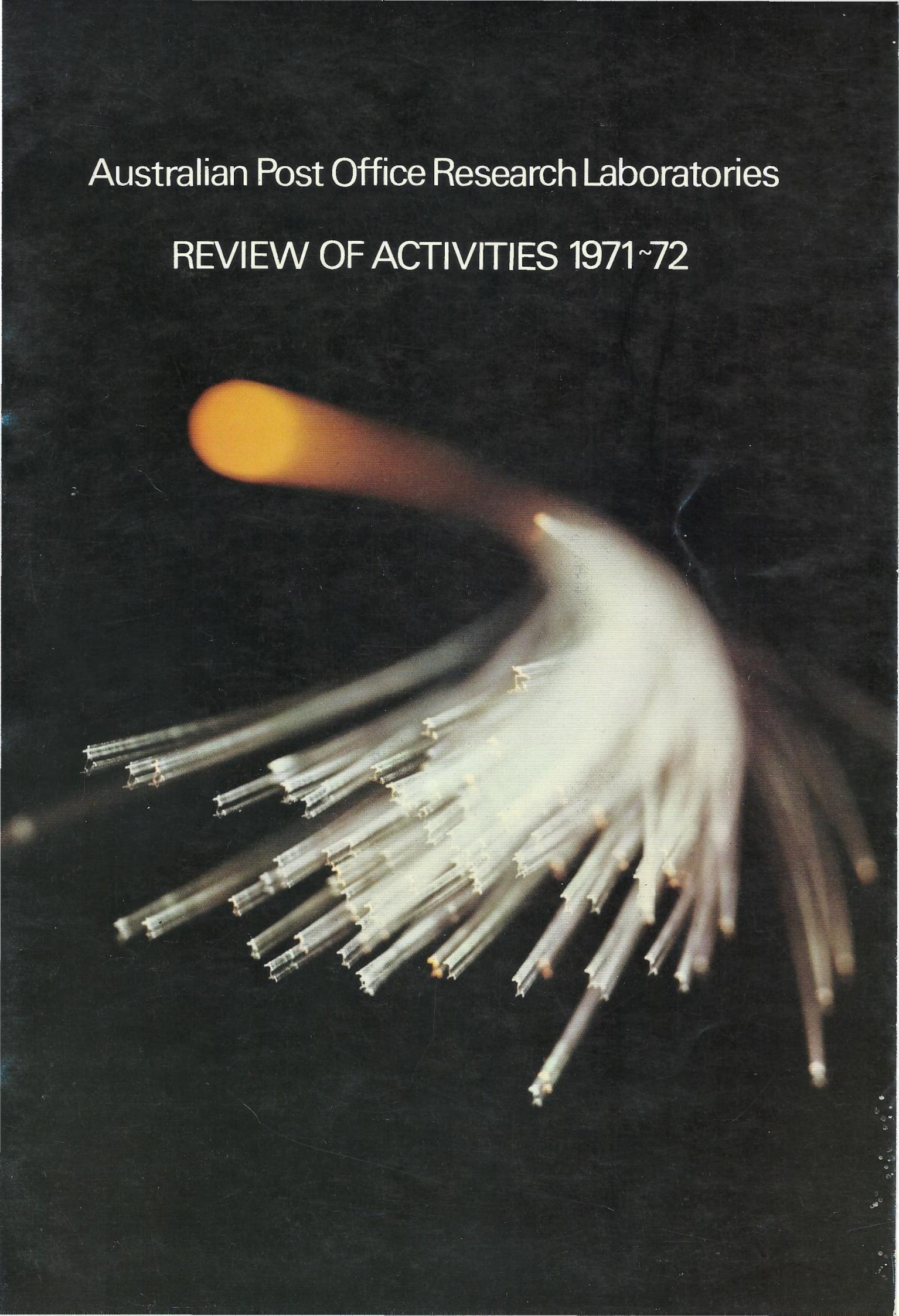
Australian Post Office Research Laboratories

REVIEW OF ACTIVITIES 1971~72



AUSTRALIAN POST OFFICE RESEARCH LABORATORIES 59 LITTLE COLLINS STREET MELBOURNE 3000 AUSTRALIA

Foreword

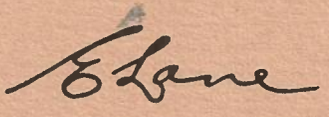
Today's society is increasing in complexity, not only through population growth and the formation of new and varied communities but also through increase in technical, economic and social interdependence on a regional, national and international scale.

