELERATORS OF IONS AND ELECTRONS by Gestmir Simane (Constable & Co. Ltd, London), 1958. Pp. 191. Price 16*s*. net

INTRODUCTION TO THE THEORETICAL AND EXPERIMENTAL ANALYSIS OF STRESS AND STRAIN — McGraw-Hill Series in Mechanical Engineering, by A. J. Durelli, E. A. Phillips & C. H. Tsao (McGraw-Hill Book Co. Inc., New York, Toronto, London), 1958. Pp. xxx + 498. Price $ 12.50

REFLEX KLYSTRONS by J. J. Hamilton (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), 1958. Pp. xi + 260. Price 45*s*. net

VAPOUR-LIQUID EQUILIBRIUM by Eduard Hala, Jiri Pick, Vojtech Fried & Otakar Vilim (Pergamon Press Ltd, London), 1958. Pp. xviii + 402. Price 90*s*. net

AIR INTAKE PROBLEMS IN SUPERSONIC PROPULSION, Agardograph 27. Editor: J. Fabri (Pergamon Press Ltd, London), 1958. Pp. xx + 82. Price 30*s*. net

THE PROCEEDINGS OF THE THIRD SYMPOSIUM ON COSMICAL GAS DYNAMICS — Symposium Series, Symposium No. 8. Edited by J. M. Burgers & R. N. Thomas (Smithsonian Symposium Publication No. 1, International Union of Theoretical & Applied Mechanics & International Astronomical Union), 1957. Pp. 905-1108

THEORETICAL PRINCIPLES OF ORGANIC CHEMISTRY: Vol. II, by Walter Huckel (Elsevier Publishing Co., Amsterdam, London, New York, Princeton; *Distributors*: D. Van Nostrand Co. Inc., London), 1958. Pp. xi + 1046

NOTES & NEWS

Bacterial and Viral Infections

A SYMPOSIUM ON CHEMOTHERAPY in Bacterial and Viral Infections, organized by the Central Drug Research Institute, Lucknow, was held at the Institute during 2-4 November 1958. More than 40 delegates from different parts of the country attended the symposium. Forty-four papers including a paper each from England, Czechoslovakia and Indonesia were presented for discussion in four technical sessions.

During the first session twenty-seven papers, on the chemotherapy in bacterial infections, discussed subjects like molecular configuration of anti-tubercular and anti-mycobacterial agents, electronic status of the potential reactive centres in such molecules and the inter-atomic distances that provide a working hypothesis for chemotherapeutic investigations. The importance of the multi-enzyme attack method in the chemotherapeutic investigations as against the traditional device of an anti-metabolite against a single enzyme or its substrate was emphasized. The problems of T.B., leprosy, cholera and dysentery from chemotherapeutic angles were discussed right from the enzymatic pathways in the causative organism to the synthesis of different types of compounds and their testing. Excellent results have been obtained with cortisone therapy in pulmonary tuberculosis and extra-pulmonary tuberculosis under adequate antibiotic cover in critically ill patients, clinically resistant cases, endobronchial tuberculosis, laryngeal tuberculosis, tubercular meningitis, and in one case which was bacteriophagically resistant to drugs. The results of clinical trials on the role of synthetic drugs like *p* - ethylamino - *p'* - aminodiphenyl sulphone (S.N. 44) and *p*-methylamino-*p'*-aminodiphenylsulphoxide (S.N. 87) in the treatment of leprosy, presented in two papers, show that S.N. 87 is superior to 4 : 4-diaminodiphenyl sulphone (DDS) or S.N. 44 and side reactions are fewer with sulphoxide S.N. 87. The antibiotic neomycin has been studied for its vibriocidal activity against cholera and its effect on experimental cholera in the infant rabbit. The results show that in casein hydrolysate medium neomycin is vibriocidal in a concentration of 2 μg./ml. and a population count of 10^6 vibrios/ml. The antibiotic was reported to prevent the death of infant rabbits suffering from experimental cholera if it is given fairly early and its use in cases of clinical cholera was suggested. Methods for determining the sulphonamide resistance of beta-haemolytic streptococci *in vitro* were also discussed.

The importance of folic acid in inhibiting bacteriophage; role of ribonucleotides, specially yeast adenylic acid (YAA), in Ranikhet disease virus; and the utility of average survival rate and viral titration methods, in assessing the chemotherapeutic activity, were discussed in five papers during the second session. Studies on the effect of various ribonucleotides on the chick embryo strain of Ranikhet disease virus have revealed that yeast adenylic acid has a marked effect on the virulence of the virus both *in vivo* and *in vitro*. Other nucleotides such as uridylic acid, cytidylic acid, guanylic acid, muscle adenylic acid and adenosine diphosphate do not have a similar effect on the virus.

The third session was concerned with the technique of testing compounds in filariasis, the role of hetrazan in filariasis, the mechanism of action of nucleotoxic agents in malignant diseases and recent trends of research in antimalarials. It was observed that chloroquin behaves like other drugs containing quinoline group and at the same time inhibits DNA synthesis *in vitro*, which the nuclei of the mature schizonts and merozoites contain in much excess than RNA which is in excess in the gametocytes. This two-way action of chloroquin may be responsible for its superiority over quinine. Desoxy hexahydroquinine, a modified form of cinchona alkaloid, and its effect as an amoebicidal agent in rats were discussed in detail. The metabolism of *L. donovani* and the sensitivity of yeast-like fungi to standard drugs were elaborated.

The papers presented at the concluding session discussed miscellaneous chemotherapeutic agents. Piperazine was considered as the drug of choice in the treatment of ascariasis. The isolation of two antibacterial substances, X340 and X1285, from soil micro-organisms and their properties were reported. The former is presumed to be a new member of the tetracyclin family of antibiotics. This antibiotic, in contrast to other well-established tetracyclines, has poor solubility in water. The antibiotic X1285 has been found to be a promising amoebicidal compound even in its present crude form. When administered orally this antibiotic has been found to be free from toxic symptoms in intestinal amoebiasis of rats.

Theoretical and Applied Mechanics Congress

THE FOURTH CONGRESS ON THEORETICAL and Applied Mechanics was held at the Bengal Engineering College, Howrah, from 28 to 31 December 1958, under the Presidentship of Dr S. R. Sen Gupta, Director, Indian Institute of Technology, Kharagpur. About 250 scientists and engineers from several countries, viz. Australia, Burma, Czechoslovakia, Egypt, Hungary, Italy, Japan, Poland, U.S.A. and the U.S.S.R., besides those from India, participated in the deliberations of the Congress. Forty papers were read at the Congress. The subjects dealt with included: Finite deformation; Visco-elasticity; Stress waves; Stresses in strips; Columns and discs; Plasticity; Elasto-porous problems; Vibration and stability, Fluid flow; Ballistics; and Statistics.

In his presidential address, Dr S. R. Sen Gupta stressed the importance of experimental methods in the solution of engineering problems. He considered in detail the causes of cracking of some capitals of stone columns in the Arts Faculty Building of the Osmania University, Hyderabad.

Half-hour addresses on propagation of elastic waves across conti-

nents and oceans; propagation of a cylindrical shock wave produced by the instantaneous release of energy from an infinite wire into the surrounding medium; and on molecular aspects of gas flow were delivered. Two popular lectures, one on 'The present concept of the universe' and the other on 'Mechanics and the engineer', were arranged during the Congress.

Some important lines of research considered at the Congress and a few of the conclusions arrived at are briefly described below.

Bending of a non-homogeneous transversely isotropic plate, taking finite strains into account, and the stresses due to nucleus of thermo-elastic strain in an infinite solid in the presence of rigid spherical inclusion were discussed. A solution was presented for the mixed boundary value problem for a thin elastic plate with a triangular hole. A semigraphical method was described for determining the influence diagrams in loaded plates. Studies on experimental stress analysis by reinforced concrete deep beams have indicated the difference in stress distribution and reinforcements of deep beam from those of a simple beam. Experimental investigation into the strength of concrete under combined stresses has confirmed the basis of failure criteria developed theoretically. The critical value of Bingham number for rotatory flow of visco-plastic material determined were discussed and a method was described for the design of portal frame with heavy axial load by the plastic wall.

Approximate solutions to the characteristics of the slip flow regime in fluid flows were reported. An electrical analogy to the problem of volute siphons was presented. The flow of a rotating fluid past a sphere in a large cylindrical pipe was investigated by considering an initial value problem; this has confirmed the experimental result that the waves ultimately are propagated only in the downstream side. The problem of an infinite plane lamina started from rest with acceleration and the flow of a visco-elastic liquid near a stagnation point were considered. The velocity defect law for turbulent boundary layer flow over smooth surfaces was shown to hold also for rough surfaces. The results of studies on the compressibility effects in inviscous curved flows and the energy losses in pipeline due to Globe values in series were reported.

The burning condition inside an H/L gun before nozzle operation, some aspects of microseismic waves associated with cyclones, and longitudinal vibration under damping were discussed. Information collected on crankshaft failures encountered by internal combustion engine users was presented and the effect of inlet pipe on the volumetric efficiency of a four-stroke single cylinder internal combustion engine was evaluated. The accuracy of the saddle point method of integration to cosmic ray shower problems was shown to be more than 90 per cent. Several methods were discussed for the computation of propagation of tides in rivers. The application of coincidence principle in the design of electronic tachometers was demonstrated.

Convention of Telecommunication Engineers

THE SECOND TECHNICAL CONVENTION of the Institution of Telecommunication Engineers, New Delhi, was held on 27 and 28 December 1958 at the Indian Standards Institution. Practising engineers, research scientists drawn from various research centres, universities, national laboratories, engineering institutions and services research organizations participated in the Convention. Twenty technical papers, covering transmission, propagation and reception of radio waves; mathematical and physical theory and their application to the design of communication equipment; ionospheric and radio physics studies; electronic circuitry (including transistorized ones); measurements of sound absorption, etc., were presented and discussed at the Convention.

Two papers, one on a transistorized rural community receiver (for use in India) and its performance, and another on the tropicalization of communication equipment in India, are of special interest. The former attempts to evaluate the most economic design of a transistorized receiver by balancing the capital cost and the complexity of design and operation against the certain advantages, viz. negligible heating up, low operating and maintenance costs and reliable performance of transistorized circuitry. The latter paper brings out the significance of climatic and durability tests for electronic components and equipment and the importance of safety considerations in designing electronic equipment meant for use in the tropics; it also gives the national and international standards laid down for such tests.

