Australian Post Office Research Laboratories Open Days: 1969

Australian Post Office Research Laboratories Open Days
15-18 September 1969

GENERAL INFORMATION

Times for visitors

The Laboratories will be open to the public for inspection during the following times:

Monday 15 September 1969 2 pm–4.30 pm
Tuesday 16 September 1969 10 am–4.30 pm
Tuesday 16 September 1969 7 pm–9.30 pm
Wednesday 17 September 1969 10 am–4.30 pm
Wednesday 17 September 1969 7 pm–9.30 pm
Thursday 18 September 1969 10 am–4.30 pm

Enquiries & registrations

Enquiry desks will be located on the ground floor of each building. Visitors are requested to register at one of these where they will be issued with a lapel badge.

Transport between buildings

Due to the scattered nature of the buildings a free bus service will operate continuously between them. Details of times and routes are available at the enquiry desks.

Contents

1 General information for visitors

3 Foreword

4 Organisation chart

5 History and functions of the Research Laboratories

7 List of exhibits and locations

12 Details of exhibits

12 Computation facilities

13 Internal services

18 Material and component investigation

25 Radio propagation

28 Reference standards

33 Research into new components

34 Telephone instrument development

35 Telephone switching research

37 Test equipment development

40 Transmission systems

43 Index

49 Notes

Back cover Location map

Foreword

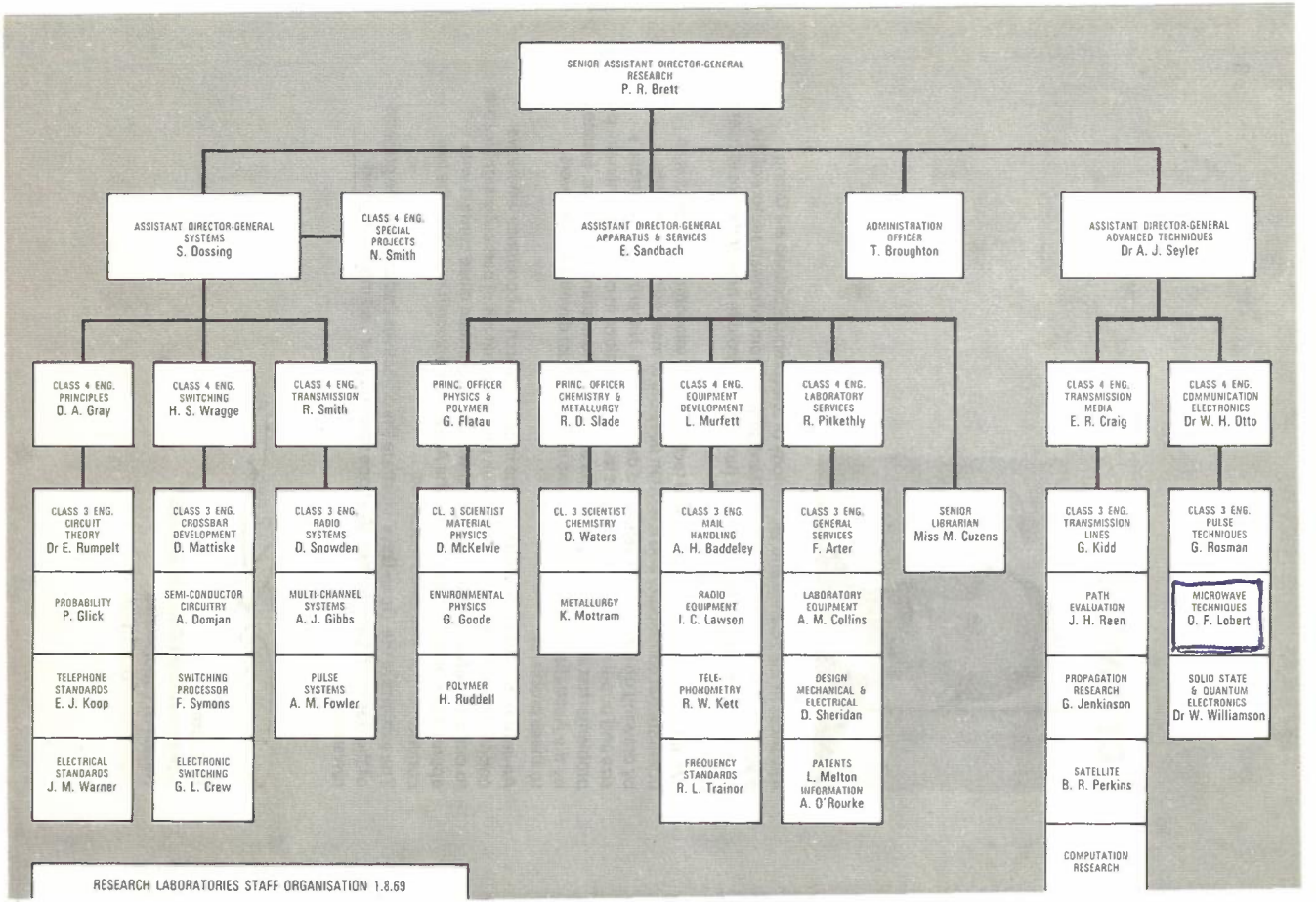
Advances in the science and technology of telecommunications are taking place continually and there is a resultant demand from informed sectors of the community for these advances to be put to use to provide new and more efficient communication services.

We are fortunate in that science and technology in telecommunications is an international commodity and it is often possible to meet our requirements by drawing on overseas research and development. Nevertheless, Australia's size and population distribution, and its wide variations in climate and terrain, pose problems that are peculiar to Australia alone. The Australian Post Office, assisted by the Australian telecommunications industry, must develop the answers to these problems.

An important part of this work is done in our Research Laboratories where we conduct research and development on problems that are of particular significance to our own network requirement and where we maintain close contact with appropriate research performed in the Australian Universities and by the telecommunication and allied industries.

The exhibits at the 'Open Days' illustrate the objectives and some of the projects of the Research Laboratories. We hope you find your visit interesting and rewarding.

P. R. Brett
Senior Assistant Director-General
Research Laboratories
Australian Post Office


SENIOR ASSISTANT DIRECTOR-GENERAL
RESEARCH
P. R. Brett
ASSISTANT DIRECTOR-GENERAL
SYSTEMS
S. Dossing
CLASS 4 ENG.
SPECIAL
PROJECTS
N. Smith
ASSISTANT DIRECTOR-GENERAL
APPARATUS & SERVICES
E. Sandbach
ADMINISTRATION
OFFICER
T. Broughton
ASSISTANT DIRECTOR-GENERAL
ADVANCED TECHNIQUES
Dr A. J. Seyler
CLASS 4 ENG.
PRINCIPLES
O. A. Gray
CLASS 4 ENG.
SWITCHING
H. S. Wragge
CLASS 4 ENG.
TRANSMISSION
R. Smith
PRINC. OFFICER
PHYSICS &
POLYMER
G. Flatau
PRINC. OFFICER
CHEMISTRY &
METALLURGY
R. D. Slade
CLASS 4 ENG.
EQUIPMENT
DEVELOPMENT
L. Murfett
CLASS 4 ENG.
LABORATORY
SERVICES
R. Pitkethly
CLASS 4 ENG.
TRANSMISSION
MEDIA
E. R. Craig
CLASS 4 ENG.
COMMUNICATION
ELECTRONICS
Dr W. H. Otto
CLASS 3 ENG.
CIRCUIT
THEORY
Dr E. Rumpelt
PROBABILITY
P. Glick
TELEPHONE
STANDARDS
E. J. Koop
ELECTRICAL
STANDARDS
J. M. Warner
CLASS 3 ENG.
CROSSBAR
DEVELOPMENT
D. Mattiske
SEMI-CONDUCTOR
CIRCUITRY
A. Domjan
SWITCHING
PROCESSOR
F. Symons
ELECTRONIC
SWITCHING
G. L. Crew
CLASS 3 ENG.
RADIO
SYSTEMS
D. Snowden
MULTI-CHANNEL
SYSTEMS
A. J. Gibbs
PULSE
SYSTEMS
A. M. Fowler
CL. 3 SCIENTIST
MATERIAL
PHYSICS
D. McKelvie
ENVIRONMENTAL
PHYSICS
G. Goode
POLYMER
H. Ruddell
CL. 3 SCIENTIST
CHEMISTRY
D. Waters
METALLURGY
K. Mottram
CLASS 3 ENG.
MAIL
HANDLING
A. H. Baddeley
RADIO
EQUIPMENT
I. C. Lawson
TELE-
PHONOMETRY
R. W. Kett
FREQUENCY
STANDARDS
R. L. Trainor
CLASS 3 ENG.
GENERAL
SERVICES
F. Arter
LABORATORY
EQUIPMENT
A. M. Collins
DESIGN
MECHANICAL &
ELECTRICAL
D. Sheridan
PATENTS
L. Melton
INFORMATION
A. O'Rourke
SENIOR
LIBRARIAN
Miss M. Cuzens
CLASS 3 ENG.
TRANSMISSION
LINES
G. Kidd
PATH
EVALUATION
J. H. Reen
PROPAGATION
RESEARCH
G. Jenkinson
SATELLITE
B. R. Perkins
COMPUTATION
RESEARCH
CLASS 3 ENG.
PULSE
TECHNIQUES
G. Rosman
MICROWAVE
TECHNIQUES
D. F. Lobert
SOLID STATE
& QUANTUM
ELECTRONICS
Dr W. Williamson
RESEARCH LABORATORIES STAFF ORGANISATION 1.8.69

History & Functions of the Research Laboratories

The Research Laboratories were established in 1923 to assist in the introduction of new telecommunication techniques which followed the development of the electron tube. Since that time the range of knowledge and complexity of telecommunication technology have increased dramatically.

The Laboratories have been expanded progressively to apply these advances to the requirements for new or improved services and to provide the research and development back-up needed to allow the Australian Post Office to carry out its day-to-day activities and to prepare for the demands of the future.

In general terms the research and development objectives of the Australian Post Office are :

1) to ensure that research and development are undertaken at an adequate intellectual level and in sufficient fields of work to satisfy its needs for new knowledge, new expertise and new developments ;
2) to assist the Australian telecommunication manufacturing industry in maintaining the required level of innovation and an up-to-date manufacturing technology, and
3) to encourage Universities to accord telecommunications research a prominence that will attract talented engineering and science students in sufficient numbers to meet future national needs.

With these objectives in mind, the Research Laboratories operate to the following charter.

1) To conduct research and development in telecommunications theory and practice, particularly as applying to the Australian region.
2) To appraise new developments in telecommunication equipment and, in appropriate cases, to conduct field trials.
3) To develop apparatus and systems required in the Australian communications network and for mail handling and which are not available from commercial sources.
4) To act as consultant on scientific and engineering matters to the Department.
5) To participate in the work of national and international organisations associated with telecommunications research and to be represented on their committees.
6) To encourage research and development in telecommunications and allied disciplines in universities and industrial laboratories.

These functions are distributed over the following main classifications of work : Basic research (10%) ; applied research (20%) ; development (25%) ; specialist services and problem solving (30%) ; internal service work (15%).
The Research Laboratories have the status of a Branch of the Planning and Research Division of the Department. They have an organisation of approximately 350 made up of 120 engineers and scientists, five librarians, 180 technical and artisan staff and 45 administrative staff, and occupy six buildings in the eastern city areas of Melbourne. In 1968/69 operating costs were approximately $3 million.

List of Exhibits & Locations

Exhibits are on display at six separate buildings, located as follows:
Building A — 59 Little Collins Street, Melbourne 3000
Building C — 140 Exhibition Street, Melbourne 3000
Building F — 31 Flinders Lane, Melbourne 3000
Building R — 1009 Rathdown Street, North Carlton 3054
Building T — 10 Lonsdale Street, Melbourne 3000
Building W— 262 Exhibition Street, Melbourne 3000

A free bus service will operate between buildings.