To satisfy the communication needs of this increasingly complex society in the future will require more than just the multiplication of existing techniques and services. New concepts, new systems, new materials and new techniques must be continually explored and developed in anticipation of expanding and changing community needs. In addition, the effectiveness of existing facilities and available manpower must be increased.

The Research Laboratories serves a vital role in this forward-looking work by providing a source of basic knowledge and professional skill for the innovative effort needed by the Post Office to meet these challenges. To discharge their responsibilities within the framework of the Research and Development Objectives of the Australian Post Office, the Laboratories must create and maintain a spectrum of expertise which is adequate in scope and quality to support the policy decisions governing the future development of the Post Office.

This Review presents an outline of the activities, the achievements, the organisation and the staff resources of the Laboratories. It also provides a stimulus for information exchange and interaction with other organisations having related interests and problems.

It gives me pleasure to commend this Review of Activities to you.



Director-General
Australian Post Office

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THE CHALLENGE OF THE FUTURE

Australia is achieving a rapid growth by world standards in both its population and in the number of telephone services per head of population. Currently we have about 13 million people with an annual increase of 2-2½% per annum, which is enabling rapid development to take place both in the cities and in the country. This rapid growth is responsible for an increase in the total demand for telecommunication services, which exceeds the population growth by a factor of about five.

If these increasing demands are to be met, with a work force which only maintains a fixed share of the population, it is necessary that there should be a continual advance in the technologies available to those who provide and operate the telecommunication services. It is against this background that we are seeing a succession of developments of transmission equipment which provides an ever increasing number of trunk line circuits per system, and switching systems which are incorporating increasingly more powerful control systems, such as computer-type control.

While the demand for services continues to increase, there must be a steady progression in the development of new principles and techniques to enable future demands to be met. Studies are also necessary to determine which of these techniques can be most gainfully utilised, at what time, and in what manner.

The A.P.O. Research Laboratories is continually pressing ahead to meet this challenge in its quest for new techniques which have potential to meet future demands and in the determination of application principles for those which have been selected for utilisation in the ever expanding A.P.O. communications network. Some of those which are now receiving intensive study include the investigation of optical fibres and digital modulation to provide higher capacity transmission systems, optical character recognition to help speed the sorting of mails, integrated switching and transmission to reduce network complexity and microelectronic circuitry techniques to reduce the cost and volume of electronic circuitry. The successful execution of this work necessitates a blending of staff with a diversity of skills, including the scientific research worker, the engineer with operational experience who can appreciate the utilisation of new techniques and help guide their successful integration into the existing communications network, and the manager who is able to ensure that investigations, studies and development will mature successfully by the time they are needed.

The A.P.O. Research Laboratories currently has a dedicated staff of approximately 400 who are bringing a high level of skill to bear on the exciting challenge of the future. Besides being of direct benefit to the development of the Australian telecommunications services, their work is also contributing to the ever widening fund of knowledge available on a world-wide basis.

One of the primary objectives of the Australian Post Office is to conduct the research necessary to assure the efficient development of the postal and telecommunications services. During the year 1971/72, consideration has been given by the Central Board of Management of the Post Office to a more detailed exposition of this objective, and a Statement of Research and Development Objectives has been approved.

The Statement sets out the objectives of the Australian Post Office in the search for new knowledge and in the development of new applications of knowledge in all areas of Post Office endeavour, and is summarised in an Overall Objective:

> "The underlying purpose of research and development in the Post Office is to provide, within the limits of financial and other resources allocated for the purpose, the new or improved products and services and the new or improved management systems, procedures and techniques which the Post Office, through its various management processes, determines are important for the achievement of the overall and primary objectives of the Post Office."

In the Statement of Research and Development Objectives, a broad view is taken of needs, and it is stated that the Post Office will conduct basic and applied research in the natural sciences and engineering and in the social sciences and humanities on topics judged to be important for the discharge of Post Office responsibilities. In addition, specific developments, investigations and studies will be carried out aimed at developing new equipment, concepts and managerial techniques, and at developing a better understanding of existing and new demands for Post Office services. It is recognised that not all such research and development must necessarily be conducted within the Post Office, and there is a positive policy of encouraging such work on appropriate topics in universities and other centres of higher learning and in industry.