A method for tuning a magnetron by means of a variable permeability ferrite has been proposed in another paper. In this method, instead of the usual mechanically tuned shorting plunger, a ferrite material is placed near the shorted end of the line where the r.f. magnetic field is strong. Tuning is effected by controlling the effective permeability of the ferrite by means of modulating the current through a magnetizing coil. Absence of sliding contacts and other mechanically moving parts is a distinct advantage of the method. Among other specialized instruments reported is a new high resolution two-antenna interferometer for the study of bright radio spots and bursts in the sun on 3·2 cm. waves. The instrument enables exploration of the different regions of the Fourier spectra of the angular brightness distribution without having the necessity of displacing the antennas. The arrangement, enabling the instrument to be utilized for both parallel and crossed polarizations makes it particularly suitable for the study of brightness distribution of the polarized and unpolarized sources on the sun. Another interesting device described is an electronic speech sampler for articular measurements which can accurately determine, in position and duration, the segments of vowels, semi-vowels and consonants from nonsense CVC words for articulation measurements.

Other papers presented and discussed were: (1) Application of Boolean algebra to the logical design of switching circuits, (2) Investigation on radiation from the disturbed sun at 100 Mc/s., (3) Absorption of sound under water by wedges, (4) Wooden panel absorbents for low frequency sound absorbents, (5) Root-locus approach to the design of feedback control systems, and (6) Theory of of tapered dielectric rod aerials.

New methods for production of labelled compounds

THE INCREASING DEMAND FOR molecules which cannot be readily labelled by the usual methods, viz. biosynthesis, chemical synthesis and chemical exchange, has led to the development of two new methods — recoil labelling and radiation-induced labelling. These methods often involve a form of isotopic exchange which are different from other chemical changes in that they do not rely on thermal energy (and catalysts) to activate the exchange process. Instead they give an excess of energy to an individual atom by nuclear recoil or radiation process, and allow this energy to accomplish labelling. The labelling of an organic compound by these methods is comparatively simple and easy, and does not require very elaborate equipment.

Nuclear recoil method — Nuclear reactions produce atoms which possess much greater than thermal energies in the form of ionization, electronic excitation, and/or high kinetic energy. This extra energy allows a freshly produced radioactive atom to undergo comparatively unusual chemical reactions ('hot-atom reactions') with organic compounds. An important fraction of these energetic chemical reactions lead to isotopically labelled molecules which are either chemically identical with, or closely related to, the surrounding organic molecules. In this form radioactive molecules are obtained merely by permitting the radioactive recoil atoms to lose their energy and come to rest in the presence of the desired pure compound.

Useful nuclear reactions for recoil labelling must form a desirable isotope with a good cross-section. The most important reactions are shown in Table 1. The tritium atoms from each reaction have high kinetic energies and long ranges, even in condensed phases — H^3 from Li^6 recoils through a distance of 40 μ in solid organic molecules. This long recoil range allows irradiations to be carried out in a thermal neutron flux under a variety of experimental arrangements. The lithium compound used as H^3 source and the organic compound to be labelled must be completely mixed, but need not be homogeneous. The H^3 recoils will thoroughly penetrate the organic fraction in crude powdered mixtures, stopping proportionally in each phase. Irradiations can also be carried out with slurries, gels, and with liquid and solid solutions. Natural lithium (7·5 per cent Li^6) compounds are always used — the radiation damage effects are such that enriched Li^6 compounds offer no improvement in yields or specific activities[3]. Tritium from He^3 is very convenient and useful for irradiations in the gaseous phase.

TABLE 1 — NUCLEAR REACTIONS FOR RECOIL LABELLING

REACTION	NEUTRON CROSS-SECTION *barns*	RECOIL ENERGY *keV.*
$Li^6(n, \alpha)H^3$	945·0	2740
$He^3(n, p)H^3$	5400·0	190
$N^{14}(n, p)C^{14}$	1·8	40

Approximately 10-50 per cent of the H^3 atoms stopped in an organic compound will react to produce a labelled form of the compound. These tritium incorporations will take place in all of the H-positions of the molecule, including the normally non-labile C-H positions. Some of the remaining H^3 atoms will be found in molecules similar to the organic parent compound, while a large percentage will be found as simple molecules such as hydrogen and methane. The higher charge and mass of the recoiling C^{14} atom, as well as the lower recoil energy, result in a much shorter range. A negligible percentage will escape into another phase in a mixed powder; normally C^{14} recoil labelling is limited to homogeneous, nitrogenous mixtures — either pure molecules or solutions. The C^{14} recoils will combine with the parent molecule in two important ways: (a) substitution to replace one of the ordinary carbon atoms without other detectable change in the molecule, and (b) addition to form a close relative of the parent molecule. Approximately 0·1-10 per cent of the recoil atoms may follow each of these two reactions in specific cases; the remaining C^{14} atoms will be found in other derivatives, degradation products, and polymer from the parent molecule.

The specific activities which may be obtained in a given molecule by nuclear recoil labelling are limited by the general radiation destruction of the compounds in an irradiated mixture, as well as by the nuclear reaction cross-sections, half-lives, and percentage incorporation into a particular molecule.

By this procedure highly radiation-resistant molecules such as benzoic acid have been labelled with H^3 activities as high as 5×10^6 disintegrations per minute per milligram (DPM/mg.), while activities of 2×10^5 DPM/mg. have easily been obtained for glucose, reserpine, cholestane, etc.

Radiation labelling — Labelled organic molecules can be obtained by exposure to some form of ionizing radiation of a mixture of an organic compound and one containing the radioactive isotope. Tritium-labelled molecules have been successfully produced by supplying radiation in the form of electric discharge, external Co^{60} source[9], and self-irradiation with highly radioactive pure tritium gas. The radiation causes the ionization of the organic molecules, and the subsequent reactions of excited ions with the radioactive source compound produce a labelled form of the original molecule. Some of these reactions also lead to radioactive products which are close relatives of the original molecule. Since the labelling procedure depends primarily on the reaction between the organic ions and the tritium molecules, an intimate mixture is necessary. The best results with self-irradiated tritium-organic mixtures are obtained with high tritium pressures and large exposed surface areas for liquid or solid organic compounds. Mixtures of several curies of tritium with a gram of organic material for several days have produced specific activities of 10^7 to 2×10^8 DPM/mg. in molecules such as toluene, cholesterol, digitoxin, lysozyme and ribonuclease.

The most important experimental problem in all these methods is the purification of the labelled compound following irradiation. Multi-step physico-chemical purifications yield products of radiochemical purity. When a reliable and simple scheme of purification is available, these labelling

methods are easier to perform than all but the simplest chemical and biological synthesis. The most serious limitation of these new methods is, however, the non-specific and non-uniform nature of the labelling process; but as the important applications of labelled compounds obtained by these methods are in tracer experiments in which the molecule remains intact throughout, the location and distribution of radioactivity within the molecule is of minor importance [*New methods for the production of radioisotope labelled compounds*, F.S. Rowland, Second United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958].

A new synthesis of aldehydes

A NEW CONVENIENT SYNTHESIS OF aldehydes, which is claimed to provide a valuable new preparative route from the carboxylic acids to the corresponding aldehydes, is reported. The synthesis consists in the reduction of acid chlorides by addition of lithium tri-*t*-butoxyaluminohydride in diglyme solution at −78°. The procedure has been used successfully in cases of 30 representative acid chlorides exhibiting widely varying structural characteristics. Aromatic acid chlorides containing substituents in the *meta* and *para* positions form aldehydes in yields of 60-90 per cent. Many types of substituents can be tolerated, including those which might be considered sensitive to reduction, such as nitro, cyano and carbethoxy.

An example of the new method of synthesis is provided by the formation of *p*-nitrobenzaldehyde from *p*-nitrobenzoyl chloride. *p*-Nitrobenzoyl chloride (0·200 mole, 37·1 g.) was dissolved in 100 ml. of diglyme and placed in a flask fitted with a stirrer, a separatory funnel, low temperature thermometer and nitrogen inlet and outlet. The flask was flushed with dry nitrogen and cooled to approximately −78° by immersion in a cooling bath of solid CO_2 and trichloroethylene. To the stirred flask the reagent, 0·200 mole of lithium tri-*t*-butoxyaluminohydride in sufficient diglyme to make 200 ml. of solution, was added over a period of 1 hr, avoiding any major rise in temperature. The cooling bath was then removed and the flask allowed to warm up to room temperature, over a period of approximately 1 hr. The contents were then poured on to crushed ice. The precipitated aldehyde (with some unreacted product) was filtered, pressed dry, and then extracted several times with 95 per cent ethanol. Distillation of the solvent gave 24·5 g. of crude aldehyde, m.p. 103°-4°, a yield of 81 per cent. Recrystallization from hot water (or aqueous ethanol) gave 20·3 g. of light yellow flakes, m.p. 104°-5°, a yield of 67 per cent [*J. Amer. chem. Soc.*, **80** (1958), 5377].

Synthesis of DNA

SCIENTISTS AT THE SLOAN-KETTERing Institute have announced the synthesis of a substance that has the characteristics of natural DNA (deoxyribonucleic acid). The synthesis was successfully carried out without using any natural DNA or enzymes to help building the living molecule as has been done in previous attempts to synthesize DNA. In this synthesis nucleotides were used as the starting material. The most important problem was the prevention of the separation of the DNA-like molecules as soon as they are formed by the coming together of the nucleotides. This difficulty was overcome by shaking the nucleotides with a solution of 'Ecteola', a substituted cellulose, which has special affinity to DNA but not to nucleotides. As Ecteola removes the DNA-like molecules from the solution more are formed by the nucleotides in order to restore equilibrium. The synthetic DNA molecule could be washed off the surface of the Ecteola with solvents.

The DNA-like substance thus obtained is expected to have an important role in cancer treatment because it interferes with the activity of natural DNA. This inference is based mainly on the finding that artificial DNA inhibits the natural substance's ability to cause heritable changes [*Sci. Newslett.*, **74** (1958), 166].

Anti-cancer antibiotics

AT THE SIXTH ANNUAL ANTIBIOTICS symposium held in Washington a number of new cancer fighting antibiotics were reported.