Exhibits are coded to facilitate location, for example CG.13 is situated in Building C, Ground Floor, Exhibit No. 13.

No.	*Room*	*Title*	*Page*
BUILDING A			
Ground Floor			
AG.1	2	Model Shop Operations	17
First Floor			
A1.2	101	Engineering Library	13
A1.3	126	Printed Wiring Processes	17
A1.4	125	Signal Fading at Optical Wavelengths	25
A1.5	126	Research into New Semi-Conductors	33
A1.6	126	Fabrication of Miniaturized Semi-Conductor Devices	33
BUILDING C			
Ground Floor			
CG.7	9	PBX Extension Traffic Recorder and Analyser (PETRA)	35
CG.8	9	Signalling Conversion Relay Sets	35
CG.9	11	Exchange Control Processor	35
CG.10	11	Integrated Switching and Transmission Project (IST)	36
CG.11	22	Probability Studies Using the Olivetti Programmable Calculator	12
CG.12	22	Attenuator Calibration	28
CG.13	30	Standard Cell Enclosure	28
CG.14	30	Direct Current Comparator Potentiometer	28
CG.15	30	Calibration of A.C. Voltmeters	28
First Floor			
C1.16	139	Automatic Speech Level Meter	37
C1.17	137	Data Transmission	40

No.	Room	Title	Page
C1.18	123	Graphical Symbols for Logic Diagrams	36
C1.19	129	Rural Radio Telephone System	40
C1.20	128	Satellite Radio Telephone System	40
C1.21	123	Electronic Circuit Tester	38
C1.22	123	Custom Integrated Circuits	36
C1.23	118	Rural Party Line Service with Tone Dialling	36
C1.24	114	Automatic Recording of Measurements	38
C1.25	115	Pulse Code Modulation (PCM) Systems	40
C1.26	117	Delta Modulation	41
C1.27	115	Pseudo-Random Binary Sequence Generator and Error Counter	38
C1.28	117	Logic Test Probe	38
C1.29	121	Electronic Signalling Equipment	37
C1.30	119	Common Channel Signalling	37
C1.31	121	Signalling Equipment for PCM Junctions	37
C1.32	122	Printed Wiring Processes (Photography)	17
Second Floor			
C2.33	236	APO Standard of Frequency & Time	29
C2.34	201	The Hewlett Packard Calculator	12
C2.35	234	Transmission of Standard Frequencies over Carrier Systems	29
C2.36	233	Future Standard Frequency and Time Signal Service, VNG	29
C2.37	225	Fluidics	17
C2.38	225	Printed Wiring Artwork	17
C2.39	225	Endurance Test of a Clutch and Life Testing Machines	17
C2.40	221	Design of Radio Equipment	25
C2.41	223	Quartz Crystal Laboratory	33
C2.42	219	Quartz Crystal Laboratory	33
C2.43	218	Quartz Crystal Laboratory	33
C2.44	216	Improved Microphone for Telephones	34
C2.45	216	Telephone for the Hard of Hearing	34
C2.46	216	High Sensitivity Telephone	34
C2.47	214	Telephone Efficiency Tester	32
C2.48	213	Subscribers' Instrument Tester	32
C2.49	209	Co-ordinatograph	17

BUILDING F

Third Floor			
F3.50	305	Digital Computer	12
Fifth Floor			
F5.51	522	Variable Equaliser for Data Transmission Circuits	41

No.	Room	Title	Page
F5.52	520	Pulse-Echo Testing of Co-axial Cables	41
F5.53	501	Field Measurement of Transmission Conditions	26
F5.54	504	Field Microwave Propagation Measurements	26
F5.55	510	Measurement of Radio Refractive Index of the Air	26
F5.56	513	Impedance Properties of Slot Radiators	26
F5.57	514	Transmitter Power Telemetering	26
F5.58	516	Propagation Measuring Equipment, Records and Analyses	27
F5.59	525	Television Ghosts	27
F5.60	525	Radar Refractometry	27

BUILDING R

Ground Floor

RG.61	9	Fatigue of Lead Sheathed Telephone Cable	22
RG.62	4	Tip Welding of Conductors	20
RG.63	5	Measurement and Control of Colour and Photometry	30
RG.64	8	Sustained High Voltage Testing	20
RG.65	7	Impulse Voltage Testing	20
RG.66	6	Environmental Facilities	21

BUILDING T

First Floor

T1.67	101	NOSFER Telephone Transmission Reference Standard	30
T1.68	101	Loudness Balancing Techniques	30
T1.69	120	Objective Measurements of Telephone Transmission Performance	31
T1.70	105	Acoustic Test Rooms	31
T1.71	105	Anechoic Room	31
T1.72	105	Reverberent Room	31

Second Floor

T2.73	213	Microwave Fading Phenomena—Millimetric Wave Demonstration	27
T2.74	220	Assessment of Cables with Pulsed Carrier Techniques	42
T2.75	205	Adaptive Echo Canceller	42
T2.76	212	Klystron Frequency Stabilisation	38

BUILDING W

Ground Floor

WG.77	5	Equipment Records	14
WG.78	13	Acceptance Testing Laboratory	14
WG.79	20	Instrument Makers Machine Shop	14

No.	Room	Title	Page
First Floor			
W1.80	113	Data Logging System	39
W1.81	113	Photography of Lightning Current Waveforms	39
W1.82	106	Clockwork Recorders	15
W1.83	123	Instrument Repair	15
W1.84	110	High Frequency Calibration	15
W1.85	108	Museum	15
W1.86	115	Electronic Service	15
W1.87	114	Evolution of Electronic Instruments	16
W1.88	116	General Instrument Calibration	16
W1.89	117	General Instrument Calibration	16
Second Floor			
W2.90	204	Luminescent Tape Testing	21
W2.91	224	Life Testing of Telephone Dials and Switchboard Cord Cassettes	21
W2.92	206	Reed Relay Testing	21
W2.93	207	Infra-Red Absorption Spectrophotometer	22
W2.94	210	Evaluation of Plastics	24
W2.95	212	Plastic Welding	24
W2.96	216	Soft Magnetic Iron	22
W2.97	216	X-Ray Fluorescence Spectrograph	22
Third Floor			
W3.98	305	Strain Age Embrittlement of Structural Steel	22
W3.99	307	Heat Treatment of Non-Aging Soft Magnetic Iron	23
W3.100	307	Sulphur Dioxide Cabinet	23
W3.101	309	High Temperature Tensile Tests on Wire	23
W3.102	308	Flaw Detection Techniques in Metals	23
W3.103	316	Carbon Determination Apparatus	23
W3.104	316	Instrumental Plating Thickness Measurement	23
W3.105	319	Bausch & Lomb Metallograph	23
W3.106	320	Connectors for Upgrading Part Privately Erected Telephone Lines	24
Fourth Floor			
W4.107	406	Soxhlet Extraction	19
W4.108	406	Determination of the Detergent Resistance of Floor Polishes	19
W4.109	406	Determination of the Phosphate Content in Laundry Powders	19
W4.110	408	The Atomic Absorption Spectrophotometer	19
W4.111	408	Gas Chromatograph	19
W4.112	409	Epoxy Resins	24

No.	*Room*	*Title*	*Page*
W4.113	413	Jointing Methods for Plastic Sheathed Cables	24
W4.114	413	Loading Coil Cases	25
W4.115	413	Insect Proof Plastic Cable	25
W4.116	418	Investigation and Testing of Batteries	20
W4.117	401	Corrosion of Cables and Underground Metallic Structures	20

DETAILS OF EXHIBITS

Computation Facilities

A wide range of calculating machines, ranging from simple adding and subtracting devices, through electrically powered calculators to modern programmable, electronic desk machines are used in the Laboratories.

F3.50 Digital Computer

The Laboratories' computer, a CDC 160-A general purpose digital unit, is operated on an 'Open-House' basis to perform scientific calculations for our staff and other APO Sections, to act as hardware controller during experiments etc. This unit has also been employed in computer to computer communication trials via a satellite link established through the Cooby Creek (Qld) ground station.

Its magnetic-core memory contains some 16,000 12-bit words with a cycle time of 6.4 micro-sec. The peripheral equipment includes a paper tape reader and punch, a line printer, two magnetic tape units and a digital plotter. The most frequently used programming language is 'APO Research Fortran', developed in the Laboratories to give shorter compilation and execution times as well as more comprehensive editing facilities. *B. Warren 630 7336*

CG.11 Probability Studies using the Olivetti Programmable Calculator

A number of programmes have been written for this machine for handling the more routine statistical calculations. On this occasion the calculator will be demonstrated playing as an opponent to a human operator in a dice game known as 'Angela', in which visitors are invited to participate. Other programmes and applications can also be demonstrated. *P. Glick 630 7306*

C2.34 The Hewlett Packard Calculator

A particular convenience of this calculator is the keyboard availability of trigonometric and hyperbolic functions and their inverses, and the ability to manipulate complex numbers, as required in impedance and admittance calculations.

In one programme, spherical trigonometry is applied to the calculation of range, bearing and radio time delay between points on the earth's surface. The relationship between a radio path and the sunset and sunrise fronts (which is important in the study of Very Low Frequency radio propagation) is the subject of another programme.

The calculator is also used for statistical evaluation of data and general engineering designs, e.g. filter design and antenna polar patterns. A number of programmes are available for demonstration. *R. Trainor 630 7948*

Also of interest *Page*

CG.9 Exchange Control Processor 35

Internal Services

A considerable number of staff is involved in providing in-house services for the investigatory groups of the Laboratories. These services include a large reference library and information service, a specialised design team, a mechanical and telecommunications model shop, a maintenance and calibration facility for all test equipment, and a patents service. A number of these activities are discussed below :

A1.2 Engineering Library

The large library attached to the Research Laboratories provides a back-up service to the engineering activities of the Department as a whole. There are five small 'branch' libraries attached to other sections of the Department's Headquarters engineering staff, all located in Melbourne, and a library in each State (except Tasmania). By virtue of the wide scope of the Department's responsibilities and activities, the Engineering Library is developing into the leading library in the communications engineering field in the South West Pacific area.

The primary field is telecommunications engineering. Important subject fields are : light electrical engineering including engineering costing and drawing practice ; electronics, including radio, television, electronic switching and instrumentation ; telephony and line practices ; mathematics and statistics ; computers and data processing ; physics, chemistry and metallurgy.

Services available to Australian Post Office staff are : reference and information searching, compilation of bibliographies, translations, loans, periodical circulation, selective dissemination of information from the latest periodical literature, and technical services which cover selection, acquisition, cataloguing and classifying of literature. *Miss M. Cuzens 630 7935*

LABORATORY EQUIPMENT DIVISION

The main functions are as follows :

1) Provision of instrumentation facilities for the Laboratories including the issue, recording, servicing and calibration of laboratory-type scientific, electrical, electronic and electro-mechanical equipment.
2) Development of special purpose instrumentation techniques and equipment.
3) Provision of instrument-making facilities and special measuring services including technical photography.
4) Preparation of technical specifications of new items of laboratory equipment, evaluation of tenders, preparation of technical reports recommending purchasing action and the acceptance testing of deliveries of new laboratory equipment. *A. M. Collins 630 7980*

WG.77 Equipment Records

On display are the numerical and alphabetical Index Records of the Laboratories' equipment assets which are prepared, and regularly updated, by the Group. The machine used for this purpose is an automatic typewriter which is exhibited along with the tape library for each page of the Index. A complete page of the Index can be typed out in less than three minutes : new tapes are readily produced when additions or amendments are necessary.

Examples of laboratory equipment handbooks and handbook binding equipment are on display. *Miss D. Chapman 630 7976*

WG.78 Acceptance Testing Laboratory

All new equipment received into the Laboratories must be tested for compliance with the manufacturer's stated performance claims, or specifications as stated in tenders, before it is accepted and authorisation for payment is given.