The Statement recognises that the benefit is obtained from research and development only if the function is properly integrated with planning, marketing, operations and other functions, and one of the objectives is to achieve such integration.

The pursuit of the objectives is not the sole responsibility of any one organisational unit. The need for new knowledge and for new developments will arise throughout the whole A.P.O. organisation and appropriate organisational units will be provided to meet the need. The major such unit is the Research Laboratories which is responsible for the pursuit of the objectives in the natural science and engineering fields.

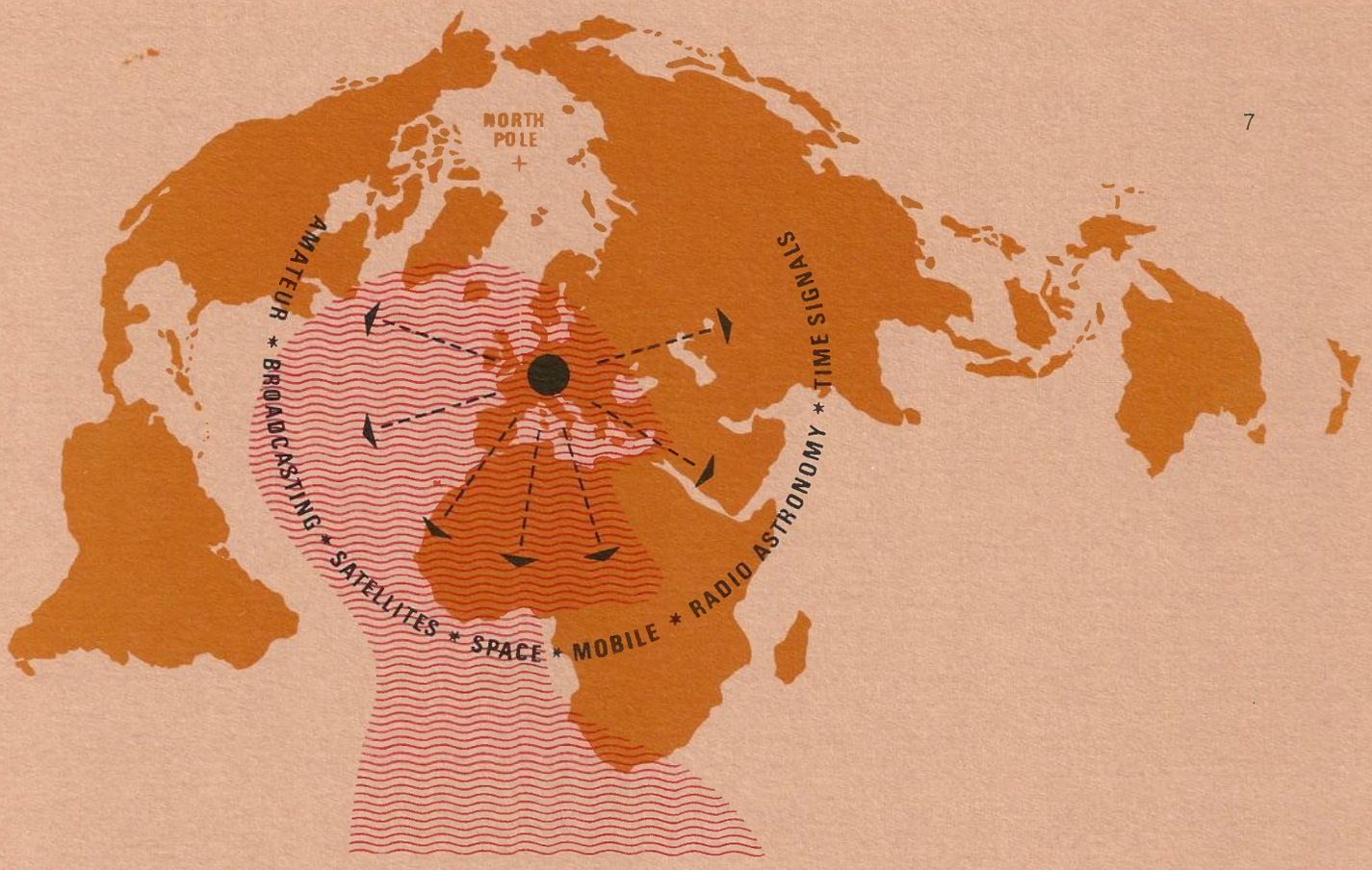
RESTRUCTURING OF THE ENGINEERING ORGANISATION

On 10th February, 1972, a restructured engineering organisation of the A.P.O. was implemented throughout the Commonwealth, following a comprehensive review of the existing organisation. The major feature of the new organisation is that it is based on managerial units, called Sections, which generally comprise more engineers — on the average seven to eight — than the Divisions around which the old organisation was based. This enlarged unit has greater capacity to meet varying load conditions and to withstand the effect of temporary absences. It will enable the better use of technical and administrative officers with special skills, and provide better scope for the use of engineers on specialist functions.

Another important feature is the use of Staff Engineers to share management work load at Branch level, and thus enable the Branch Heads to encompass a wider span of control than would otherwise be possible. The Staff Engineers exercise delegated authorities at the same level as the managers they assist and are totally responsible for restricted and clearly defined functions.

The three previous Sections in the Laboratories have been re-named Branches, each being headed by an Assistant Director-General as before, and in addition a new Branch, the Switching and Signalling Branch, has been established. The Research Laboratories, headed by a Senior Assistant Director-General, now form a Sub-Division of the Planning and Research Division.

An important consequence of the restructuring exercise is increased career opportunities for engineers and scientists who wish to make a career as a "technical expert" rather than as a "manager". It is expected that this feature will assist in attracting and retaining highly skilled officers, to enable the Laboratories to maintain and extend its R & D responsibilities on a national as well as on an international level.