Actinobolin, derived from a species of *Streptomyces*, shows activity against a wide range of tumours in animals at relatively high doses — around 1000 mg./kg./day. Best results are obtained with young tumours — 24 hr implants — while against well-established tumours the results are not too good. The mechanism of action of the antibiotic seems to be different from other anti-tumour agents like 5-fluorouracil and amethopterin. Mitomycin C, an antibiotic isolated from *Streptomyces caespitosus* by Japanese scientists, has shown promising result in human patients. In ten patients in which the Mitomycin C was given to prevent recurrence of malignancy after the radical surgery, one patient recovered completely while the other nine showed excellent results. Mitomycin C treatment is generally accompanied by leucopenia but the patients recover within three weeks after medication is stopped. Being low in toxicity its use in more tumours like leukemias and choriopithelioma has been suggested.

Streptovitacin A, an antibiotic isolated as one of the components of beer solids from streptomyces fermentation, has shown activity against a wide range of tumours in animals, especially young ones, with best activity against Sarcoma 180. It has also been reported that the difference between an effective dose of Streptovitacin A is small and further the chemical is only a growth inhibitor and not carcinolytic [*Chem. Engng News*, **36** (43) (1958), 19].

A new sterol

A NEW COLOURLESS CRYSTALLINE sterol, physarosterol, has been recently isolated from the slime mould, *Physarum polycephalum*. The sterol has been shown to have an empirical formula $C_{30}H_{50}O_3$ and is an unsaturated, trihydroxy sterol with one of its hydroxyl groups in the 3β-position. The basic skeleton is a cyclopentenophenanthrene nucleus. The sterol has been isolated by separately homogenizing three different batches of tissue (15-20 g. each) in the hydrualic homogenizer with three volumes of 0·007M potassium arsenate buffer (*p*H 7·0). The homogenate is acidified with sulphuric acid and one-third volume of alcohol is added. After addition

of filter aid, the slurry is filtered using vacuum. The yellow filtrate was saturated with sodium chloride, filtered, and continuously extracted with ether until no more pigment was carried over into the solvent. The ether extract was concentrated to 100 ml. at 60°C., made alkaline with 4*N* sodium hydroxide solution and again extracted five times with ether. The colourless ether solution is allowed to evaporate slowly at room temperature when a layer of lipid formed on the top of the solution and crystals deposited on the bottom of the vessel [*Nature, Lond.*, **182** (1958), 1234].

Analysis of nuclear materials — new developments

NEW AND IMPROVED METHODS OF analysis of thorium, beryllium, niobium and tantalum, and uranium in nuclear raw materials developed by and successfully applied over a period of years at the Indian Atomic Energy Establishment, Trombay, are presented in a paper to the Second United Nations International Conference on the Peaceful Uses of Atomic Energy [*New and improved methods of analysis of some nuclear raw materials* by V. T. Athavale *et al.*].

Thorium — Oxalic acid separation of precipitated thorium oxalate from iodates is not quite accurate. An improved procedure has been worked out wherein iodate separation of thorium has been carried out in 40 per cent nitric acid containing oxalic acid sufficient to complex zirconium, titanium and bismuth. Only in presence of large proportions of these interfering elements was a reprecipitation found necessary. Thorium hydroxide formed is finally converted to oxide. The method has been successfully applied to the analysis of monazite sand. Also, using the principle of this method, over 2000 complex minerals and ores with thorium content down to 0·01 per cent have been analysed with accuracy. The method is simpler than the standard method.

Beryllium — In the determination of macro quantities of beryllia in minerals, particularly beryl, associated felspar, quartz, apatite and mica interfere in the procedures of estimation. The method after Schoeller and Powell, in which the major amount of alumina is removed by sodium carbonate fusion and the residual aluminium and iron removed by oxine precipitation, is reproducible but gives a value for BeO always lower by 0·2 per cent as compared to other methods. In samples with high apatite, the method is unreliable. For overcoming this, a rapid volumetric method has been developed which consists in precipitating beryllium as phosphate in presence of EDTA and titrating against standard bismuth perchlorate using diallyl-dithio-carbamido hydrazine as an extraction indicator. In the presence of small amounts of titania in weathered samples of beryls, addition of a little hydrogen peroxide at the time of precipitation obviates error due to the precipitation of titania as phosphate. Further saving in time of analysis is achieved by first fusion of beryl with sodium fluoride followed by fuming with sulphuric acid. The solution is then directly available for the phosphate precipitation and titration.

Another quicker method developed is based on the adsorption of beryllium on a cation-exchange resin, IR 120, from a solution in which all the associated elements are converted to anionic complexes with EDTA at *p*H 3·5 and titanium as peroxy complex with hydrogen peroxide. The adsorbed beryllium is then eluted with hydrochloric acid, precipitated as hydroxide, ignited and weighed as beryllium oxide.

An indirect colorimetric method developed for determining trace amounts of beryllium in alloys and low grade ores is based on the spectrophotometric estimation of the equivalent phosphate as molybdiphosphoric acid. The lowest limit of determination in the final solution is about 70 μg. of beryllium in 20 ml.

Uranium — Extraction of uranium by TBP with a countercurrent column is used for the recovery of uranium from ores, metal wastes, etc. Based on this extraction, a volumetric method has been developed which can be applied to the analysis of uranium in monazite and also in various intermediate products in the manufacture of thorium nitrate and crude uranium salt from it. The range of determination is from 1 mg. to 100 mg. of U_3O_8 and 0·01 per cent of U_3O_8 can be determined in thorium nitrate by taking a 10 g. sample. The small amount of thorium extracted with uranium does not offer any difficulty during the reduction of uranium in a Jone's reductor.

The method is as follows: (i) the sample is brought into solution in the form of nitrates and the acidity adjusted to 2*N*, particular care being taken to see that chlorides are absent; (ii) uranium is extracted with a 5 per cent solution of TBP in kerosene thrice, followed by a couple of washes of the organic phase with 50 per cent ammonium nitrate solution; (iii) the TBP extract is stripped with water (twice) and then with a solution of ammonium carbonate (50 per cent w/v), and the strippings fumed with sulphuric acid; and (iv) uranium is reduced to the quadrivalent state by means of a Jone's reductor and titrated with standard ceric sulphate using ferroin as indicator. For the range 10-100 mg. U_3O_8, 0·02*N* ceric sulphate (1 ml. = 2·806 mg. U_3O_8) is used; and for the range 1-10 mg. U_3O_8, 0·008*N* ceric sulphate (1 ml. = 1·122 mg. U_3O_8) is useful.

In estimating trace amounts of uranium in thorium nitrate, the extraction of thorium is prevented by complexing it with EDTA and uranium is extracted with 5 per cent TBP in kerosene at *p*H 2·5 using calcium nitrate as salting-out agent. After washing the organic phase with saturated ammonium nitrate (*p*H 2·5) the uranium is back extracted with ammonium carbonate and determined fluorimetrically.

Beryllium — new analytical methods

8-HYDROXYQUINALDINE (2-METHYL-OXIDE), which is very similar to oxine in its analytical properties except that it does not form aluminium chelate in acetic acid-acetate nor in ammoniacal solutions, is found useful in volumetric, gravimetric, spectrometric and fluorometric determinations of beryllium. The methods of beryllium estimation with this reagent are simple and fairly sensitive. The precipitate formed is well defined, insoluble, crystalline, easily filtered and washed and thermally stable. The gravimetric factor is very small, 0·02770, and the volumetric factor

is low, 1 ml. of 0·1*N* potassium bromate solution corresponds to 0·1127 mg. of beryllium so that a few milligrams of beryllium can be determined, both gravimetrically and volumetrically with accuracy.

Gravimetric determination — To a solution containing 2-10 mg. of beryllium, 5 ml. of 4*N* ammonium chloride solution and 5 ml. of 10 per cent sodium tartrate are added and then the volume is brought to about 50 ml. The solution is heated to 60°-70°C., and the *p*H is brought up to about 9 with 2*N* ammonium hydroxide, thymol blue test paper being used. Then, sufficient amount of 8-hydroxyquinaldine solution is added, dropwise with stirring, so as to contain 20-30 per cent in excess of the amount necessary to precipitate completely the beryllium present in solution. The resulting precipitate is digested at this temperature for about half an hour to facilitate crystallization of the precipitate, and the precipitate is filtered through a weighed sintered-glass filter crucible (porosity No. 4), washed several times with small portions of dilute ammonium hydroxide (1: 100) and dried at 110°C. to constant weight, which will be obtained in about half an hour. The weight of beryllium present in the sample is calculated by multiplying the weight of precipitate by gravimetric factor 0·02770.

Volumetric estimation — The chelate, containing 2-10 mg. of beryllium, after being precipitated and washed similarly as in the gravimetric procedure, is dissolved in hot 6*N* hydrochloric acid, in which case 20 ml. or more are necessary in proportion to the amount of precipitate, and transferred to a glass-stoppered flask. To this solution are added a few drops of 0·1 per cent solution of methyl red as indicator, then titrated slowly with standard potassium bromate-bromide solution with constant stirring, and after the colour has changed to yellow, a few millilitres of standard potassium bromate-bromide solution are added. The flask is stoppered and allowed to stand for a few minutes and 1 g. of potassium iodide added and titrated against 0·1*N* sodium thiosulphate solution using starch as indicator. From the amount of standard potassium bromate-bromide solution required to brominate the 8-hydroxyquinaldine, the weight of beryllium can be calculated. As before, 1 ml. of 0·1*N* potassium bromate-bromide solution corresponds to 0·1127 mg. of beryllium.

Spectrophotometric procedure — Approximately 35 ml. of slightly acidic solution containing not more than 30 μg. of beryllium are treated with 5 ml. of 10 per cent ammonium chloride solution and 3 ml. of 8-hydroxyquinaldine solution, and the *p*H of the resulting solution is adjusted to 8·0 ± 0·2 with 2*N* ammonium hydroxide. The solution is transferred to a cone-shaped 130 ml. separating funnel which is graduated at 50 ml., with a few ml. of rinsed water, and the volume made up to 50 ml. After standing for half an hour, extraction is made with 10·0 ml. of chloroform added from an automatic measuring pipette, by vigorous shaking for a minute. The chloroform layer is drawn off into a small amber glass bottle with glass stopper, containing a gram of anhydrous sodium sulphate, and is shaken to remove droplets of water. Then the absorbency of this extract is measured at 380 mμ. Beryllium is determined by the use of a calibration curve which is prepared by similar treatment of a series of known amount of beryllium. By this method, 2-30 μg. of beryllium in approximately 40 ml. can be determined with accuracy. Small quantities of aluminium do not interfere with this method, and even in the presence of a minute amount of iron, beryllium can be determined by making a correction for the iron present.