The exhibit in this laboratory shows a test performed on a Low Voltage Power Supply to establish the output voltage versus load regulation characteristic. Here a storage oscilloscope is being used to display the pattern of the output voltage variations as load is switched, sequentially, from the off to the on state.

Instruments which are to be acceptance tested by the group are on display. *H. B. Fitzsimons 630 7974*

INSTRUMENT-MAKING REPAIR & SERVICE

WG.79 Instrument Makers Machine Shop.

Machines used for fine instrument work, coil winding, engraving and the magnetisation of instrument magnets are on display, with some typical examples of the work produced.

W1.82 Clockwork Recorders.
A large number of recorders and hygrographs are clockwork driven, for application in remote field sites. The clockwork type of recorder is repaired and calibrated by this Group. Clockwork mechanisms are regularly stripped down, cleaned and re-timed after periods determined by the programmed recall system. Some of the Laboratories' recorders are on display in this area. A recorder clock is on display in a perspex case so that visitors may observe the action of a typical mechanism.

W1.83 Instrument Repair.
The Instrument Makers employed in this section are concerned with the repair of accurate laboratory instruments and the construction of precision standards. This work may involve the construction of instrument component parts which are not available commercially. Some typical samples of the work carried out in this area are on display. *R. Jepson 630 7975*

W1.84 High Frequency Calibration
This Group undertakes the calibration of laboratory instruments at frequencies generally above 10 MHz and up to about 10 GHz.

On display in this area are :

Calibration of a High-Performance Oscilloscope. A complete performance check and calibration routine is performed to establish absolute accuracy in time and voltage, and the functional performance of features such as transient response and rise-time. The various items of test equipment required for the full performance testing of an oscilloscope of this type are on display and include a constant amplitude signal generator, standard amplitude calibrator, fast rise-time generators, plug-in test modules and capacitance standards.

Calibration of an Attenuator. The set up shown illustrates the equipment required to calibrate an attenuator at microwave frequencies. This equipment comprises a signal generator, slotted line, standing wave indicator, stub tuner, directional coupler and the attenuator under test. *B. Cranston 630 7978*

W1.85 Museum
On display some examples of radio and electronic test equipment of the early 1920s. *R. Jepson 630 7975*

W1.86 Electronic Service
This section performs a fault location, repair and maintenance service for the full range of electrical and electronic equipment used in the Laboratories. On display are :

Alignment of a UHF Signal Generator. Having replaced a faulty Klystron oscillator it is necessary to re-align accurately the repeller tracking. Here a frequency modulated signal is being used to set up the repeller tracking voltage so that the dial frequency accuracy and output voltage level is maintained over the entire frequency band.

Alignment of a Field Intensity Measuring Set. In the exhibit shown the swept frequency signal is being fed into the input of the measuring set under test. The resulting frequency response patterns are illustrated on a large cathode-ray tube. *B. McEwen 630 7978*

W1.87 Evolution of Electronic Instruments

Opportunity has also been taken to exhibit some of the earlier instruments used in the Research Laboratories so that visitors may compare these with their present day counterparts. The exhibits include :

Cathode Ray Oscilloscopes ranging from a 1925 Optical Oscillograph to the modern 'solid state' instrument.

Electronic Voltmeters ranging from a 1925 single range 'thermionic' model to the modern solid state multi-range instrument.

Signal Generators ranging from a two-triode 1934 model to the modern type.

Frequency Comparison Equipment ranging from an early 'Precision Wavemeter' to a modern electronic frequency counter. *R. Jepson 630 7975*

W1.88 General Instrument Calibration

W1.89 This Group undertakes the calibration of the Laboratories' indicating instruments, bridges, potentiometers, oscilloscopes and volt-ratio boxes at d.c. and frequencies generally up to about 10 MHz. The period between calibrations for the majority of these instruments is regulated by a programmed and systematic recall system operated by the Records Group. On display in this laboratory are :

Calibration set-ups for Multimeters and Electronic Voltmeters. Here the instruments are undergoing calibration against a Digital Voltmeter Standard, and closed-circuit television being used to expand the meter scale for viewing on a 10 inch TV screen. The viewing of meters scales, or sections of the scale, by this means reduces operator eye strain and fatigue and lessens the probability of accidental errors.

Calibration of a Universal Measuring Bridge. Accurately known standards of capacitance, inductance and resistance are being used to determine the dial reading accuracy of the bridge. *A. Adamson 630 7979*

MECHANICAL & ELECTRICAL DESIGN

This team designs specialised mechanical and electro-mechanical equipment for other Laboratories groups and engineering sections of the Department. Particular interests are listed below :

C2.37 Fluidics

Fluidics covers the technology of using low pressure jets of gas (air) or liquid to control higher pressure systems, particularly in the control of machines and equipment and where the working fluid of the machine itself can be applied to the control system.

On display are some types of fluidic components showing the principle of operation, and a working model. *R. Kilby 630 6777*

C2.39 Endurance Tests of a Clutch and Life Testing Machines

A torque-limiting clutch is used in driving the letter stacker of each coding machine at Sydney Mail Exchange, in order to prevent overload of the machine components. This exhibit shows a stop-start wear test on a prototype clutch which was designed in the Laboratories. This test will prove whether the clutch is capable of performing its assigned task for long periods without maintenance or re-adjustment.

Machines are frequently required for the life testing of components and telecommunication equipment. Where suitable machines cannot be obtained from commercial sources appropriate designs are prepared in the Mail Handling Division of the Laboratories. Photographs of recently constructed equipment are displayed. *A. H. Baddeley 630 7327, S. Tjio 630 7329, D. Sheridan 630 7328*

AG.1 C1.32 C2.38 C2.49 A1.3 **The Model Shop** provides workshops support services for the Laboratories as a whole. Skilled tradesmen equipped with a wide range of machine tools, sheet metal working and welding facilities manufacture prototype mechanical components or equipment as required. The work ranges from the precise machining of waveguide components ; the fabrication of larger life testing machines required for environmental or reliability studies of items of Departmental equipment ; the construction of unprocurable mechanical test equipment ; to routine preparation of standard test specimens for tensile and similar tests.
C. V. Eyre 630 7311

Photo-mechanical and chemical etching processes have been developed in the Laboratories to produce local requirements for prototype printed wiring boards from copper-clad laminate sheet. More specialised applications of these techniques and of plated-through-hole processes are being investigated for microwave stripline and multi-layer printed wiring applications. This work involves three Laboratory Divisions :

C1.32 C2.38 C2.49 A1.3 **The Mechanical and Electrical Design Division** which designs board layouts for customer groups, and prepares the artwork necessary for the production processes : when master artwork is required with dimensional tolerances better than $\pm 0.002''$, a co-ordinatograph is used. *S. Tjio 630 7329*

The Model Shop Group processes the copper-clad laminate sheet to reproduce the conductor patterns of the artwork on the laminate sheet as a printed wiring board. *P. Battlay 630 7312*

The Chemistry Division acts as consultants to the Model Shop Group and helps to formulate the chemical processes required in production. *J. Der 630 7996*

There are two displays of aspects of this work. The full production technique used to produce printed wiring boards is demonstrated in the General Services Division (A1.3). The methods and equipment used in the preparation of the necessary artwork are on display in the Mechanical and Electrical Design Laboratories (C1.32, C2.38 & C2.49).

Also of interest *Page*

Computation Facilities .. 12
Electrical Standards .. 28
Frequency Standards .. 29
Telephone Standards .. 30

Material & Component Investigations

The materials and component parts used in the Australian Post Office are expected to retain their properties over periods from 20 to 40 years. Hence it is necessary to study these properties at the design stage, in order to predict life time behaviour and to ensure that the equipment of which the materials and components form part will perform reliably under the various environmental conditions to which it may be subjected. At the same time it is necessary to find the reasons for failures or degradation phenomena so as to take the necessary remedial actions.

The Chemists, Metallurgists and Physicists in the Physical Science Group apply their specialised knowledge and techniques to the solution of these problems and co-operate with the departmental engineers in the continuing quest for improved performance.

CHEMICAL RESEARCH

Many Departmental problems are solved or more clearly understood when submitted to chemical investigation. In addition to the general analytical and investigation work or short- and long-term projects, advice is constantly requested on matters of immediate concern. Chemical knowledge is of vital importance in evaluation of the properties and performance of materials and the elimination and prevention of potential accident and health hazards. The functions of the Division also include rendering assistance in devising or amending Departmental operation and procurement specifications ; this latter feature often involves giving guidance to the suppliers of materials under Departmental contracts.

W4.107 Soxhlet Extraction

This apparatus is convenient and widely used for the separation of substances by solvent extraction. It is employed frequently for the removal of the impregnants in textiles, and telegraph and similar papers. *F. Petchell 630 6621*

W4.108 Determination of the Detergent Resistance of Floor Polishes

This scrubbing machine has proved most successful for the determination of the resistance of floor polishes to removal by cleaning agents. It was constructed to provide a practical and reproducible method of test, to overcome the subjective character of previous methods, and also to accommodate the newer and better quality products. *F. Petchell 630 6621*

W4.109 Determination of the Phosphate Content in Laundry Powders

The phosphate content in soap products can be determined readily by the use of automatic titration apparatus. This demonstration also shows how a neutralisation end point can be determined in coloured solutions which preclude the use of indicators. *F. Petchell 630 6621*

W4.110 The Atomic Absorption Spectrophotometer

This method of chemical analysis permits the determination of the concentration of a particular element in a solution, by measurement of the absorption of light emitted from the same element. By means of this instrumental technique, most of the metallic and some non-metallic elements can be determined accurately and specifically in the presence of others without the necessity for tedious chemical separation. *J. Der 630 7996*

W4.111 Gas Chromatograph

This instrument is used to analyse volatile organic substances, in particular in the analyses of gas mixtures and solvents, and for the separation of volatile organic mixtures for identification by infra-red spectrophotometry. It is currently planned to extend its use to analyse and identify less volatile organic substances using esterification techniques. *J. Der 630 7996*

W4.116 Investigation and Testing of Batteries

Acceptance tests are carried out on lead-acid and nickel-cadmium alkaline secondary cells. Their capacity, float current and charge retention are determined according to specification.

In case of battery failure the electrolyte and various components of the battery are examined to establish the cause of failure. In the electrolyte the more frequent impurities are chloride, perchlorate, iron, acetate, nitrate, ammonia. Classical, and where possible instrumental analytical methods are used.

Several exhibits are shown to demonstrate some of the characteristic failures. *J. Der 630 7996*

W4.117 Corrosion of Cables and Underground Metallic Structures

Samples of the corroded metal together with soil and water samples from the surrounding areas are examined. Spot test methods are used for identification of corrosion products as well as for corrosive agents in water and soil. Once the cause of corrosion is established appropriate preventive measures are recommended.

Several corrosion samples are exhibited and the probable causes of the faults are indicated. *J. Der 630 7996*

ENVIRONMENTAL PHYSICS

RG.62 Tip Welding of Conductors

This tool, which is being patented, welds copper or aluminium wires in an arc between an electrode and the wire pair. A high voltage pulse breaks down the inter-electrode air gap, the welding arc is then maintained by a low voltage current, and extinguishes as the melting tip retracts. The reliability and resistance of such joints are being studied. *E. Bondarenko 387 1574*

RG.64 Sustained High Voltage Testing

50 kV D.C., 50 kV 50 Hz and 30 kV Radio Frequency generators are shown affecting various solid insulating materials. The Radio Frequency generator is also demonstrated being used to calibrate gas discharge tubes used for field gradient measurements of Radio transmitter aerials.

A 5000 volt repetitive impulse generator is shown life testing various lightning arrestors. The number of times that the device being tested fails to fire is recorded, and the equipment is automatically switched off when the insulation resistance falls below a preset level. *H. Pether 38 6588*

RG.65 Impulse Voltage Testing

The high voltage impulse generator can provide up to 1.4 mega volts of various wave shapes with a rise time as little as 1 microsecond. It is used to study the effects of lightning and power surges on APO equipment, and hence design suitable protection schemes.