WORLD ADMINISTRATIVE RADIO CONFERENCE

Two members of the Laboratories staff were included in the Australian delegation to the World Administrative Radio Conference for Space Telecommunications (WARC) held in Geneva over the period 7th June to 17th July, 1971, and attended by about 700 delegates. The Conference was organised by the International Telecommunication Union (ITU) to consider the frequency spectrum requirements of space telecommunication services for about the next decade, and where necessary, to make changes to the International Radio Regulations to implement the conclusions reached. These conclusions have been published in the form of "Final Acts" which will become an integral part of the Radio Regulations when they come into force on 1st January, 1973.

In addition to a revision of the Table of Frequency Allocations, the Final Acts include new provisions concerning the sharing of frequency bands between space and terrestrial services, and for the efficient use of the geo-stationary satellite orbit. These regulatory provisions depend heavily on technical factors, and consequently one of the major sub-divisions of the Conference was a Technical Committee.

Mr. E. F. Sandbach, Assistant Director-General, Applied Science and Laboratory Services, who was one of the delegates from the Laboratories, was appointed Chairman of this Committee.

COMMISSIONING OF MODEL PROCESSOR CONTROLLED EXCHANGE

A model processor controlled exchange was brought into service in November, 1971, as part of an international field trial of the C.C.I.T.T. Common Channel Signalling System No. 6. Switching is carried out by means of crossbar switches of the type used in the A.P.O. telephone network; the switches are controlled by a processor utilising an internally stored program.

The programs, consisting of almost 16,000 words of 16 bits each, were designed and developed by Research Laboratories' staff with programming assistance from the A.D.P. Branch of the A.P.O. The necessary electronic circuitry to interface the processor with the switches was also developed within the Research Laboratories.

Since commissioning, the exchange has been in almost continual use on various aspects of the field trial, and will be used in the near future to switch STD (Subscriber Trunk Dialling) traffic between Melbourne and Sydney.

The project is described in more detail later in this Review.