For fluorometric determination, approximately 35 ml. of slightly acidic solution containing 0·3-3·0 μg. of beryllium are treated with 5 ml. of 10 per cent ammonium chloride solution and 2 ml. of 8-hydroxyquinaldine solution, and the *p*H of the solution is adjusted to 8·0 ± 0·2 with 2*N* ammonium hydroxide. The solution is transferred to a separating funnel with a few millilitres of rinsed water, and the volume made up to 50 ml. By the same procedure as in spectrophotometric method, extraction is made with 10·0 ml. of chloroform and the chloroform solution is dried with anhydrous sodium sulphate. Then the intensity of fluorescence of this chloroform solution is measured with a Beckman photofluorometer setting the chloroform at 0 and the standard quinine sulphate solution to 100 (or 50 when the intensity of fluorescence of the sample solution is stronger than this standard) on the transmittancy scale with the selector switch in the 1-position. Beryllium is determined by the use of the calibration curve prepared by similarly treating a series of known amounts of beryllium.

This method is accurate for determining beryllium up to 0·35 μg. in 40 ml. of solution [*New analytical methods for beryllium* by Kenji Motojima, Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958].

Geology of Uranium

TO ENABLE THE ENGLISH-SPEAKING countries to keep abreast of the latest Russian developments in the field of fissionable material, particularly uranium, the Consultants Bureau Inc., New York, have recently made available an English translation of a supplement (No. 9, 1957) to the *Soviet Journal of Atomic Energy* devoted entirely to current problems on geology of uranium. The translation is titled as *Geology of Uranium* (124 pp.; case bound; price $ 6.00). This supplement is a collection of 12 important papers by leading Soviet specialists in their respective fields written in a concise style and which are graphic expositions of the main problems encountered in current investigations, with emphasis mainly on the study of uranium deposits which formed contemporaneously with sedimentary rocks. The important role of diagenesis and of subsequent epigenetic and metamorphic phenomena, which have produced redistribution and concentration of uranium under favourable geological conditions, is clearly illustrated by actual cases. Processes which lead to formation of epigenetic infiltration uranium deposits in coal basins are thoroughly analysed and the various hypotheses reported, in Soviet and foreign literature, on the origin of such deposits are discussed in detail. Besides, the new work covers a comprehensive survey of aerial geophysical methods in various

countries; methods for radiometric study of uranium in three-component ore containing radioactive elements of the uranium and thorium series; a description of several new minerals (including recent data on *nenadkevite*); and the results of thermal investigations on a number of uranium minerals. This highly authoritative volume not only gives a most up-to-date account of Soviet progress in this branch but also adds new knowledge on the subject and stimulates further investigations on the geology of uranium.

Dr B. B. Dey (Obituary)

DR B. B. DEY, FORMERLY HONORARY Director, Central Electrochemical Research Institute, Karaikudi, passed away at Madras on 17 January 1959.

Dr Dey (born, 1 November 1889) was educated at the Presidency College, Calcutta. He took his D.Sc. degree from the London University and joined the Presidency College, Madras, as Professor of Chemistry and was later appointed Principal of the College. He was the first Indian Director of Public Instruction, Madras, and was also Director of the Biochemical Laboratory, Madras University, for sometime. He was also the first Director of the Central Electrochemical Research Institute, Karaikudi.

Dr Dey published a large number of memoirs in different fields of chemistry, specially on electro-organic compounds and natural dyes. He was the author of the book *Laboratory Manual of Organic Chemistry*.

He was a member of the Academic Council and a Fellow of the Senate of the Madras University. He was a member of the Indian Advisory Board of the Institute of Chemistry, the Council of the Indian Chemical Society and of various research committees of the Council of Scientific & Industrial Research.

Announcements

▪ *Committee for Exploration Geophysics* — At the recommendation of the Central Board of Geophysics at its seventeenth meeting held on 29 October 1958, the Government of India have appointed a Committee for Exploration Geophysics under the Central Board of Geophysics. The Committee consists of: Shri L. N. Kailasam, Secretary, Central Board of Geophysics and Chief Geophysicist, Geological Survey of India (*Convener and official member*); Dr B. C. Roy, Director, Geological Survey of India, Dr M. B. Ramachandra Rao, Director of Geophysics, Oil & Natural Gas Commission (*official members*); and Dr M. S. Krishnan (*non-official member*). The Committee will advise the Central Board of Geophysics in formulating research programmes at the Geophysical Research Wing of the Central Board of Geophysics.

▪ *The International Convention on Transistors and Associated Semiconductor Devices* has been planned by the British Institution of Electrical Engineers. The convention will be held from 25 to 29 May 1959 at London. About 2000 experts from many countries including the U.S.A. and the U.S.S.R. are being invited to participate in the convention, which is going to be the most comprehensive ever held on the subject. The convention will cover design, manufacture, basic theory, transistor characteristics,

FORTHCOMING INTERNATIONAL SCIENTIFIC CONFERENCES, 1959

Date	*Conference*	*Place*
1 April	Ninth Plenary Assembly of the International Radio Consultative Committee	Los Angeles
1-29 April	Third Session of the World Meteorological Organization	Geneva
6-11 April	International Conference on Co-ordination Chemistry	London
27-30 April	International Symposium on the Physical Chemistry of Process Metallurgy	Pittsburgh
11-13 May	Symposium on Instrumentation and Computation in Process Development and Plant Design	London
21-27 May	Sixteenth International Veterinary Congress	Madrid
25-29 May	International Convention on Transistors and Associated Semiconductor Devices	London
25-31 May	Fourth International Congress of Electroheat	Stresa (Italy)
30 May-5 June	Fifth World Petroleum Congress	New York
4-8 June	International Symposium on Electrolytes	Trieste (Italy)
9-11 June	International Symposium on Interferometry	Teddington
15-20 June	Fifth International Congress on Combustion Engines	Wiesbaden (Germany)
15-20 June	International Conference on Information Processing	Paris
15-24 June	Fourteenth Congress of the International Commission on Illumination	Brussels
29 June-4 July	Fifth International Congress on Glass	London
23-30 July	Ninth International Congress of Radiology	Munich
9-15 August	Twenty-first International Congress of Physiological Sciences	Buenos Aires
19-26 August	Tenth International Congress of Refrigeration	Copenhagen
24-30 August	Fifth Plenary Session of the International Optical Commission	Stockholm
26-29 August	Twentieth Conference of the International Union of Pure and Applied Chemistry and Seventeenth International Congress of Pure and Applied Chemistry	Munich
30 August-6 September	Ninth International Congress on the History of Science	Barcelona and Madrid
30 August-12 September	International Oceanographic Congress	New York
1-8 September	Third International Congress on Acoustics	Stuttgart (Germany)
9-10 September	Second International Congress on Air Pollution	New York
21 September-3 October	Eleventh International Roads Congress	Rio de Janeiro
September	International Computer Conference	Moscow
September	International Association for Hydraulic Research	Montreal
14 October (2 months)	International Telecommunication Union	Geneva
8-13 November	International Rubber Conference	Washington

applications and equivalent circuits. The meeting will enable the exchange of information on various production techniques and a discussion and assessment of their applications. It will also provide a basis on which further developments can be foreseen and planned.

An international trade exhibition covering all aspects of transistor and semiconductor devices will also be held simultaneously with the convention.

▪ *P. C. Dutta*, Professor of Organic Chemistry, Indian Association for the Cultivation of Science, Jadavpur, Calcutta, has been awarded a Commonwealth Research Bursary under the Royal Society and Nuffield Foundation Scheme. The scholarship is tenable for 10 months commencing from May 1959. The award will enable Prof. Dutta to gain experience in the field of alicyclic compounds related to terpenoids, at the Imperial College of Science & Technology, London, and at Oxford.

▪ *Dr M. C. Khosla*, Central Drug Research Institute, Lucknow, has been awarded the Swiss Government scholarship for postgraduate study/training in Switzerland during 1958-59. The subject of study Dr Khosla would pursue is synthetic organic chemistry.

▪ *Award of Doctorate Degrees* — The following have been awarded the Ph.D. degree of the Delhi University for the theses noted in parentheses against their respective names:

Shri Kesho Ram Laumas (*A study of natural and synthetic leucoanthocyanidins*); Shri Bal Krishna Sharma (*Electrochemical properties of some layer-lattice silicates in relation to their structure, with special reference to the role of structural hydroxyl groups*); Shri G. B. Venkatasubramanian (*Synthesis of some lichen depsides and mould toluquinones*); Shri Ram Niwas Goel (*A chemical study of naturally occurring flavanones and 3-hydroxy flavanones*); Shri Indra Kumar Vasil (*The cultivation of excised anthers and the culture and storage of pollen grains*) and Shri A. T. Natarajan (*A cytogenetical study of the effects of mutagens on plants with special reference to the induction of mutations*).

Shri Shashikant Avantilal Vasavada has been awarded the Ph.D. degree of the Poona University for his thesis entitled *Studies in the autoxidation of fats*.

INSTRUMENTS AND APPLIANCES

Differential thermal and thermogravimetric analysis apparatus

THE U.S. NATIONAL BUREAU OF Standards has devised an automatic arrangement combining both the differential thermal and thermogravimetric analyses apparatus conducing to ease of operation, saving of time and effort. The differential thermal analysis apparatus is useful to study reactions in solids at high temperatures, e.g. reversible transitions in solid solutions of divalent carbonates, oxide systems and mineral polymorphism, which cannot be done by the usual quenching. The method consists in heating the sample at a carefully controlled rate and observing the slight deviations from the impressed heating rate due to reactions that absorb or evolve heat. In solid state reactions involving a gaseous phase, sample weight also changes as the reaction proceeds. Such reactions can be studied by the thermogravimetric apparatus which automatically records the weight changes as a function of time and temperature. This apparatus is employed to study the high-temperature behaviour of natural and synthetic minerals (oxides, carbonates, phosphates, etc.). The final output of the combined unit is obtained on a single recording chart which simultaneously exhibits the three quantities temperature, change in weight and the differential temperature, plotted against time [*Tech. News Bull. U.S. Bur. Stand.*, **42** (1958), 129].