A simulated lightning strike across an insulator mounted on a wooden pole will be shown, together with examples of high voltage damage to various plant items. *H. Pether 38 6588*

RG.66 Environmental Facilities

Four chambers of approximately 6 cubic metres each are on display. One has a temperature range from −40°C to 93°C, whilst the others have a smaller temperature range but have relative humidity control from 10% to 100%. Typical applications can be seen inside the chambers.

A weatherometer and smaller chambers can also be seen around the laboratory. *S. Noble 387 1596*

MATERIAL PHYSICS

W2.90 Luminescent Tape Testing

A test which has been developed to measure the luminescent properties of the tape used to code letters in mail exchanges is shown. An imprint from the tape on to manila card and a primary standard phosphorescent source are placed behind different windows in the test jig. The jig is dropped under gravity past a U.V. tube and a photomultiplier tube to obtain the correct illumination and reading delay times. The output pulses are compared on a storage oscilloscope. The secondary standard consisting of a pre-aged lamp, energised with a precise current, is housed in a similar jig. *N. Sadler 630 7987*

W2.91 Life Testing

Telephone Dials are life tested by repetitive operations of the finger plate to simulate the dialling of the digit '8'. The pulses produced by the dials are measured by means of a digital pulse analyser which can display the length of any pulse, and indicate whether there is contact bounce. All the information for one pulse train from a dial is stored and can be fed out to a paper punch. *I. Dew 630 6614*

Switchboard Cord Cassettes. These devices, which are designed to replace the weight and pulley as cord retractors, are being life tested by a machine which simulates the action of the switchboard operator. *A. Bauer 630 6531*

W2.92 Reed Relay Testing

The apparatus shown can operate and test 300 reed relay inserts at the one time at a contact operating rate of 750 per minute. The amount and type of load connected in series with each contact is readily changed. Each operation of each insert is checked for correct timing. If a timing error is found, the identifying number of the insert responsible is stored for punching onto paper tape at the end of the next even 1,000 operations. At selected intervals the contact resistance of each insert is measured and recorded on paper tape. *I. Dew 630 6614*

W2.93 Infra-Red Absorption Spectrophotometer

The use of this instrument to determine the amount of plasticiser present in a nylon moulding is shown. In the spectrum of the mixture of compounds present in a plastic article it is sometimes possible to select absorption peaks which are representative of the components of interest and which are not affected by the presence of the other components. If a range of mixtures of known composition is available, the proportions present in unknown samples can be determined by measuring the ratio of these absorption peaks, and comparing them with those of the known samples. *D. McKelvie 630 7985*

W2.96 Soft Magnetic Iron

The magnetic parameters of the soft magnetic iron used in telecommunications equipment are measured using a B-H curve tracer developed and built in the Laboratories.

An iron sample in the form of a ring is wound with a small secondary winding and then placed in the current cage (primary winding). The B-H curve is automatically drawn in 1½ minutes. The coercive force Hc and the remanence Br are read from the graph with an accuracy of $\pm$0.01 oe for Hc and $\pm$100 gauss for Br.

N. Sadler 630 7987

W2.97 X-Ray Fluorescence Spectrograph

The use of this instrument to determine the concentration of copper-chrome-arsenic preservative in timber poles is shown. Cores taken from the poles are cut into discs. The concentration of each of the metals in each disc is determined by a conventional X-Ray fluorescence method. Pellets made from treated timber flour which has been analysed by wet chemical methods are used as calibration standards. *D. McKelvie 630 7985*

METALLURGICAL RESEARCH

RG.61 Fatigue of Lead Sheathed Telephone Cable

During the transport of lead sheathed telephone cable to remote areas in Australia, fatigue failure of the lead sheathing occurs. A fatigue testing machine has been designed and built by the Research Laboratories so that an investigation into the fatigue properties of lead sheathed cables can be performed. The effects of frequency and amplitude of vibration, internal air pressure and temperature are being evaluated. *T. Keogh 630 7895*

W3.98 Strain Age Embrittlement of Structural Steel

Following the catastrophic failure of the 500 ft Mt Gambier Television mast during construction, the effects on structural steel of severe cold work followed by galvanizing have been studied. Samples displayed show the effect of the combination of galvanizing and different cutting techniques. *K. Mottram 630 7993*

W3.99 Heat Treatment of Non-Aging Soft Magnetic Iron

The magnetic properties of non-aging soft magnetic iron, used in large quantities for the manufacture of switch and relay components, are very sensitive to heat treatment. A constantly increasing e.m.f. fed at a predetermined rate into series with the furnace control thermocouple circuit allows cooling after annealing, at set rates lower than the natural cooling rate of the annealing furnace. *K. Keir 630 7991*

W3.100 Sulphur Dioxide Cabinet

With controlled amounts of sulphur dioxide admitted into the cabinet, electroplated coatings can be tested for corrosion resistance and porosity, whilst aluminium anodic coatings can be tested for adequacy of sealing. *K. Keir 630 7991*

W3.101 High Temperature Tensile Tests on Wire

The tensile properties of various types of aerial line wires are being investigated over a range of temperature from ambient to 600°C.

The apparatus used is a conventional tensile tester and a specially built small tube furnace, the temperature of which can be accurately measured and controlled. *K. Mottram 630 7993*

W3.102 Flaw Detection Techniques in Metals

The inspection of metals often involves the use of non-destructive techniques, to determine the presence and/or extent of any flaws which may exist. For this purpose the Laboratories have a range of non-destructive flaw detection equipment. Ultrasonic, dye penetrant and magnetic particle flaw detection equipment are included. *T. Keogh 630 7895*

W3.103 Carbon Determination Apparatus

Many metallurgical investigations include the determination of the carbon content of the metal under investigation. The Leco carbon determination apparatus employs both conductometric and gravimetric processes allowing analysis over a very wide range of carbon contents. Sulphur determinations using a titration procedure are also carried out employing this apparatus. *P. Ramsden 630 7991*

W3.104 Instrumental Plating Thickness Measurement

A number of non-destructive test methods are used in plating thickness measurements, employing Beta-Ray backscatter, low frequency eddy current, high frequency eddy current, and magnetic type instruments. A locally destructive coulometric apparatus is used for certain plating materials and for cumulative measurements on multiple layer plating. *P. Ramsden 630 7991*

W3.105 Bausch and Lomb Metallograph

A Bausch and Lomb metallograph is used for the study of metal structures. A polaroid attachment can be used for the rapid production of photo-micrographs, whilst a TV monitor allows of intensified images being viewed simultaneously by a group of observers. *T. Keogh 630 7895*

W3.106 Connectors for Upgrading Part Privately Erected Telephone Lines

Part privately erected telephone lines in outback areas are often broken by falling trees, storms, wandering cattle etc., and the wire, often heavily rusted, is frequently rejoined in a manner which gives rise to noisy and unsatisfactory communications. A simple sleeved connector has been designed to permit reliable joints to be made without necessitating difficult cleaning and soldering operations. *K. Keir 630 7991*

POLYMER CHEMISTRY

W2.94 Evaluation of Plastics

To differentiate between grades of the same polymer materials, melt flow index and density gradient column determinations provide a quick answer. The methods will be demonstrated respectively for polythene and nylon.

To ascertain the life expectancy under field conditions of a material, long term accelerated ageing tests are conducted, such as the thermal cycling under water immersion of phenoxy moulds, repairs in polythene cable and epoxy resin joints in moisture barrier cable, being shown. *B. Chisholm 630 6619*

W2.95 Plastic Welding

Polythene and polypropylene being virtually inert chemically no solvent has been found that permits joining of structural parts by cementing. For this reason, welding has become the most practical method of jointing parts. Torch or hot-gas welding, heated-tool welding, glass-tape welding and electric element welding will be demonstrated. *J. Smith 630 7991*

W4.112 Epoxy Resins

Epoxy resins are extensively used in the APO and exhibits show their use in cable jointing, component encapsulation, cable pulling eyes, terminal blocks, grouts for anchor bolts, non-skid coatings etc. Each application requires special formulation to achieve the desired properties and various test methods used are demonstrated. *H. Ruddell 630 7995*

W4.113 Jointing Methods for Plastic Sheathed Cables

Polythene has been a most successful substitute for lead as a cable sheath but because of its inertness, jointing of polythene covered cable is still a world-wide problem.

The APO method of total encapsulation of joints in epoxy resin will be shown on small size cables (1" in diameter or smaller) and a new development involving fluidised-bed coating, expansion and contraction of polythene mouldings and electric element welding will be demonstrated on large size cable. *R. Western 630 6622*

W4.114 Loading Coil Cases

Metallic barriered, fibre-glass re-inforced epoxy resin or PVC containers are being evaluated for future use as 10-1200 miniaturized loading coil assemblies. Prototypes are being tested as shown for moisture permeation and deformation under pressure. *H. Ruddell 630 7995*

W4.115 Insect Proof Plastic Cable

As polythene and PVC are subject to termite and ant attack, special insect proof barriers must be provided, such as nylon jacketing. Examples of insect attacks on various plastic materials are shown. Promising materials are evaluated in specially constructed test plots in Northern Australia for periods up to five years. *H. Ruddell 630 7995*

Also of interest *Page*

Research into New Components 42
A1.3 Printed Wiring Processes 17
C1.22 Custom Integrated Circuits 36
C2.39 Endurance Test of a Clutch and Life Testing Machines 17
C2.44 Improved Microphone for Telephones 34
RG.63 Measurement and Control of Colour and Photometry 30

Radio Propagation

A number of teams is concerned with various aspects of radio propagation, with the emphasis on extremely high frequencies. A great deal of work is carried out at microwave frequencies, which are used for high capacity telephone and television relay circuits.

A1.4 Signal Fading at Optical Wavelengths

In very much the same way as radio waves, light may be used for the transmission of information over large distances. Because of the much higher frequencies of these waves, an optical system would have the advantage of carrying an extremely large number of telephone and television channels. However the propagation of light through the atmosphere is very much affected by the weather, for instance by rain and fog which may completely interrupt the link for several hours.

These aspects are demonstrated using a modulated semiconductor source. *N. Teede 630 6899*

C2.40 Design of Radio Equipment

The Radio Laboratory is engaged in the design of radio apparatus required for various purposes within the Laboratories and the Department. Instruments used for experimental and testing work will be exhibited. Two particular items of equipment to be shown are as follows :

I.F. Level Recorder. This unit is part of a project currently in progress to re-equip the Propagation Divisions of the Laboratories with radio equipment for microwave propagation surveys. It records the level of an I.F. Signal from a microwave receiver on a paper chart, over a wide range of levels, with high accuracy.

Solid State Microwave Source. This unit is a low power source for a receiver local oscillator at 6 GHz. It consists of an oscillator at 1 GHz phase locked to a crystal oscillator at 100 MHz and a step recovery diode multiplier to 6 GHz. The output power is about 6 mW. *I. Lawson 630 7917*

F5.53 Field Measurement of Transmission Conditions

Display boards here cover an Australia-wide range of field installations for the measurement of transmission conditions. Photos show, in particular, microwave propagation measurements over Bass Strait and on Nullarbor Plain, with diagrams illustrating some very adverse propagation phenomena. *G. Jenkinson 630 7922*

F5.54 Field Microwave Propagation Measurements

This activity is illustrated by a slide-show with sound commentary, describing the field operations of the two Radio Propagation Divisions 'Path Evaluation' and 'Propagation Research'. In particular it embraces the use of complex microwave measuring equipment in a variety of remote field sites, and methods of obtaining refractive index gradients, reflection coefficients and meteorological parameters. *S. Barnard 630 7925*

F5.55 Measurement of Radio Refractive Index of the Air

Radio waves, in propagating through the lower levels of the earth's atmosphere, are influenced by the refractive index of the air. The radio refractive index is a function of air temperature, humidity and pressure.