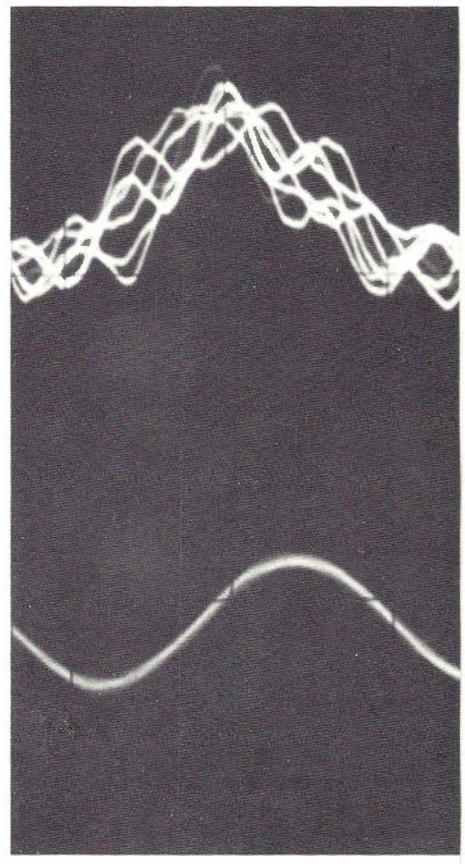
SELECTED LABORATORY

Activities

INTRODUCTION

As a result of the Laboratories' charter to carry out research and development on all aspects of telecommunications and postal services, the work of the Laboratories covers a wide range of activities ranging from scientific to applications oriented projects, and embracing a number of disciplines, such as electronics, human factors and psychology, chemistry, physics, mathematics, etc.

In the limited space available, it is not possible to present an exhaustive coverage of the work carried out during the year. As a consequence, the presentation covers a fairly limited number of projects only, selected to give a reasonably balanced view of the Laboratories' activities. To achieve this balance, it has been necessary also to cover to some extent work carried out in the period preceding the current "Review of Activities". By virtue of the specialised knowledge and talents available in the Laboratories, a considerable amount of time is expended on ad hoc consulting activities within and without the Department. Such consulting work is considered a normal part of the duties of the staff, as is liaison and participation in the activities of universities, learned institutions, lecturing and other kindred activities.



SIGNALS AFTER ANALOGUE (TOP) AND DIGITAL FREQUENCY MODULATION — IDENTICAL CARRIER TO NOISE RATIOS

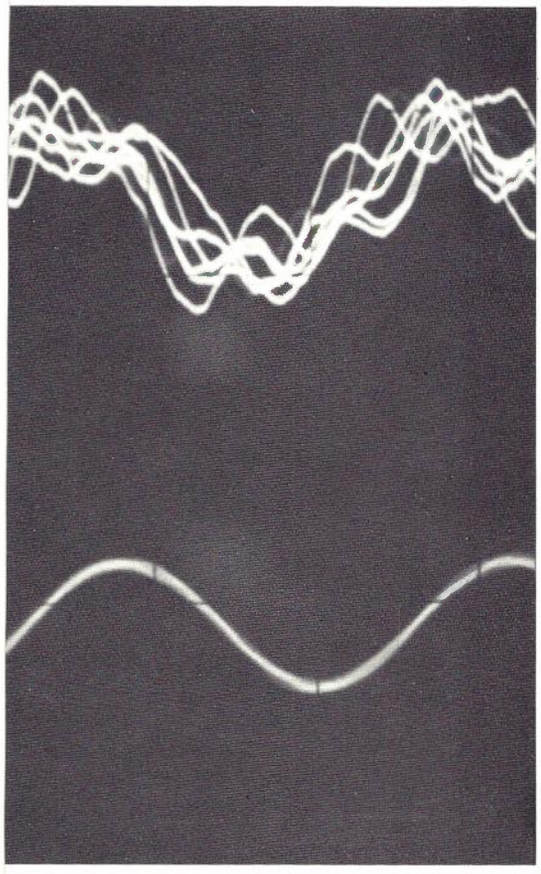
DIGITAL MODULATION FOR VHF RURAL RADIO-TELEPHONE SERVICES

It is an objective of the A.P.O. to provide services suitable for fully automatic telephone working to all rural subscribers as soon as practicable. The implementation of this policy will increase greatly the usage of VHF radio-telephone systems which in many areas provide the only economic means of establishing circuits of sufficiently high quality. This is stimulating a critical examination of the technology and economics of providing VHF services, and in particular of the advantage that might accrue from the application of digital modulation techniques to radio-telephones.

The Laboratories have developed an experimental radio-telephone system using delta coding and digital binary frequency shift keying. The experimental system is switchable between digital and normal analogue FM operation to facilitate a rapid comparison of both under identical operating conditions. As expected from theoretical analysis these comparisons have confirmed that digital operation offers a number of advantages. The audio noise level is lower than in analogue working for low radio signal levels right down to threshold. Digital operation is more resistant to interference and is itself only marginally worse than analogue in producing interference into other systems. In addition, signalling is very simply arranged by generating and detecting a digital code; an extremely simple procedure with modern integrated circuits.