Calorimeter for rapid determination of heat of wetting

A CALORIMETER SUITABLE FOR THE rapid determination of heat of adsorption as low as 0·001 cal./g. is described. The apparatus consists essentially of a cell filled with an adsorbent, thermocouples placed in direct contact with the adsorbent and a suitable jacketing arrangement. The cell is kept at a constant temperature and a liquid is allowed to flow through the cell at a constant rate. The rise in temperature that results when the liquid comes into contact with the solid is measured by the thermocouples. The heat of adsorption of the liquid on the solid is evaluated by reproducing the temperature rise by passing a known current through a nichrome coil (resistance, 10 Ω), situated at the centre of the cell. Heats of replacement of one liquid by another liquid on a given adsorbent may be estimated by allowing a carrier liquid to flow through the cell at a constant rate and introducing into this liquid the second material. The thermoelectric effect is measured either with a galvanometer or a potentiometric recorder.

An ice bath encloses the cell containing the adsorbent which is retained by a small plug of cotton-wool. A capillary jet is attached to the end of the separating funnel containing the carrier liquid and the bore of the jet controls its rate of flow. A glass tube connected directly to the cell and extending to a special attachment is used for introducing small quantities of unknown substances from a micrometer syringe [*Nature, Lond.*, **182** (1958), 1152].

Progress Reports

INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE FORTY-EIGHTH ANNUAL REPORT (1956-57) OF THE Indian Institute of Science, Bangalore, records a sustained progress in research and developmental activities as revealed by over 200 research papers emanating from the Institute. The annual budget of the Institute was Rs 69,13,800. The strength of the scholars in the various departments was 395 which included two students from Nepal under the Colombo Plan and two students from Yugoslavia under the Government of India Reciprocal Scholarships Scheme. A postgraduate diploma course in Automobile Engineering was started during the year in the Department of Internal Combustion Engineering. A postgraduate course in High Voltage Engineering was started at the instance of the All-India Council of Technical Education. A one-week course on Measurement Techniques in Mechanical Engineering was organized at the Institute.

General chemistry — Studies on the inhibition of corrosion of aluminium have shown that among the various inhibitors used, gum arabic, with an inhibitor efficiency of 86 per cent, is the best for corrosion inhibition of aluminium in sodium hydroxide solutions.

A method has been standardized for the estimation of lithium as orthophosphate of lithium, by employing potassium phosphate reagent of *p*H 9·5. The amount of lithium that can be determined is 5 mg. to 100 mg., even in the presence of sodium and potassium ions. The solubility correction factor was found to be 0·36 mg. for every 50 ml. of the precipitating medium. Methods have been worked out for the spectrophotometric estimation of arsenic, antimony, tin, bismuth, copper, zinc and iron present in pig lead. Analytical methods have been developed for the estimation of lithium as trilithium phosphate.

Synthesis of samin, a degradation product of sesamolin, has been achieved. Conversion of samin into sesamolin is in progress. A number of amino acid conjugates and their derivatives have been prepared as possible tuberculostats. Four of the new derivatives of isonicotinic acid have been shown to inhibit the *in vitro* growth of tubercle bacilli up to 1: 10,000 dilution. The gross structures of carissone and isomers of selinene have been synthesized. The synthesis of C_{12}-acid, which is a degradation product of abietic acid, has been achieved. A stereo-specific route for DL-6-methoxy-podocarpane has been established. The mechanism of abnormal Dieckmann condensation has been fully explained. In the field of heterocyclics, a few new quinazolones have been synthesized.

Biochemistry — A new electrophoresis technique has been developed for the separation of minor protein components from blood. As the minor components are different in various types of diseases, the technique affords an easy method for diagnosis and prognosis of diseases such as cancer, tuberculosis, etc. Other important investigations relate to the isolation of enzymes synthesizing flavin nucleotides from yeast and the isolation of a new antibiotic, β-guttiferin, from gamboge. Large number of actinomycetes have been screened from soil samples collected from various parts of South India for the formation of antibacterial and antifungal substances. Investigations on the nutritional value of heated vegetable oils and their adverse effects on digestibility and growth in animals, physico-chemical studies on indigenous seed proteins, anti-coagulants from plant materials and disorders of blood coagulation under pathological conditions constitute other important lines of investigations during the period. Microbiological and structural analyses of 73 soil samples have shown that some relationship exists between the structure of the soil and the physiological groups of micro-organisms it carries.

A method for microbiological assay of iron has been standardized by making use of Clostridium lacto-acetophilum and the method has been tried in determining the iron contents of indigenous fermented products in wide use as tonics. Likewise, microbiological procedures have been adopted for examining the fermented products for the claims made in their behalf in the *Indian Pharmacopoeia*.

Physics — The research activities centred round the various problems connected with solid state physics. One of the important achievements has been the development of techniques for growing crystals of alkali halides from melts. The development has reached a stage when crystals weighing 2 lb. can be grown with ease. Under a scheme sponsored by the C.S.I.R. an analogue computer of an entirely new design for the summation of the double Fourier series encountered in crystal structure analysis using the synchronous magnetic recorder developed is under construction.

The thermal expansioto data for CsBr in the temperature range —140° to 300°C. have been determined for the first time; this data will be of great use in optical instrumentation. An accurate photo-electric polarimeter, capable of measuring rotation to an accuracy of a few seconds of arc, was set up and precise magneto-optic data over the range λ5790-λ2848 have been obtained for a large number of crystals and glass. In each case it has been possible to correlate the magnetic-optic dispersion with optical dispersion. The magneto-optic method developed earlier has been perfected for the study of the dispersion of piezo-optic coefficient in glasses.

Metallurgy — The effect of unsaturated fatty acids in the flotation of non-sulphide minerals like calcite, quartz, etc., was investigated by both contact angle measurements and vacumatic cylinder flotation tests. A comparison of the performance of oleic and linoleic acids, under identical conditions of collector and hydrogen-ion concentrations and temperature through contact angle measurements on calcite, has revealed that equilibrium is attained quicker in the case of the latter; the difference being pronounced at

higher *p*H values. The suitability of Indian vegetable oils containing high percentages of unsaturated fatty acids in mineral flotation is being assessed.

A process has been developed for the separation of hafnium from zirconium which yields a valuable zirconium intermediate analysing less than 0·2 per cent hafnium.

The standard technique of obtaining replicas from the surface of aluminium by anodic oxidation and stripping the resultant oxide film from the surface by amalgamation with mercury has been modified for obtaining satisfactory replicas from duralumin type alloys. A method for reclaiming the specimens after amalgamation has been devised.

Chemical technology and chemical engineering — A total gasification process for low rank Indian coals has successfully been completed and the process has been worked out on a pilot plant. A pilot plant for hydrocarbon synthesis was nearing completion and was expected to go into operation soon.

The erection of a pilot plant for the reduction of haematite using the fluidized solids technique is in progress. The separation method for purification of Indian graphites has shown that graphite from any impurity level can be easily purified, without any pre-treatment, up to 98 per cent in certain cases; the graphite thus purified showed boron contents less than 3 parts in 10 million or less making them useful for atomic reactor purposes.

Internal combustion engineering — The Kirloskar 10 h.p. diesel engine (1500 r.p.m., type 1M 11×11) and Central 10 h.p. diesel engine were tested at the instance of their makers for their rating using power alcohol as the fuel. It has been shown that prolonged operation of a diesel engine with neat alcohol as the principal fuel does not lead to any adverse effect and besides there is noticeable reduction in engine deposits. The following investigations were completed as well: Wear in high speed diesel engines operating on power alcohol as principal fuel; combustion chamber for a medium speed horizontal diesel engine; the effect of heating the inlet air in a diesel engine inducting alcohol; stress analysis in the Kirloskar 10 h.p. engine; two-stroke diesel with self-induced fuel injection; flame propagation in oscillating gas columns and particle separation in free vortex, continuous and pulsating flow; and air-cooling of S.I. engines by exhaust-operated ejectors.

Data on heat-transfer by liquids enclosed in vertical tubes have been obtained and studies are being carried out on liquid metal heat transfer systems. Forced convection heat transfer data have been obtained with mercury and the work is being extended to the system Na-K-Pb, and to Bi, Sn and Hg alloys.

Electrical communication engineering — In the field of microwaves, the subjects of study have been the radiation field of a dielectric rod antenna, and the propagation characteristics of a conductor embedded in three coaxial dielectrics. Work was also carried out in designing suitable matching terminations for surface waves of 3·2 cm. travelling over single wires. Other studies in progress in this field include the use of tubes (in place of crystals) as microwave detectors and parallel metal strips as artificial dielectrics.

For the accurate measurement of voltages in the transformer analogue computer under construction a null method has been devised and a direct reading equipment for rapid measurements has been constructed. A preliminary design for a quick acting voltage regulator for use in the transient analyser has been completed. For use in the study and analysis of the behaviour of electric circuits and equipment under different types of surge waves, a small mobile generator for 100 kV. has been designed. A 500 kV. 12·5 kW. secondary impulse generator is being completed in which the triggering is achieved by trigatron circuit; this method avoids the oscillions that are present on the front of the impulse wave when the surge generator is fired by an impulse of more than 50 kV. A dust sampling device to study the dust loading of boilers has been designed and fabricated. An imported frame costs about $ 2000 whereas the one fabricated in the laboratory would not cost more than Rs 1200. The frame has been subjected to about 600 kV. r.m.s. and has withstood this voltage.

LAC RESEARCH

IN SEPTEMBER 1956, THE INDIAN LAC CESS COMMITTEE celebrated its Silver Jubilee. In order to focus attention on the necessity for increasing the utilization of the lac products within the country, and in view of a severe competition from Siamese lac and synthetic materials, an exhibition of lac and lac products was organized as a part of the celebrations.

An Export Promotion Council for Shellac with the object of promoting the exports of shellac and other lac products was constituted in June 1957 under the Central Ministry of Commerce with a contribution of Rs 50,000 from the Committee and Rs 1 lakh from the Government of India.

During the year under report steady progress in extension of lac cultivation was achieved in the States of Assam, Bihar, Orissa, Uttar Pradesh, Bombay, Madras and Andhra. The total production of all the four lac crops this year was the highest (13,15,000 maunds) in the last five years and even higher than the normal production of 11,16,000 maunds (based on the average production of ten years preceding 1956). Though lac was exported to 82 countries during the year, yet the total quantity of the lac exported was less as compared to last year. A number of meetings of the Committee during the years 1956-57 were held and the important items discussed at the meetings related to regulation of prices by fixation of maximum and minimum prices at the export stage, measures to improve the lot of primary producers, training in lac cultivation to instructors in the National Extension Training Centres and setting up of nucleus brood farms.

A summary of the research work done at the Indian Lac Research Institute, Namkum, during 1956-57 is given below.