The equipment on display continuously measures the radio refractive index by measuring the dielectric constant of the air using a resonant microwave cavity. This equipment is carried in a light aircraft to study the variations of refractive index in space and time. *G. Jenkinson 630 7922*

F5.56 Impedance Properties of Slot Radiators

A knowledge of slot impedance properties is essential for the design of slot antenna arrays with a desired shape of radiation pattern.

The slot impedance amplitude and phase are affected by the slot's dimensions, position in the guide, and by the presence of dielectrics.

The display, using an automatic impedance plotter, shows on a Smith Chart plot the effects on impedance of various slot configurations. *S. Sastradipradja 630 7250*

F5.57 Transmitter Power Telemetering

In radio propagation studies the test transmitter power must be continually monitored, generally to yield a strip chart record at the transmitter site. This exhibit displays five separate devices realised over the last decade for telemetering, generally by modulating the transmitted signal itself with a pattern indicating the power level fed to the transmitter aerial. *R. Harvey 630 7924*

F5.58 Propagation Measuring Equipment, Records and Analyses

Typical propagation measuring equipment, as used in recent investigations on the Nullarbor Plains and over Bass Strait, will be on show. Records of long term signal-strength observations at different antenna heights, and records exemplifying a variety of fade mechanisms, will be displayed, together with analysis instruments and the derived statistics produced, in a variety of formats and time scales. *R. Harvey 630 7924*

F5.59 Television Ghosts

'Ghosts' are occasionally observed on domestic TV receivers, appearing as a weak replica of the normal picture and displaced to the right of it. They may be 'positive', with black and white values as in the original picture, or 'negative' (with black/white values interchanged).

A ghost will change type with slight aerial movement, or weather variations. These effects are demonstrated, and explained. *J. Reen 630 7921*

F5.60 Radar Refractometry

Radio refractive index measurements, essential in tropospheric propagation research, currently require a radio refractometer, carried aloft by a light aircraft or large balloon (see F5.55).

This 'concept feasibility' demonstration shows how the resonant frequency of a simple dipole structure varies with the refractive index of the medium in which it is imbedded. The radar return signal reflected from such a dipole hence varies with that refractive index. This opens the way to possible applications of such simple sensors for the remote reading of atmospheric refractive index. *J. Reen 630 7921*

T2.73 Microwave Fading Phenomena—Millimetric Wave Demonstration

The Department's line-of-sight radio systems, which carry the bulk of this country's long distance communications, operate between 2 and 8 GHz (wave length between 16 and 4 cm). The distance between transmitters and receivers is typically 30 miles (= 50 km).

The strength of the received radio signal from the distant transmitter depends not only on the radiated power and distance but also on the atmospheric conditions which exist between transmitter and receiver, and on the number of reflected rays from ground and upper atmosphere.

One type of fading is caused by the combination of the various rays at the antenna, another one by deviation from a straight path. The following effects will be demonstrated:

1) Fading due to reflection from flat ground.
2) Fading due to reflection from rough ground.
3) Fading due to limited ground clearance between transmitter and receiver.
4) Fading due to layer formation in the atmosphere.

These effects, modelled in this demonstration, are illustrated by records obtained in practical field measurements. *O. F. Lobert 630 7942*

Reference Standards

The Research Laboratories has the responsibility to maintain reference standards for the wide range of physical and engineering measurements carried out throughout the Department. The various standards are grouped below :

ELECTRICAL STANDARDS

The Electrical Standards Division is registered with the National Association of Testing Authorities for specific tests in the field of electrical testing. Some of the reference standard equipment and the techniques employed are shown in this group of exhibits.

CG.12 Attenuator Calibration

Waveguide and coaxial attenuators for use up to 10 GHz are calibrated by means of a heterodyne technique against a reference standard operating at 30 MHz. The standard attenuator has an optical projection scale with a resolution of 0.005 dB and is free from backlash. *J. M. Warner 630 7303*

CG.13 Standard Cell Enclosure

An insulated portable oven containing four standard cells, and capable of operation from the mains or internal batteries is used to transfer a standard of voltage from the National Standards Laboratory in Sydney to the Research Laboratories in Melbourne without the delay for cells to stabilise after temperature change. One day is sufficient for the round trip instead of over four weeks. *E. Pinczower 630 7296*

CG.14 Direct Current Comparator Potentiometer

This potentiometer operates on the current comparator principle of Kusters and MacMartin. Its accuracy is dependent on the ratio of turns on magnetic cores instead of relying on the stability of wirewound resistors. The resolution of the potentiometer is 0.1 microvolts in 2 volts and the accuracy of subdivision and long term stability is within 0.00005%. *E. Pinczower 630 7296*

CG.15 Calibration of A.C. Voltmeters

Alternating current voltmeters are calibrated at frequencies up to 100 MHz in terms of true r.m.s. volts against certified thermal transfer instruments. For rectifier type instruments, such as the typical digital voltmeter, which are considerably affected by waveform errors, a low distortion (0.05%) supply is used over the range 20 Hz to 100 kHz. *J. M. Warner 630 7303*

FREQUENCY & TIME STANDARDS

The frequency standard installation has been appointed by the National Standards Commission as a working standard of frequency and time interval for the Commonwealth under the Weights and Measures (National Standards) Act 1960-1964. It forms the basis for the legal verification of the Post Office's activities in the field of frequency and time, e.g. Radio Branch frequency measuring centres, the time signal service which is broadcast from VNG Lyndhurst and speaking clocks in capital cities.

C2.33 APO Standard of Frequency and Time

Caesium beam and rubidium gas cell atomic devices generate the standards of frequency and time. The standard is compared continuously with similar overseas standards at N.P.L., N.B.S. and U.S.N.O. by the reception of VLF within very close limits. The duplication of facilities gives the standard a high degree of reliability. The Installation is shown in block diagram form. *G. Willis 630 7290*

C2.35 Transmission of Standard Frequencies over Carrier Systems

Some requirements, e.g. the calibration of State Radio Branch frequency standards, have made it necessary to examine the transmission of a standard frequency from the APO standard over the carrier system. Asynchronism of the carrier frequencies which modulate and demodulate the signal at the send and receive ends respectively causes a slight displacement of the frequency transmitted. This display shows a means adopted to minimise this effect on a standard tone by transmitting it as the difference between two tones. *B. Endersbee 630 7950*

C2.36 Future Standard Frequency and Time Signal Service, VNG

Equipment has been developed to improve the range of services provided by VNG. Digital phaseable clocks and time code generators, supervisory alarm and switching system, fixed frequency synthesisers, distribution amplifiers and phase comparator and no-break power supplies have been combined with commercially available quartz crystal frequency standards and announcing machines to form a complete standard frequency and time signal installation to be operated at the Lyndhurst transmitter site. The performance of the installation will be continuously measured at the Laboratories by the Frequency Standards Division, as part of the procedure for legal verification under the Weights and Measures Act. *I. Macfarlane 630 7949*

PHYSICAL STANDARDS

A number of the instruments used in the Physical Sciences Groups are reference standards for particular measurements for the Department as a whole. A particular example is quoted below, and reference made to other appropriate exhibits at the end of 'Reference Standards' (page 32).

RG.63 Measurement of Control of Colour and Photometry

Visual methods using 'Munsell' standard colour cards under standard illuminants, and instrumentation methods based on the C.I.E. tristimulus system, as applied to coloured telephone mouldings will be demonstrated ; together with photometric equipment used in measuring properties of lamps. *E. Bondarenko 387 1574*

TELEPHONE STANDARDS

The Laboratories are responsible for the study, maintenance, and review of the overall effectiveness of the transmission performance of the Department's telephone network, taking into account particularly, subjective reactions of subscribers.

It is engaged in the development of techniques for precision acoustic measurements, electro-acoustic and telephone transmission reference standards, and carries out telephone transmission investigations involving both subjective tests and electro-acoustic measurements.

T1.67 NOSFER Telephone Transmission Reference Standard

To provide a basis for an internationally recognised loudness (volume) rating of telephone circuits, the International Telegraph & Telephone Consultative Committee (CCITT) has defined the performance of a standard reference transmission system known as NOSFER.

Such a reference system has been set up in these Laboratories and is utilised as a standard of volume efficiency, against which telephone circuits can by means of subjective loudness balances, be rated in terms of volume 'reference equivalents'.

A test team, maintained for carrying out a variety of subjective transmission tests, will demonstrate the 'reference equivalent' rating of a telephone circuit.
E. J. Koop 630 7619

T1.68 Loudness Balancing Techniques

The basic loudness balancing technique, as used in rating telephone circuits against the NOSFER for 'reference equivalents', and as used in other subjective comparisons of telephone circuit performance, is demonstrated in a simple experiment in which visitors are invited to balance the loudnesses of pairs of recorded speech signals, heard through head-phones, in an alternating sequence.
R. Wood 630 7627

T1.69 Objective Measurement of Telephone Transmission Performance

A set of commercially produced equipment, designed to carry out a range of objective measurements of transmission on telephone instruments and telephone circuits is shown. Using a swept-sine wave source varying between 300 Hz to 4000 Hz and back in a period of one second, with a mean spectrum energy distribution during this cycle approximately that of average speech, and using an artificial voice and an artificial ear and a special loudness summation circuit, this equipment measures the volume (or loudness) efficiency of telephone instruments and transmission circuits against an internally calibrated standard in such a way as to produce nominal 'reference equivalents'. The Equipment can also display and produce graphs of frequency responses of the circuits and components under test and also provide a measure of the harmonic and intermodulation distortion present in carbon microphones. *T. Duke 630 7622*

T1.70 Acoustic Test Rooms

T1.71 Anechoic Room

The anechoic room which is lined internally with fibre-glass wedges, provides a suitable environment for free-field acoustic measurements down to about 200 Hz. Its chief applications are in the free-field calibration of microphones—a particular case being the microphone of the NOSFER speech transmission reference system—for the determination of directional characteristics of electro-acoustic transducers and noise sources, and for loudspeaker frequency and transient response measurement. *E. J. Koop 630 7619*

T1.72 Reverberant Room

This room with hard reflecting surfaces and non-parallel walls, floor and ceiling provides an environment in which the reverberant field is highly predominant and in which the field is both highly randomised and of uniform intensity at most points within the room for frequencies about 300 Hz. Its main application is in calibrating sound level meter microphones (for random incidence) and for measuring the spectrum and total sound power of noise sources such as telephone bells.

The effect of anechoic and reverberant environments on the quality of speech communication will be demonstrated. *E. J. Koop 630 7619*

TELEPHONE ACCEPTANCE TESTING

Further equipment is required to directly measure the performance of individual telephone instruments or their components.

C2.47 Telephone Efficiency Tester

The performance of all telephones in the network is controlled by specifications ensuring a minimum sensitivity and adequate electrical characteristics at the manufacturing stage and later when reconditioned in Departmental Workshops. To enable telephones to be tested to these specifications, about fifty Telephone Efficiency Testers are spread throughout the Commonwealth, situated in State Material Inspection Laboratories, Workshops and the premises of several manufacturers.