Entomological research — The method of improving crop production on *palas* (*Butea monosperma*) by artificial partial defoliation has enabled an increasing number of trees to be brought under cultivation every year so that at present the entire forest at Kundri with over 40,000 *palas* trees is under regular lac

cultivation. Partial defoliation has proved better in preserving brood from the summer crop. At Namkum, where the summer is not so severe, partial defoliation does not appear to have any particular advantage over non-defoliation.

The work carried out on the influence of environmental conditions on the lac insect showed that with *Rangeeni* strain, all the insects died after the first instar stage at 18°C. and relative humidity (R.H.) 29-82 per cent. At a temperature of 25°C. and R.H. of 52-87 per cent, some insects survived till the completion of their life cycles. Similar results were obtained with the *Kusumi* strain also. It was generally noticed that the development was faster at higher temperatures than at lower ones.

In a survey of lac enemies and their parasites, it was observed for the first time that rats cause rather heavy damage to lac crop, feeding on lac and removing broodlac sticks. It was also found that rats consume the adult lac insects from the broodlac.

Chemical research — A rapid method for the determination of the bleach index of lac for its standardization and grading involves bleaching of the lac at 37·5°±1°C. instead of 27°±2°C. and applying a constant correction of −3 to the bleach index value determined from the bleach index versus colour ratio curve. The time of determination can be reduced by this procedure from 24 to 3 hr. For reading the values directly and also for eliminating the necessity for the correction factor of −3, a new reference curve appropriate to the bleaching of lac at this enhanced temperature may be employed. With a view to bring about improvements in the manufacture of seedlac, shellac, bleached lac, etc., a number of new methods were tried. For the manufacture of shellac it was found that if the final acid precipitation of alkali-dissolved lac was carried out in an atmosphere of carbon dioxide, the final product has very nearly the same colour as shellac made by the country process. In the manufacture of shellac by autoclave the colour of the product can be greatly improved by using a stainless steel steam-heated cooking pan. Also if the seedlac is moistened before being put into the sieves, the time of melting is shortened, and the colour of the final product is also improved.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH: ANNUAL REPORT, 1957

THE SUCCESSFUL COMPLETION AND BRINGING INTO operation of the 600 MeV. synchro-cyclotron at full energy on 1 August 1957 was the most significant event in the programme of the European Organization for Nuclear Research (EONR) during 1957. It marks the beginning of a new and active phase of experimental research. Thus the practical realization of the fundamental aim of the Organization, viz. providing facilities of a unique kind for co-operative experimental research for visiting scientists from member States, has been attained after years of planning, preparation and execution. An extensive experimental programme to be carried out with the help of this super-energy accelerator has been worked out.

The Proton Synchrotron Division, with all its branches installed at Meyrin by 1957, has completed the design, planning and ordering stage and entered upon the most active phase of construction of the machine and its ancillary parts. A special research group formed to outline a programme on new principles of particle accelerators directed its research effort towards electron plasma rings and beam stacking methods.

The Theoretical Study Division, besides its role in providing for the eminent visiting and guest scientists for profitable exchanges with the EONR staff and its research fellows, leading to experimental checking of theoretical conclusions on the one hand, and setting fresh theoretical problems as new experimental facts come to light on the other, has carried out a number of useful theoretical studies. Outstanding among them are the studies on radiative pion-nucleon scattering and development of a new simple method of solving integral equations occurring in the general theory of pion-nucleon interactions.

The Scientific and Technical Services Division was engaged in the development and design of bubble chambers, hydrogen liquefying plant, electronic computer programming and calculations, and of methods for instrumental evaluation of track chamber pictures, which accessories are of immense importance in connection with the experimental work with the two super-energy machines.

The Electronics Group devoted its efforts to supply the experimental teams with the necessary electronic instrumentation either by developing new or constructing and assembling of conventional equipment. Chief among the equipment developed during the year were: 100-channel Hutchinson Scarrof pulse height analyser with nickel wire memory; trochotron scalers (1 MHz region); millimicrosecond coincidence circuits with discriminators; fast pulse generators; prototype of photograph evaluation instrument; delay boxes (hand operated and remote controlled); robot printer for printing from scalers; and control circuits and flash equipment for bubble chambers.

During the year the number of staff has registered a considerable rise and there were about 250 technical personnel and 36 fellows. The total budget for 1957 was estimated at 61,825,800 Swiss francs. A number of colloquia and conferences, on specific aspects of subjects like experimental high energy physics, elementary particle theory, electronic instrumentation for nuclear research, etc., have been organized and valuable results and experience on such studies were exchanged. More than 50 research papers emanating from the various Divisions of the organization have been published during the year.

Some important studies conducted and outstanding results obtained by the research Divisions are briefly outlined below.

Theoretical Studies Division — The activities of this Division related to the detailed study of the properties, structure and interactions of elementary particles, low energy phenomena like beta decay, quantum field theory, nuclear models, and excited states of the nucleus. Mention should be made of (1) a detailed study of the production of a meson in a pion-nucleon collision and (2) a study of the scattering of high energy electrons by nucleons. These two

studies are expected to have immense significance in the experimental fields. A complete analysis of a one-dimensional model of field theory which partially overcomes the difficulties encountered by the physical theory has been undertaken by one group. Another group's studies resulted in the formulation of several theories intended to explain some recently observed facts in hyperon or K-meson decay (branching ratios of Σ^+, comparison between mean lifetimes of Σ^+ and Σ^-, and non-conservation of parity in these types of decay). The group has also given a general description of weak interactions in which new particles are incorporated and which accounts for decays with and without leptons.

Proton Synchrotron Division — Work in this Division during the year was mainly confined to a number of theoretical and experimental investigations aimed at proper design or to improve their performance (by experimenting with new designs) of the functional components and of the ancillary equipment of the proton synchrotron. In one study the practical conditions on the rates of sweep and exciting perturbations to avoid the ' lock-in ' in betatron oscillations under dynamic working conditions have been established. The oscillation analogue was improved by (1) a direct display of the phase plane paths of one-dimensional particle on an oscillograph screen and (2) a pulse generator producing 20 adjustable pulses per revolution, for the simulation of misaligned magnets. The device will be used for the study of methods to straighten a distorted closed orbit. For the study of the mechanism of particle loss by betatron oscillations, a second analogue has been devised using electrons ' suspended ' in a combined electric and magnetic field. In this analogue a bunch of electrons can be subjected to all the kinds of perturbations likely to be encountered in the machine.

Budker's proposal for the design of a plasma ring oscillator, which has the distinct advantage of having a smaller radius of curvature of the accelerated particles, has been examined in detail. To realize the necessary formation of a very thin high current plasma thread with sufficient stability and lifetime to permit one acceleration cycle, the proper method seemed to be to form such a beam starting with a neutral plasma in a toroidal chamber situated in a betatron type field which is used to accelerate the ions in the plasma. Investigations on methods of ionizing hydrogen at very low densities revealed that high frequency discharge where the diffusion is quenched by a high frequency electric quadrupole field is advantageous because it does not need magnetic fields. Theoretical study of the problem of stability of a pinched ring current against bending perturbations (kinks) indicated that a plasma ring current cannot be obtained without applying powerful stabilizing forces in addition to that due to the magnetic field shaping the ring.

An improved electronic analogue computer for studying the phase motion of particles has been constructed and used to measure the anisochronism of large amplitude phase oscillations. The results obtained for the static (no acceleration) case agreed with theoretical values. Experience with large gas-filled Cerenkov counters has given encouraging results and attempts to realistically determine how big a chamber can be built for use with the EONR accelerators are being made.

Synchro-cyclotron Division — Assembly and testing of the various component units of the synchro-cyclotron like the r.f. system, ion source, beam bending magnets, power supply, etc., have been completed and the machine has been put into operation at full energy. A number of special equipment required in connection with the experimental programme envisaged to be carried out on the machine have been constructed or tested. Chief of them are: two argon-filled beam monitors (evacuated multiplate ionization chambers) with a saturation intensity of 10^8 protons/sq. cm./sec.; a current integrator (accuracy, 0·3 per cent) to measure the charge collected in the beam monitor chambers; a 25 MHz scaler; a ' cyclotron simulator ' which gives trains of pulses similar in pattern to those to be expected from the cyclotron; two hydrogen targets for transmission experiments with pions; and a source of protons polarized prior to acceleration.

A negative pion beam of *c.* 200 MeV. has been successfully extracted from the cyclotron at an intensity of 7×10^4 pions/sec. over an area of 100 sq. cm. The nuclear absorption of these pions in copper corresponded to a geometrical cross-section.

Experiments designed to show the circular polarization of γ-rays following β-decay were undertaken. The circular polarization of the γ-rays was measured by transmission through magnetized iron. The results on a number of allowed Gamow-Teller transitions were found to agree with the two-component theory of the neutrino. The neutrinos emitted in such decays should be of the same helicity (orientation of the spin with respect to the direction of motion).

The Spallation Group constructed equipment needed for the tritium measurements in targets and meteorites. The general parts of this set of apparatus consist of a h.f. generator to degas targets under vacuum, a vacuum system and a low level counting arrangement for low activity. Tritium measurements have been made from experiments on the irradiation of iron targets with high energy protons from the synchro-cyclotron. A preliminary tritium production cross-section of 50 mb. has been obtained at 400 MeV. (the beam was found not very accurately centred). The comparison between the production rates of protons and mesons will be of special interest for small nuclear fragments like tritium.

NEW PUBLICATIONS

of the

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

INDIAN CLAYS: PART I

A monograph giving information in respect of location, availability, physical properties and ceramic uses of some 500 Indian clay samples.

Pp. 156. Demy 4to. Price Rs 8.00

ANTIBIOTICS — THEIR PRODUCTION, UTILIZATION & MODE OF ACTION

Proceedings of a symposium held at the Hindustan Antibiotics (Private) Ltd, Pimpri.

Pp. 292 + xxvi. Royal 8vo. Price Rs 15.00

ESSENTIAL OILS & AROMATIC CHEMICALS

Proceedings of a symposium held at Dehra Dun under the joint auspices of the Council of Scientific & Industrial Research and the Forest Research Institute and Colleges. Contains 70 research papers on different aspects of the essential oil industry.

Pp. 174 + xx. Royal 8vo. Price Rs 10.00

INVESTIGATIONS ON THE COMPOSITION & NUTRITIVE VALUE OF VANASPATI: Vol. II

A collected account of the researches sponsored by the Vanaspati Research Advisory Committee of the Council of Scientific & Industrial Research during 1952.