All of these instruments derive their calibrations from standards held by the Research Laboratories, and a regular system of calibration is used to ensure that their accuracy is maintained. *R. W. Kett 630 7620*

C2.48 Subscribers' Instrument Tester

To provide a means of checking telephones in situ, the Subscribers' Instrument Tester has been developed. A test signal is transmitted from the exchange enabling the sensitivity of the transmitter and receiver to be measured. Measurements of D.C. line current and A.C. line loss may also be made. *R. W. Kett 630 7620*

Also of interest *Page*

C2.43 Quartz Crystal Laboratory 33
T2.76 Klystron Frequency Stabilisation 38
W2.90 Luminescent Tape Testing 21
W2.96 Soft Magnetic Iron 22
W3.104 Instrumental Plating Thickness Measurement 23

Research into New Components

In a number of areas, research into the performance of available components, and development of new items, is undertaken. Some examples are listed below :

A1.5 Research into New Semiconductors

The observation and device realisation of new semiconductor phenomena require a sound knowledge of semiconductor physics and materials technology. This knowledge is gained through a study of the preparation and properties of semiconductors, particularly those compounds of group III and V elements. Facilities developed in the Research Laboratories for the vacuum evaporation, plasma sputtering, vapour phase epitaxy, and electron beam zone recrystallisation of semiconductor layers and miniaturized devices are exhibited. *N. Teede 630 6899*

A1.6 Fabrication of Miniaturized Semiconductor Devices

A considerable increase in circuit complexity, reliability and economy is facilitated by the technology of semiconductor miniaturization. The exhibit shows stages of developments in miniaturized semiconductor circuitry and a range of support facilities for miniaturized semiconductor device fabrication. *N. Teede 630 6899*

C2.41 Quartz Crystal Laboratory

C2.42 The Crystal Laboratory is engaged in the manufacture of quartz crystals, the
C2.43 testing of crystals and oscillators and the design of oscillators.
The whole process is carried out, from the inspection and cutting of raw quartz to the testing of complete crystal oscillators. The machines and instruments used, samples of crystals at stages in the process and various complete crystals and oscillators are exhibited. *M. Lane 630 7919*

Also of interest *Page*

Material and Components Investigations .. 18
A1.3 Printed Wiring Processes .. 17
C1.22 Custom Integrated Circuits .. 36
C2.37 Fluidics .. 17
C2.38 Printed Wiring Artwork .. 17
C2.39 Endurance Test of a Clutch and Life Testing Machines .. 17
C2.44 Improved Microphone for Telephones .. 34
C2.49 Co-ordinatograph .. 17
W2.92 Reed Relay Testing .. 21
W3.99 Heat Treatment of Non-Ageing Soft Magnetic Iron .. 23

Telephone Instrument Development

Development work is carried out on new designs of telephone instruments for special applications, and on improved components and designs for future telephones for general application. Particular items to be seen are listed below.

C2.44 Improved Microphone for Telephones

The carbon microphone has given good service in telephony, its advantages being cheapness and its inherent amplification. It is, however, subject to ageing and its performance varies with time and attitude. New forms of microphone based on the electret principle in conjunction with an integrated circuit amplifier show promise of providing an economic replacement. *B. Everett 630 7333*

C2.45 Telephone for the Hard of Hearing

Many elderly persons are quite unable to hear the high pitched tones of a telephone bell, but are able to hear tones below 1,000 Hz. In this telephone the bell has been replaced by a swept tone oscillator producing tones in the range 400 to 900 Hz. Amplification of the receive circuit has been provided with increased gain at those frequencies which the subscriber can still hear. This allows a greater amount of amplification without howling, since the critical frequency involved is above 1,000 Hz. *R. W. Kett 630 7620*

C2.46 High Sensitivity Telephone

Considerable savings in the cost of providing subscribers' cables can be obtained by the use of a telephone of higher sensitivity. Problems of increased sidetone are encountered in so doing, and the telephone shown provides means of adjusting the instrument to suit the wide range of line impedances which may be encountered. *B. Everett 630 7333*

Also of interest *Page*

C1.16 Automatic Speech Level Meter 37
C1.19 Rural Radio Telephone System 40
C1.20 Satellite Radio Telephone System 40
C1.23 Rural Party Line Service with Tone Dialling 36
C1.26 Delta Modulation 41
RG.63 Measurement and Control of Colour and Photometry 30
T2.75 Adaptive Echo Canceller 42
W2.91 Life Testing of Telephone Dials and Switchboard Cord Cassettes . . 21

Telephone Switching Research

The Research Laboratories study the likely impact of changing technology on telephone switching in the Post Office telephone network. At the present time this is largely concerned with the application of electronics to exchange switching.

The speed of electronic circuitry allows for the control of very large exchanges, and the technique of stored program control by means of a central exchange control processor provides the flexibility which makes possible the administration of such large switching units.

CG.7 PBX Extension Traffic Recorder and Analyser (PETRA)

The expansion of Subscriber Trunk Dialling (STD) facilities now allows most trunk calls to be dialled direct by the originator of the call. To enable management to supervise the use of STD calls, an apparatus has been designed to record details of STD calls made from any PBX extension. *D. D. Mattiske 630 6343, D. Sheridan 630 7328*

CG.8 Signalling Conversion Relay Sets

As STD penetrates the telephone network situations arise where inter-exchange junctions must be used which comprise more than one type of transmission media, say cable or open wire in tandem with a carrier system. At the point of transition between the two media a device must be inserted to enable line signals to be transmitted from one transmission media to another. A family of relay sets has been developed to cater for these situations, and so allow STD to be extended further to the country areas. *D. Mattiske 630 6343*

CG.9 Exchange Control Processor

Both the IST and Common Channel Signalling projects described herein use the technique of stored program control. This technique, which is becoming accepted as the best method to be used in advanced systems, requires the use of a computer-like device called an exchange control processor. The processor acts as the centralised decision point in the exchange. By gathering information from the network being controlled, it can make decisions on the setting up, supervision and clearing down of calls while also controlling the network in an efficient manner and maintaining a high degree of reliability. Stored program control offers more flexibility and a wider range of facilities than conventional equipment due to the use of an electrically alterable program of instructions stored in the processor memory. The processor, as well as controlling the two projects mentioned, will be used to test different methods of processor control as regards reliability, load capacity and ease of administration. *F. J. W. Symons 630 7154*

CG.10 Integrated Switching and Transmission Project (IST)

PCM transmission systems which are about to be introduced into the Australian telephone network, carry speech in digital form as a series of pulses, and the different channels of a PCM system are separated in time (time division multiplexed). The introduction of PCM transmission equipment into telecommunication networks suggests the application of the same techniques to switching systems so that digital time division multiplexed switching can be used instead of the spatial separation of speech paths used in conventional exchanges. By this means the techniques of transmission and of switching may be integrated in a particular network. The Laboratories are developing a model IST network which will involve three exchanges in the Melbourne area in order that the techniques and problems of this new concept can be fully explored. *A. Domjan 630 7288*

C1.18 Graphical Symbols for Logic Diagrams

The Research Laboratories have been studying the various logic symbol standards being used. This was initiated by the increased use of Integrated Circuits, and the need for a more suitable set of symbols for the complex logic systems which are now feasible. The resulting draft specification was based on Mil-Std-806B, USA. The main advantage of these symbols was their orientation to Integrated Circuits, including the complex functions available, and the fact that most Integrated Circuit manufacturers use them on their data sheets.

The Research Laboratories' Symbols Committee has followed the basic philosophy of this standard, expanded it and modified it where appropriate, to produce a proposal for submission to the Australian Standards Association as an Australian Standard. There is already considerable agreement between this proposal and similar ones produced by other Commonwealth agencies such as W.R.E., any differences being in presentation and layout, rather than content.
N. McLeod 630 7804, A. Domjan 630 7288

C1.22 Custom Integrated Circuits

Modern electronic exchange switching systems use complex circuitry, the economics and reliability of which is considerably enhanced by the use of integrated circuits. Medium and large scale integration of electronic circuits is currently becoming possible, and this technique is under close examination to fully exploit its advantages in electronic switching projects. Special purpose devices have already been specified for use in the IST project described above.
A. Domjan 630 7288, N. McLeod 630 7804

C1.23 Rural Party Line Service with Tone Dialling

Equipment has been developed which permits automatic working of up to 10 parties over a part privately erected line, of either earth return or metallic construction. Tone dialling is used with adequate speech guard provision in conjunction with D.C. loop supervision. Individual metering is provided. The system requires the installation of a relay set at the exchange and modified telephones at the subscriber's premises. *K. Curley 630 7898*

C1.29 Electronic Signalling Equipment

The development of processor controlled exchanges has highlighted a requirement for electronic devices capable of interfacing the electronic processor and the telephone network. A group of electronic circuits has been developed to send and receive decadic impulses and to send and receive m.f.c. signals. In each case binary information is sent and received from the processor and appropriate conversion is achieved using integrated circuits. *D. Mattiske 630 6343*

C1.30 Common Channel Signalling

Conventional telephone circuits carry the signals required to establish and supervise connections. This requires the provision of special signalling equipment at each end of every circuit. Common channel signalling carries all the signals for up to 2,000 circuits over a single, high speed data link. This opens the way for considerable savings in signalling equipment used in a telephone network, but its use is restricted to exchanges having control provided by a central processor. Equipment is being developed to test a common channel signalling scheme in the national and international telephone networks. *G. L. Crew 630 7591*

C1.31 Signalling Equipment for PCM Junctions

Pulse code modulated carrier equipment employs time division multiplexing which provides increased capacity for passing telephone signals compared with that available on other types of circuit. New devices have been developed which fully exploit this additional signalling capacity, with a consequent reduction to the cost of signalling on this type of carrier circuit. *D. Mattiske 630 6343*

Also of interest *Page*

C1.21 Electronic Circuit Tester .. 38
C1.28 Logic Test Probe .. 38
W2.91 Life Testing of Telephone Dials .. 21
W2.92 Reed Relay Testing .. 21
W2.96 Soft Magnetic Iron .. 22
W3.99 Heat Treatment of Non-Ageing Soft Magnetic Iron .. 23

Test Equipment Development

This section draws attention to particular items of test equipment which have been developed for specific applications within the Laboratories or in the field.

C1.16 Automatic Speech Level Meter

Accurate knowledge of the statistics of the level of speech at strategic points within the telephone network are required for the efficient design of future telephone plant.

On display is a speech power level meter having a dynamic range of 40 dB with 2 dB resolution. Speech levels are punched on paper tape (3 times a second) for computer analysis. *R. Dempsey 630 7606*

C1.21 Electronic Circuit Tester

With the increased use of integrated circuits, circuit modules have become more complex, and module testing is consequently more difficult. A general purpose electronic circuit tester has been developed which can be used to test complex modules with up to 25 pin connections. The device is very flexible and allows the independent selection of a function for each pin connection, in much the same way as a valve tester. *N. McLeod 630 7804*

C1.24 Automatic Recording of Measurements

Certain types of measurements are time consuming because of the very nature of the characteristics which must be obtained. Such measurements as the long term frequency stability of an oscillator could occupy technical staff for an excessive period. A teleprinter attached to a Racal frequency meter is demonstrated, which reads out and prints in an orderly fashion the measurements appearing on the front of the frequency meter lamp display.

The inputs to the frequency meter are time multiplexed so that it can take measurements from eight different sources. The measuring equipment can be detached from the teleprinter and its output transmitted on standard telegraph channels if remote telemetery is required. *A. Domjan 630 7288*

C1.27 Pseudo-Random Binary Sequence Generator and Error Counter

One of the most suitable test signals for a digital transmission system is the pseudo-random binary sequence. The equipment on display can generate sequences of adjustable length. The error counter, which may be used remotely, generates a matching sequence and compares this with the received data stream to detect errors. *A. M. Fowler 630 7605*

C1.28 Logic Test Probe

In digital equipment using micrologic elements, the 'one' and 'zero' conditions are defined as a range of voltages. These are typically 0 to 800 mV for a 'zero' and 2 to 5 volts for a 'one' in T.T.L. logic. The test probe has been designed as a simple low cost unit to show whether the point tested is in the one or zero state, and within the voltage limits. *A. M. Fowler 630 7605*

T2.76 Klystron Frequency Stabilisation

The instantaneous frequency of high frequency electron oscillators such as Klystrons drifts over a small range of frequencies even if the temperature and the electrode voltages are held constant. Typically this range is one per thousandth of the actual oscillation frequency. For many purposes a more stable frequency is required. This is achieved with a feed back loop which 'ties' the Klystron frequency to that of a reference.

A frequency stabilising loop in waveguide form is displayed which locks the Klystron frequency to that of a reference cavity resonator which is tuned to a frequency of 38,000,000,000 Hz. *H. Wills 630 7946*

W1.80 Data Logging System

Data logging equipment has been constructed for the collection and recording of data for engineering investigational projects and to meet the demand for calibration equipment with automatic print-out facilities. The equipment consists of a serialiser, typewriter, control unit and paper tape punch.

In the display the equipment is being used to gather statistical information in the performance evaluation of a prototype 'Erlang' meter designed for the measurement of telephone signal traffic in terms of the number of lines occupied per hour. *A. J. Stevens 630 7981*

W1.81 Photography of Lightning Current Waveforms

Equipment recently used to photograph lightning strikes on the TV aerial tower at Mount Conobolas, Orange, N.S.W. is on display. This equipment, designed and installed by Laboratories' staff, has taken a number of photographs of lightning strikes since it was first installed in 1967. The project is, essentially, a research experiment to determine the energy and waveshape of typical Australian lightning strikes.

A model of the Mt Conobolas installation is shown and a discharge is being used to represent a strike on the tower and to 'trigger-off' the equipment actually used at Mt Conobolas. Photographs of the current waveforms produced by the strikes, having peaks of up to 30,000 amps, are on display. *A. J. Stevens 630 7981*

Also of interest *Page*

C1.16 Automatic Speech Level Meter .. 37
C2.40 Design of Radio Equipment .. 25
C2.47 Telephone Efficiency Tester .. 32
C2.48 Subscribers' Instrument Tester .. 32
F5.52 Pulse-Echo Testing of Coaxial Cables .. 41
F5.55 Measurement of Radio Refractive Index of the Air .. 26
F5.57 Transmitter Power Telemetering .. 26
F5.58 Propagation Measuring Equipment, Records and Analyses .. 27
T2.74 Assessment of Cables with Pulsed Carrier Techniques .. 42
W2.90 Luminescent Tape Testing .. 21
W2.92 Reed Relay Testing .. 21
W2.96 Soft Magnetic Iron .. 22

Transmission Systems

Under this title are a number of subjects including modulation methods, transmission of data, testing and correction of cables, and the experimental work concerned with special problems of communication to remote areas.

C1.17 Data Transmission

The Australian Post Office provides facilities for transmitting binary data over the ordinary switched telephone network at rates up to 1200 bits/sec, using frequency shift keyed modems. The display shows the effect of interfering signals on the performance of the modems, and how such interference causes errors in the received data.

To meet the increasing demand for the transmission of data at rates considerably higher than 1200 bits/sec the Research Laboratories are studying the problems of transmitting data over both private lines and the special switched telephone network at speeds of 48 kilobits/sec and higher. A typical 48 kilobits/sec modem is on display. *A. Gibbs 630 7316*

COMMUNICATION BY RADIO TO REMOTE AREAS OF AUSTRALIA

C1.19 Rural Radio Telephone System

This type of system replaces a part or the whole of the telephone line between a subscriber and his exchanges. The Laboratories are developing a system which will have a range of about thirty miles yet operate on very low power. This capability will be made possible by the use of digital modulation techniques. *D. Snowden 630 7927*

C1.20 Satellite Radio Telephone System

The Laboratories are examining the possibility of providing telephone services (and perhaps sound and television broadcasting too) to people living in very remote areas of Australia. Plans are in hand to perform experimental work using a satellite. The results of this work will yield information required in the design of a subscribers' satellite telecommunications system. *D. Snowden 630 7927*

C1.25 Pulse Code Modulation (PCM) Systems

The Department is currently carrying out field trials on PCM systems. These are new types of transmission systems for use in the telephone network and use digital rather than analogue modulation techniques. Several types of commercially available systems are being investigated to determine the optimum system characteristics for Australian conditions. Terminal equipment of a working system is on display. *M. A. Hunter 630 7626*

C1.26 Delta Modulation

Digital speech transmission systems using delta modulation are being studied for their possible application in the Australian telephone network. Several types of delta codecs have been built to examine the effects of the bit rate, the degree of companding, and digital error rate on the performance. Working models are being demonstrated. *A. M. Fowler 630 7605*

CIRCUIT THEORY DIVISION

The Circuit Theory Division is concerned with the study of active and passive networks and the analysis and design of such networks as filters for single sideband multi-channel telephone transmission systems, amplitude and delay equalisers for television and data transmission, and impedance simulating networks for terminating cables and for calibrating pulse testing equipment. Computer aided design techniques are used in the design and evaluation of networks having stringent performance requirements. *E. Rumpelt 630 7632*

F5.51 Variable Equaliser for Data Transmission Circuits

In order to transmit high speed signals effectively, i.e. at speeds higher than about 600 bits per second over telephone channels, the transmission performance of such channels often needs to be improved by the addition of attenuation and phase equalisers. Adjustable equalisers are particularly useful for this purpose because they can be installed and aligned promptly on any circuit. Whereas with a fixed equaliser there is a significant delay due to the need to measure the circuit, and to design and construct a special equaliser before it can be installed, the adjustable equalisers can be produced at comparable cost to fixed equalisers, and can be re-adjusted readily to compensate for channel performance changes, and when no longer required on the particular channel, can be applied readily to any other channels.

An active variable attenuation and phase (group delay) equaliser developed in the Laboratories is shown providing attenuation equalisation of an artificial telephone channel. *I McGregor 630 6422*

F5.52 Pulse-Echo Testing of Coaxial Cables

Pulse-echo testing is used extensively during the manufacture and installation of coaxial cables for checking the quality of the cables, for locating faults in the cable and its joints, and for measuring impedances at the cable ends. This testing technique involves sending a short test pulse into one end of the cable and examining at that point by means of a C.R. display subsequent pulse echoes which originate from all impedance irregularities along the cable.

The exhibit shows how the characteristic impedance at the ends of a coaxial cable can be measured using this technique and with the aid of a calibrated impedance matching network. *E. Rumpelt 630 7632*

T2.74 Assessment of Cables with Pulsed Carrier Techniques

The Australian Post Office has, in the ground, many thousands of 'tube-miles' of coaxial cable, which provide broadband bearers between major centres. In current use, each tube carries frequencies up to 6 MHz, and in some cases up to 12 MHz. Substantial expansion of circuit capacity is possible if the cables can be used to carry higher frequencies, say up to 60 MHz. A single tube could thus be employed to carry up to 10,800 telephone channels (or equivalent television or data traffic), rather than a maximum 1,260 telephone channels with 6 MHz carrier equipment. This great increase in the potential capacity of coaxial cables will help to meet the great increases in circuit demand expected for all types of traffic.

The performance of cable to be used in high frequency long distance systems is often assessed by observing the back-scatter of short pulses or sharp-step signals, in order to reveal the location of any discontinuities. A demonstration is provided of a measuring method which allows the effect of any discontinuities to be measured as a function of frequency, while retaining discrimination against unwanted reflections from cable connectors and terminations. Equipment has been developed to cover the range of 20 to 250 MHz, and this has been used to investigate Australian-made coaxial cable. *G. Rosman 630 7953*

T2.75 Adaptive Echo Canceller

The coming of telephone links via satellites has brought with it problems because of the comparatively long transmission delay caused by the distance to the satellite, typically ¼ sec. delay for the return trip to and from the satellite.

It is not possible to achieve perfect electrical balance in the circuits used to separate the 'go' and 'return' directions of speech in the telephone exchanges.

Thus echoes are generated which become objectionable if delays are of the order of 100 milli-seconds or greater. It is therefore necessary to suppress these echoes in such a way that a conversation is no longer affected.

An echo canceller is demonstrated in which secondary echoes are generated such that they cancel the original ones. *H. Bruggemann 630 7954*

Also of interest *Page*

C1.16 Automatic Speech Level Recorder 37
C1.23 Rural Party Line Services with Tone Dialling 36
C2.35 Transmission of Standard Frequencies over Carrier Systems 29
RG.61 Fatigue Testing of Lead Sheathed Telephone Cable 22
RG.62 Tip Welding of Conductors 20
W3.106 Connectors for Upgrading Part Privately Erected Telephone Lines .. 24
W4.117 Corrosion of Cables and Underground Metallic Structures 20

Index

	Exhibit No.	Page
Acceptance Testing Laboratory	WG.78	14
Acoustic Test Rooms	T1.70	31
A.C. Voltmeters—Calibration	CG.15	28
Adaptive Echo Canceller	T2.75	42
Anechoic Room	T1.71	31
APO Standard of Frequency and Time	C2.33	29
Artwork—Printed Wiring	C2.38	17
Assessment of Cables with Pulsed Carrier Techniques	T2.74	42
Atomic Absorption Spectrophotometer	W4.110	19
Attenuator Calibration	CG.12	28
Automatic Recording of Measurements	C1.24	38
Automatic Speech Level Meter	C1.16	37
Batteries—Investigation and Testing	W4.116	20
Bausch and Lomb Metallograph	W3.105	23
Binary Sequence Generator—Pseudo Random	C1.27	38
Board Preparation—Printed Wiring	A1.3	17
Cables—Assessment with Pulsed Carrier Techniques	T2.74	42
Cables and Underground Metallic Structures—Corrosion	W4.117	20
Cables (lead sheathed)—Fatigue	RG.61	22
Calibration—A.C. Voltmeters	CG.15	28
Calibration—General Instruments	W1.88-89	16
Calibration—High Frequency	W1.84	15
Carbon Determination Apparatus	W3.103	23
Chemical Research	W4.107	19
Chemistry—Polymer	W4.112	24
Clockwork Recorders	W1.82	15
Clutch Endurance Test	C2.39	17
Coaxial Cables—Pulse Echo Testing	F5.52	41
Colour—Measurement and Control	RG.63	30
Common Channel Signalling	C1.30	37
Communication by Radio to Remote Areas of Australia	C1.19	40
Conductors—Tip Welding	RG.62	20
Connectors for Upgrading Part Privately Erected Telephone Lines	W3.106	24
Control Processor—Exchange	CG.9	35
Co-ordinatograph	C2.39	17
Corrosion of Cables and Underground Metallic Structures	W4.117	20
Crystal Oscillators	C2.41	33
Custom Integrated Circuits	C1.22	36

	Exhibit No.	Page
Data Logging System	W1.80	39
Data Transmission	C1.17	40
Data Transmission Circuits—Variable Equalisers	F5.51	41
Delta Modulation	C1.26	41
Design of Radio Equipment	C2.40	25
Determination of the Detergent Resistance of Floor Polishes	W4.108	19
Determination of Phosphate Content in Laundry Powders	W4.109	19
Digital Computer	F3.50	12
Direct Current Comparator Potentiometer	CG.14	28
Echo Canceller—Adaptive	T2.75	42
Electrical Standards	CG.13	28
Electronic Circuit Tester	C1.21	38
Electronic Instruments—Evolution	W1.87	16
Electronic Service	W1.86	15
Electronic Signalling Equipment	C1.29	37
Endurance Test of Clutch and Life Testing Machines	C2.39	17
Engineering Library	A1.2	13
Environmental Facilities	RG.66	21
Environmental Physics	RG.66	21
Epoxy Resins	W4.112	24
Equalisers (Variable) for Data Transmission Circuits	F5.51	41
Equipment Records	WG.77	14
Evaluation of Plastics	W2.94	24
Evolution of Electronic Instruments	W1.87	16
Exchange Control Processor	CG.9	35
Fabrication of Miniaturized Semi-Conductor Devices	A1.6	33
Fatigue of Lead Sheathed Telephone Cable	RG.61	22
Field Measurement of Transmission Conditions	F5.53	26
Field Microwave Propagation Measurements	F5.54	26
Flaw Detection Techniques in Metals	W3.102	23
Floor Polishes—Determination of Detergent Resistance	W4.108	19
Fluidics	C2.37	17
Frequency Stabilization—Klystron	T2.76	38
Frequency Stabilization—Quartz Crystal	C2.41	33
Frequency and Time Standards	C2.33	29
Frequency and Time—APO Standard	C2.33	29
Future Standard Frequency and Time Signal Service, VNG	C2.36	29
Gas Chromatograph	W4.111	19
General Instrument Calibration	W1.88-89	16
Graphical Symbols for Logic Diagrams	C1.18	36
Heat Treatment of Non-Ageing Soft Magnetic Iron	W3.99	23