Pp. 80 + iv. Royal 8vo. Price Rs 5.00

Available from :

THE UNDER SECRETARY
PUBLICATIONS DIRECTORATE, C.S.I.R.
OLD MILL ROAD, NEW DELHI 1

available

WHATMAN

Glass

Fibre

Papers

- **excellent retention with rapid filtration**
- **high softening point**
- **outstanding chemical resistance**

These brilliant white, exceptionally strong papers are composed entirely of glass micro fibres with no added binding materials. Their excellent retention properties make them particularly useful for filtering very fine precipitates and semi-colloidal substances through a coarse porosity crucible. The filtration rate is very rapid, and there is no risk of blocking.

The papers are also recommended for routine filtration through Buchner and Hirsch funnels, and for certain applications in Chromatography and Electrophoresis. Although in the latter techniques they do not replace conventional Whatman papers, the intrinsic properties of Glass Fibre Papers can be utilised effectively for investigating non-aqueous systems, organic mixtures of protein origin and several other substances.

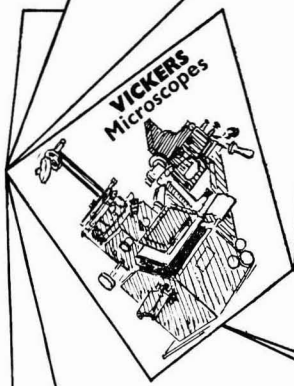
Please write for technical literature.

H. REEVE ANGEL & CO LTD
9 BRIDEWELL PLACE LONDON EC4
***also at* 52 DUANE STREET NEW YORK 7**
sole distributors of

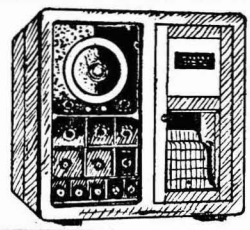
WHATMAN FILTER PAPERS

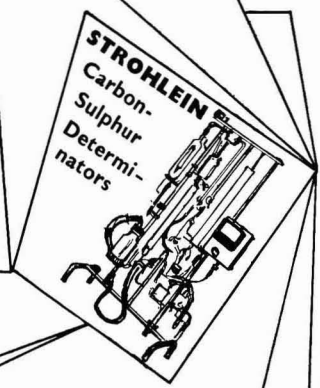
(manufacturers W. & R. Balston Ltd)

We supply a varied range of



TINSLEY POLAROGRAPHS

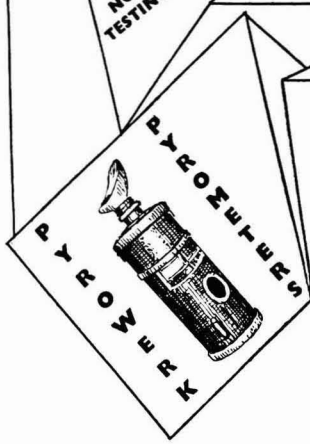




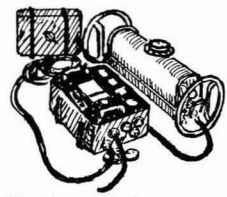
for METALLOGRAPHIC & NON-DESTRUCTIVE TESTING LABORATORIES

METALLURGICAL TESTING INSTRUMENTS

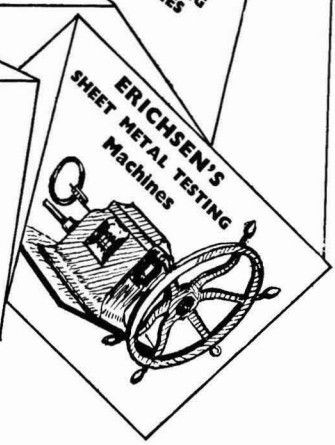
for CHEMICAL & PHYSICAL ANALYTICAL TESTING LABORATORIES



SOLUS-SCHALL



X-Ray Equipment



We also Service the equipment supplied by us

For these and all your other allied requirements, please consult:

PIONEER EQUIPMENT CO. PRIVATE LTD.

Dalhousie Square, I-Mangoe Lane, Calcutta 1.

139, Medows Street, P. O. Box 1909, Bombay 1.

193, Mount Road, Madras 2.

TRADE MARK ITL

Safe & Dependable

INJECTABLES

A wide range of parenteral preparations for meeting the growing requirements of the medical profession are processed in our laboratories. They are made from standard chemicals employing double distilled and PYROGEN FREE water. Their containers (ampoules) undergo rigid neutrality tests before they are selected for use. These injectables are, therefore, guaranteed to be absolutely safe and dependable.

The following are but a few of our well-known injectables:

- RETICULIN — A potent Extract of Liver
- HEXOPURIN — An Urinary Antiseptic
- CALCITOL — Injectable Calcium Gluconate
- BEVITAMIN — Injectable Vitamin B_1
- CEVITAMIN — Injectable Vitamin C
- GLUCOSE SOLN.— Injectable Pure Dextrose

THE MYSORE INDUSTRIAL & TESTING LABORATORY LTD.

MALLESWARAM P.O., BANGALORE 3

Selling Agents:

Messrs Khatau Valabhdas & Co., Bombay **Messrs Karnatak & Deccan Agencies, Hubli**
Messrs Deccan Drug Agency, Hyderabad (Dn.)

Potassium Dichromate

(ANALYTICAL REAGENT)

Maximum limit of impurities

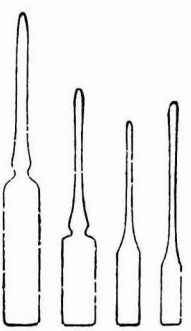
CHLORIDE	0·0005%
SULPHATE	0·01%
CALCIUM	0·005%
MOISTURE	0·05%

Tested by the
GOVERNMENT TEST HOUSE
ALIPORE

•

THE INTERNATIONAL CHEMICAL INDUSTRIES

103B UPPER CIRCULAR ROAD
CALCUTTA 9



MANUFACTURERS OF

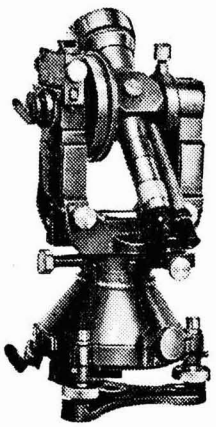
NEUTRAL GLASS AMPOULES

For further particulars, write to :

BOMBAY SCIENTIFIC GLASS WORKS

ARAB HOUSE, KHETWADI 13TH LANE
BOMBAY 4

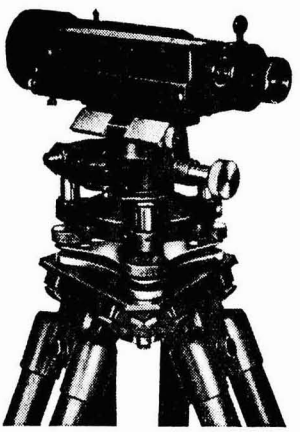
'WILD' HEERBRUGG (Switzerland)



WILD THEODOLITE T3

The manufacturers of
Highest Class Precision Optical and
Mechanical Instruments
for
WORKSHOPS
LABORATORIES &
SURVEY

* Microscopes for colleges and research
* Microscopes for angle and thread measuring
* Testing instruments for plane surfaces
* Drawing instruments of stainless steel
* Levels, theodolites and aerial cameras
* Distance measuring instruments, etc.



WILD LEVEL N2

Equipped with modern, High Precision Swiss Machines, Tools, Gauges and Collimators and with an expert Swiss trained Engineer, our Service Division undertakes repairs to WILD Levels, Theodolites, etc.

SOLE AGENTS:

RAJ-DER-KAR & Co.

SADHANA RAYON HOUSE, DR. D. NAOROJI ROAD
BOMBAY

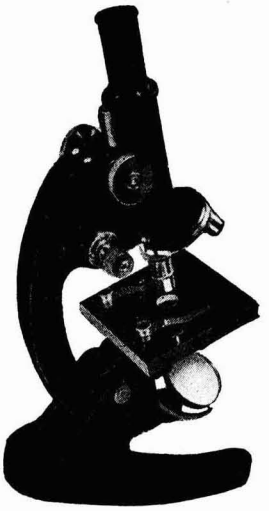
Telephone : **26-2304**

Telegram : **" TECHLAB "**

STUDENTS' MICROSCOPE

for

ADVANCED CLASSES

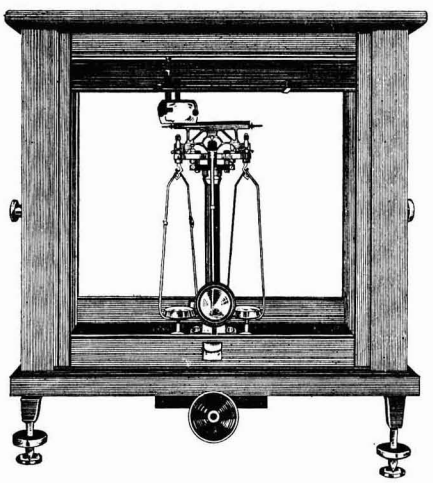


Manufactured by :

INSTRUMENT RESEARCH LABORATORY Ltd.

309 BOWBAZAR STREET, CALCUTTA 12

Gram : **INRELABTRY** Phone : **22-5778**



From

A MICRO

to

A PHYSICAL BALANCE

you may depend on

KEROY BALANCES

for their

SENSITIVITY, CONSTANCY & DURABILITY

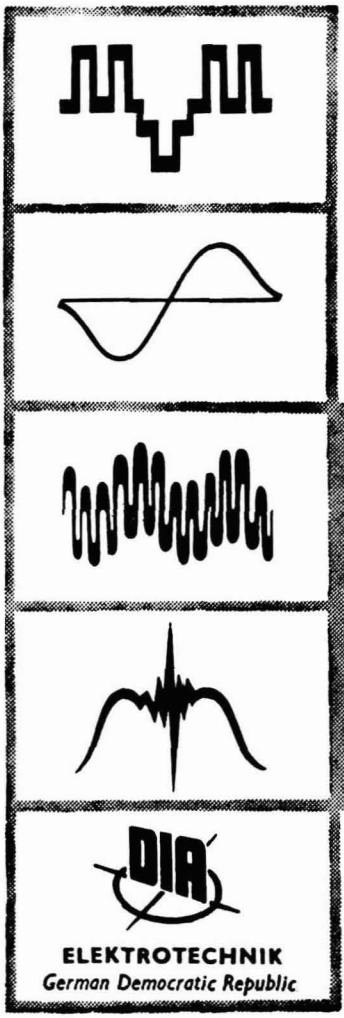
Manufactured by

Keroy (Private) Limited

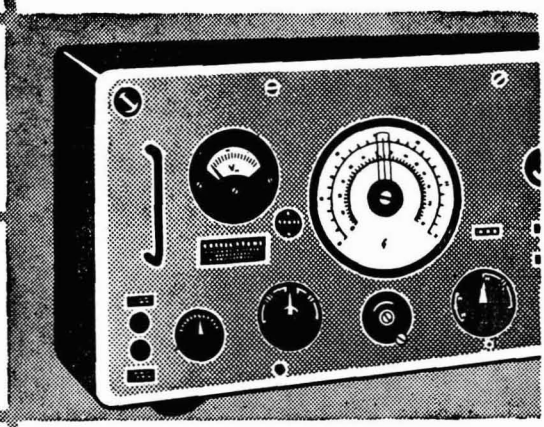
Service Station & Office
32 LATAFAT HUSSAIN LANE
CALCUTTA 10

Phone
24-3840

Factory
335 NADESHWAR
VARANASI CANTT.



A Complete Line of ELECTRONIC MEASURING and TESTING EQUIPMENT



DIA

ELEKTROTECHNIK

German Democratic Republic

- Oscilloscopes
- Frequency Meters
- Power Supplies
- Valve Voltmeters
- Level Meters
- Signal Generators
- L.C.R. Bridges
- Pulse Generators
- Ohm Meters
- Communication Receivers, etc.

P585.74

Sold and serviced in India exclusively by

BLUE STAR

BLUE STAR ENGINEERING CO. (Bombay) PRIVATE LTD.

KASTURI BUILDINGS, JAMSHEDJI TATA ROAD, BOMBAY 1

Also at CALCUTTA, DELHI, MADRAS

Before buying anything in

CHEMICALS

PLEASE CONTACT RELIABLE SOURCE

LABORATORY CHEMICAL Co.

89 PRINCESS STREET, BOMBAY 2

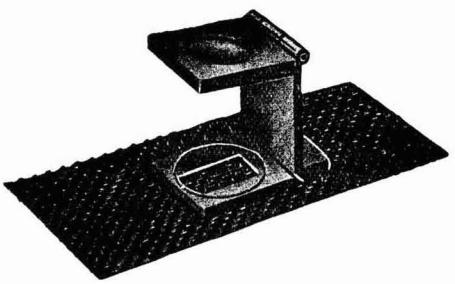
Gram: **TRIAL** • Phone: **22358**

Direct Importers, Stockists & Dealers in

A.R. ACIDS, LABORATORY CHEMICALS, AMINO ACIDS, STAINS & DIFCO PRODUCTS

★

Main suppliers of* A.R. ACIDS & FUMING ACIDS *manufactured by Well-known Firms



Accurate Wire Screen is required to solve your Screening, Grading or Filtering operation.

•

DIRECT IMPORTERS OF WOVEN WIRE MESH AND PERFORATED METALS

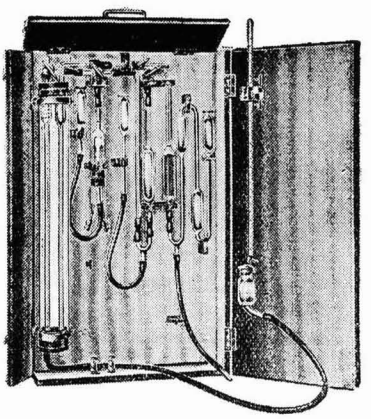
STANDARD METAL CO.

Proprietors :

B. C. GUIN & CO. (PRIVATE) Ltd.

101 NETAJI SUBHAS ROAD, CALCUTTA 1

Phone: 22-5270 • Grams: PERFOSHEET



ASSOCIATED SCIENTIFIC CORPORATION

MANUFACTURERS & DEALERS IN

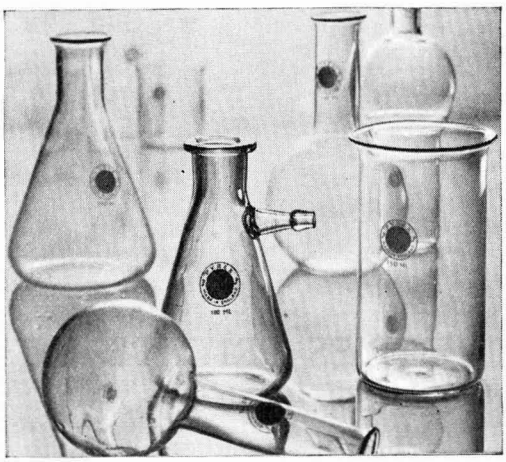
SCIENTIFIC GLASS APPARATUS & EQUIPMENT

232B UPPER CIRCULAR ROAD CALCUTTA 4

Gram: **ASCINCORP**

Phone { Factory: **55-1588** Residence: **55-2001**

A well aimed blow by Pyrex



A machine called the Turret Chain made these: it automatically makes blownware such as flasks, beakers and other types of laboratory ware, to a very high standard of uniformity. It's the only machine of its kind in Europe. Just an example of how PYREX, the first and most important source of borosilicate glassware in this country, use the latest and best processes available. PYREX are always improving their production methods to attain even higher standards of quality. This is one good reason (among many) why everyone who is looking for quality glassware, looks for PYREX

Pyrex beakers and flasks

are made in all practical sizes and shapes for students, routine or research work

Extremely low expansion coefficient

virtually eliminates breakage from thermal shock
allows more robust construction giving greatly increased mechanical strength

High stability

against attack from water and all acids (except hydrofluoric and glacial phosphoric)

THEREFORE durable, accurate, economical, dependable, most-used

PYREX

Regd. Trade Mark BRAND

MADE IN ENGLAND PYREX

Laboratory and scientific glass

Obtainable from all main dealers

INDUSTRIAL SALES EXPORT DIVISION, JAMES A. JOBLING & CO. LTD.
WEAR GLASS WORKS, SUNDERLAND, ENGLAND

RO-TAP SIEVE SHAKERS
with
AUTO TIME SWITCH

Also

WARBURG'S APPARATUS
COLD INCUBATORS
B.O.D. INCUBATORS
BI-METAL THERMOSTATS
HOT & COLD
THERMOSTATIC BATHS
etc.

Manufactured by

UDAY SCIENTIFIC INDUSTRIES PRIVATE Ltd.

5 BHABANATH SEN STREET, CALCUTTA 4

Gram : UDAYINDUST Phone : 55-3777

LABORATORY EQUIPMENT

For all your requirements of laboratory glassware, apparatus, appliances, instruments, acids, chemicals, stains, water and gas taps, etc. etc.

please write to:

THE CENTRAL SCIENTIFIC SUPPLIES COMPANY LIMITED

2 AGARAM ROAD, TAMBARAM
SOUTH INDIA

Telegrams: SYPHON Telephone: 89 Extension 123

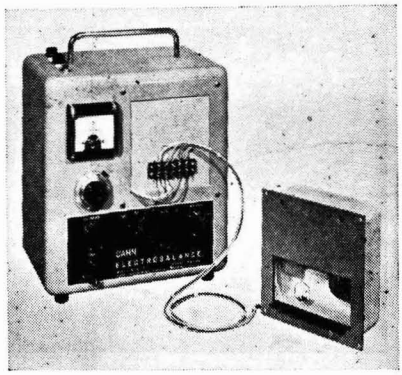
Branches at

369 ESPLANADE, MADRAS 1
53 NARASIMHARAJA ROAD, BANGALORE 2

CRAFTSMAN

A SYMBOL OF QUALITY AND SERVICE

proudly offer



CAHN — WORLD'S FOREMOST

ELECTRO-BALANCE WITH REMOTE WEIGHING
AND
RANGE-SELECTOR (6 RANGES)
from 0 to 100 mg.

MICROGRAM PRECISION AND ACCURACY
operates on 6 VOLTS DRY BATTERY
One Second Readings

Made by:

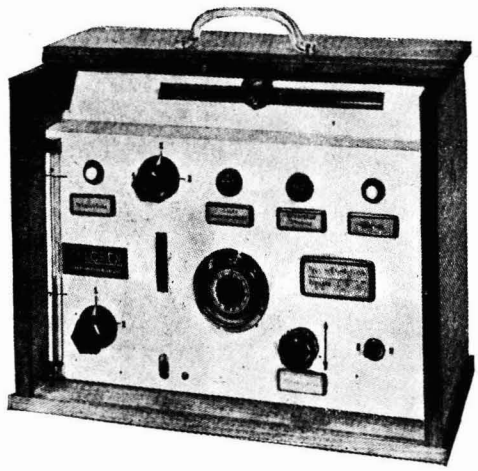
CAHN INSTRUMENT CO., U.S.A.

WORLD'S SMALLEST, LIGHTEST ECG

"VISOCARD-5000" (Portable in Briefcase) ECG
Also "VISOCARD" 1-2-3 Channel Electro-cardiographs
for BALLISTO, VECTOR, PULSE, HEART-TONE Tests
(Cheapest Prices)
Made by:

ING. WOLFGANG von KARAJAN, AUSTRIA

VISOCARD 5000



KALOREX

PROTECTS MINES and DRAINS WORKERS !
from
INCENDIARY and ASPHYXIATING GASES

Apparatus used by the Government of West Germany in Municipalities, Mines and Technical Institutes

RAPID TESTS FOR HO, CO_2, CH_4 and O_2
in three minutes

Made by:

Rob. MUELLER, GERMANY

EXCLUSIVELY REPRESENTED BY:

CRAFTSMAN ELECTRONIC CORPORATION (PRIVATE) LTD.

SETHNA HALL, NESBIT ROAD, MAZAGAON, BOMBAY 10

Gram: CRAFTRONIC

Phone: 42346

SP/Crf/1

ADAMS
MICRO-CHEMISTRY CENTRIFUGE

HIGH SPEED

13,500 r.p.m.

15,500 (RCF)

★

FAST STOPPING

Automatic electrical brake stops head in 60 seconds

★

SAFE

Each head individually X-rayed to assure absence of defects

Operates only when heavy duty cover is secured

★

QUIET & COOL

in operation

Made by CLAY-ADAMS INC., New York

Accredited Agents

MARTIN & HARRIS (PRIVATE) 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, New Delhi, India. Chief Editor: B. N. SASTRI

Regd. No. P-842