	Exhibit No.	Page
Hewlett Packard Calculator	C2.34	12
High Frequency Calibration	W1.84	15
High Sensitivity Telephone	C2.46	34
High Temperature Tensile Tests on Wire	W3.101	23
I.F. Level Recorder	C2.40	23
Impedance Properties of Slot Radiators	F5.56	26
Improved Microphone for Telephones	C2.44	34
Impulse Voltage Testing	RG.65	20
Infra-Red Absorption Spectrophotometer	W2.93	22
Insect Proof Plastic Cable	W4.115	25
Integrated Circuits—Custom Design	C1.22	36
Integrated Switching and Transmission (IST)	CG.10	36
Instrument Makers Machine Shop	WG.79	14
Instrument Making Repair Service	W1.83	15
Instrument Repair	W1.83	15
Instrumental Plating Thickness Measurement	W3.104	23
Investigation and Testing of Batteries	W4.116	20
Iron—Soft Magnetic	W2.96	22
Iron (Soft Magnetic Non-Aging)—Heat Treatment	W3.99	23
Jointing Methods for Plastic Sheathed Cables	W4.113	24
Klystron Frequency Stabilization	T2.76	38
Laundry Powders—Determination of Phosphate Content	W4.109	19
Lead Sheathed Telephone Cables—Fatigue	RG.61	22
Library, Engineering	A1.2	13
Life Testing Machines	C2.39	17
Life Testing of Switchboard Cord Cassettes	W2.91	21
Life Testing of Telephone Dials	W2.91	21
Lightning Current Waveforms—Photography	W1.81	39
Loading Coil Cases	W4.114	25
Logic Diagrams—Graphical Symbols	C1.18	36
Logic Test Probe	C1.28	38
Loudness Balancing Techniques	T1.68	30
Luminescent Tape Testing	W2.90	21
Magnetic Iron (Soft Non-Aging)—Heat Treatment	W3.99	23
Measurement—Automatic Recording	C1.24	38
Measurement and Control of Colour and Photometry	RG.63	30
Measurement of Radio Refractive Index of Air	F5.55	26
Mechanical and Electrical Design	C2.49	17
Metallograph—Bausch and Lomb	W3.105	23
Metallurgical Research	W3.102	23
Microphone for Telephones—Improved	C2.44	34

	Exhibit No.	Page
Microwave Propagation—Field Measurements	F5.54	26
Millimetric Wavelengths—Signal Fading	T2.73	27
Model Shop	AG.1	17
Museum	W1.85	15
NOSFER Telephone Transmission Reference Standard	T1.67	30
Objective Measurement of Telephone Transmission Performance	T1.69	31
Olivetti Programmable Calculator—Probability Studies	CG.11	12
Optical Wavelengths—Signal Fading	A1.4	25
Part Privately Erected Telephone Lines—Connectors for Upgrading	W3.106	24
PBX Extension for Traffic Recorder and Analyser (PETRA)	CG.7	35
PCM Junctions—Signalling Equipment	C1.31	37
Photography of Lightning Current Waveforms	W1.81	39
Photography—Printed Wiring	C1.32	17
Photometry	RG.63	30
Physical Standards	RG.63	30
Physics—Environmental	RG.66	21
Physics—Material	W2.90	21
Plastic Cable—Insect Proof	W4.115	25
Plastics—Evaluation	W2.94	24
Plastic Sheathed Cables—Jointing Methods	W4.113	24
Plastic Welding	W2.95	24
Plating Thickness—Instrumental Measurement	W3.104	23
Polymer Chemistry	W4.112	24
Potentiometer—D.C. Comparator	CG.14	28
Printed Wiring Artwork	C2.38	17
Printed Wiring Processes	A1.3	17
Probability Studies Using the Olivetti Programmable Calculator	CG.11	12
Propagation Measuring Equipment, Records and Analyses	F5.58	27
Pseudo-Random Binary Sequence Generator and Error Counter	C1.27	38
Pulse Carrier Techniques for Assessment of Cables	T2.74	42
Pulse Code Modulation (PCM) Systems	C1.25	40
Pulse Echo Testing of Coaxial Cables	F5.52	41
Quartz Crystal Laboratory	C2.41-43	33
Radar Refractometry	F5.60	27
Radio Equipment—Design	C2.40	25
Radio Refractive Index of Air—Measurement	F5.55	26
Radio Telephone System—rural	C1.19	40
—satellite	C1.20	40

	Exhibit No.	Page
Recorders—Clockwork	W1.82	15
Reed Relay Testing	W2.92	21
Relay Sets—Signalling Conversion	CG.8	35
Research into New Semi-Conductors	A1.5	33
Reverberant Room	T1.72	31
Rural Party Line Service with Tone Dialling	C1.23	36
Rural Radio Telephone System	C1.19	40
Satellite Radio Telephone System	C1.20	40
Semiconductor Devices—Fabrication	A1.6	33
Semiconductors—Research	A1.5	33
Signal Fading—at Microwaves	T2.73	27
—at Optical Wavelengths	A1.4	25
Signalling—Common Channel	C1.30	37
Signalling Conversion Relay Sets	CG.8	35
Signalling Equipment—Electronic	C1.29	37
Signalling Equipment for PCM Junctions	C1.31	37
Slot Radiators—Impedance Properties	F5.56	26
Soft Magnetic Iron	W2.96	22
Solid State Microwave Source	C2.40	25
Soxhlet Extraction	W4.107	19
Speech Level Meter—Automatic	C1.16	37
Standard Cell Enclosure	CG.13	28
Standard Frequency and Time Signal Service—Future	C2.36	29
Standard Frequencies—Transmission over Carrier Systems	C2.35	29
Strain Age Embrittlement of Structural Steel	W3.98	22
Structural Steel—Strain Age Embrittlement	W3.98	22
Subscribers' Instrument Tester	C2.48	32
Sulphur Dioxide Cabinet	W3.900-100	23
Sustained High Voltage Testing	RG.64	20
Switchboard Cord Cassettes—Life Testing	W2.91	21
Telephone Acceptance Testing	C2.47	32
Telephone Cables (Lead Sheathed)—Fatigue	RG.61	22
Telephone Dials—Life Testing	W2.91	21
Telephone Efficiency Tester	C2.47	32
Telephone for the Hard of Hearing	C2.45	34
Telephone—High Sensitivity	C2.46	34
Telephone Standards	T1.67	30
Telephone Transmission Performance—Objective Measurement	T1.69	31
Telephone Transmission Reference Standard—NOSFER	T1.67	30

	Exhibit No.	Page
Television Ghosts	F5.59	27
Tensile Tests on Wire—High Temperature	W3.101	23
Time and Frequency—APO Standard	C2.33	29
Time Signal Service, VNG—Future	C2.36	29
Tip Welding of Conductors	RG.62	20
Tone Dialling—Rural Party Line Service	C1.23	36
Traffic Recorder and Analyser for PBX Extensions	CG.7	35
Transmission Conditions—Field Measurement	F5.53	26
Transmission of Standard Frequencies over Carrier Systems	C2.35	29
Transmission Power Telemetering	F5.57	26
Variable Equalisers for Data Transmission Circuits	F5.51	41
VNG Standard Frequency and Time Signal Service—Future	C2.36	29
Voltage Testing (High)—Sustained	RG.64	20
Voltage Testing—Impulse	RG.65	20
Welding—Conductor Tips	RG.62	20
X-Ray Fluorescence Spectrograph	W2.97	22

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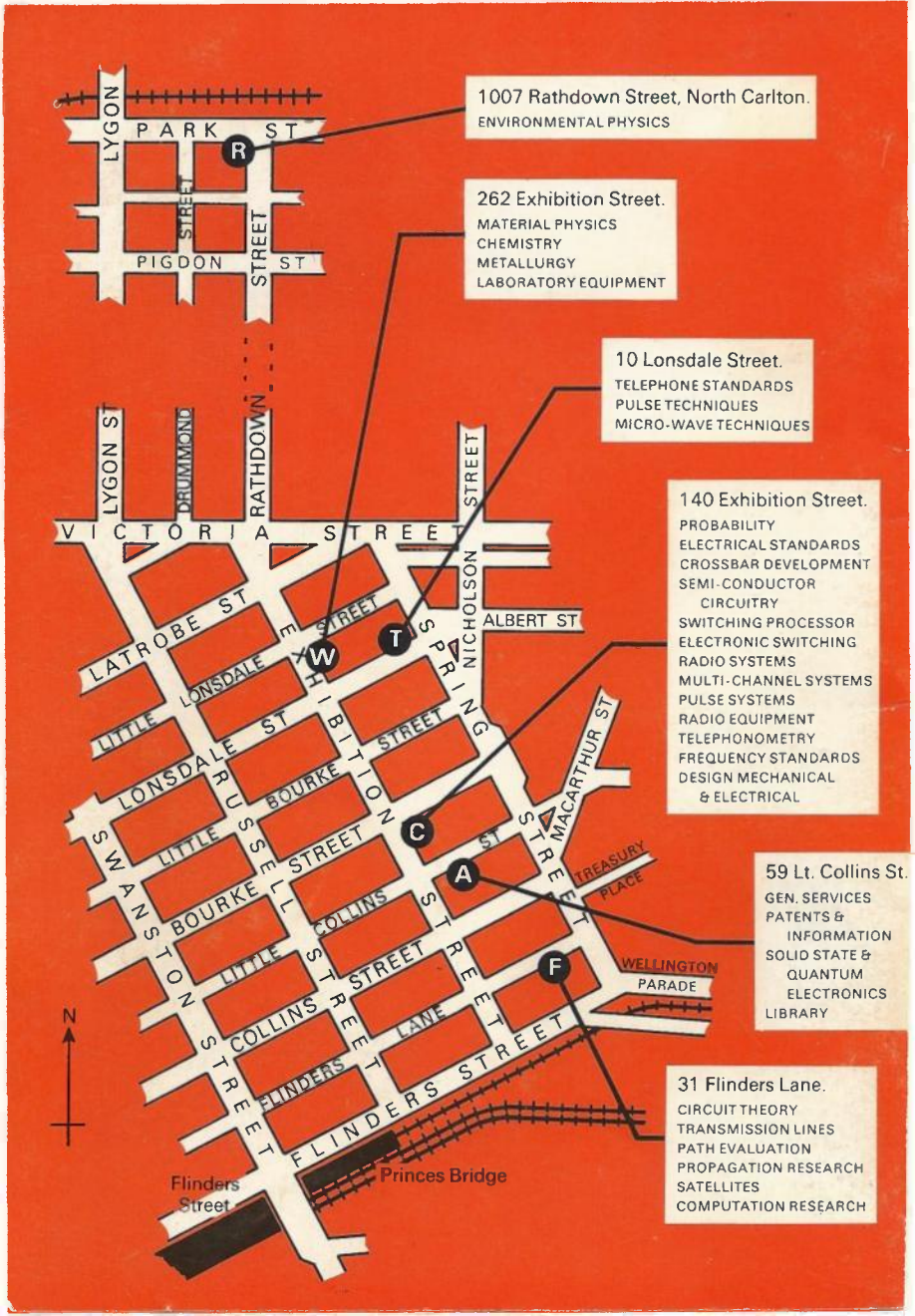
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Flinders Street