Digital operation has also some disadvantages. The transmitted bandwidth in digital operation is somewhat wider than in analogue, but the greater immunity to interference permits comparable channel spacings. Hence, there is little loss in the efficiency of the available spectrum with digital working.

A study of the economics of digital systems is proceeding. Undoubtedly the basic equipment cost of a digital system will be higher than that of an analogue system, but it is expected that this will be more than offset by savings in other areas, such as path engineering, antenna structures and transmitter power requirements.

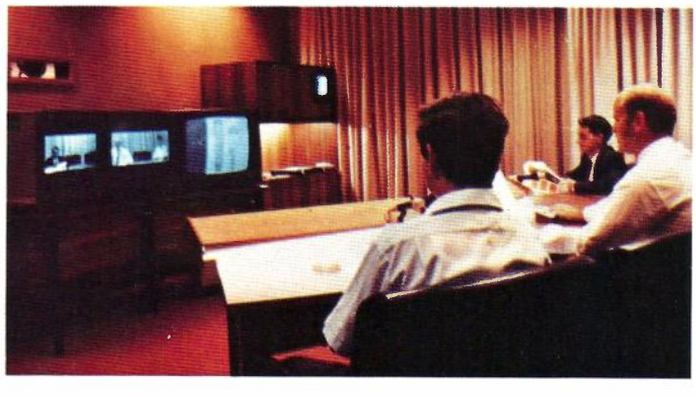


A digital codec is the interface unit in a transmission system which performs the conversion between the analogue and digital forms of a signal. Codecs for two types of digital transmission systems, namely pulse code modulation (PCM) and delta modulation, are being studied in the Laboratories.
In a PCM system, the analogue signal voltage is sampled at regular intervals, and a code group or character corresponding to the amplitude and sign is generated. At the receiving end of the digital system, this character is converted back to an analogue signal by a second codec.
To provide a sufficiently high quality for the transmission of speech over a telephone circuit, the ratio of the largest to the smallest voltage after decoding should be about 2000 to 1. This requires in the simplest case a 12 bit character, having one sign bit and 11 bits representing the possible amplitudes ($2^{11} = 2048$).
Although such fine steps are needed to transmit the lowest speech levels with an acceptable quality, the steps can be much coarser at high levels without appreciably degrading the performance. This change in size of step may be accomplished by a process called companding, so that in practice it is sufficient to have only 256 different code groups, each of which may be represented by an eight bit character; a reduction by one third of the amount of digital transmission to be handled by the system. Companding may be carried out by instantaneously compressing the dynamic range of the signal with a non-linear element before sampling, by using a non-linear codec, or by using a linear codec followed by a code converter. Similarly, several different approaches may be used at the receiver end. Provided that a suitable companding law is chosen, any of these processes will produce satisfactory signals.
In delta modulation, the codec generates a tracking signal which attempts to closely follow the input signal. It does this by comparing the tracking signal with the input at regular intervals, typically 40,000 times per second for speech, and generating a pulse only if the input differs from the tracking signal. The output is a series of pulses separated by gaps. These pulses are transmitted as the digital signal and are also fed through a low pass filter to generate the tracking signal. At the receiver end a similar low pass filter is used to convert the received digital signals into the original analogue signal. Again various forms of companding may be used to increase the dynamic range of signals which may be handled by the system, without using too large a capacity in the digital link.
Both subjective and objective tests conducted in the Laboratories have confirmed that PCM and delta modulation are capable of providing high quality performance with speech signals provided that appropriate companders are included, although discerning listeners may be able to detect the quantisation distortion. However, codecs optimised for the transmission of speech do not necessarily perform equally well with other signals such as data or facsimile. Since the type of channel for these transmissions may not be known in advance in a practical telephone network, the relative merits of PCM and delta modulation together with alternative approaches in design are being investigated.

Public demand for national and international visual communications facilities is expected to increase steadily and become a major factor in A.P.O. operations within the next decade or so. International standards for such services are at present under discussion in the C.C.I.T.T., while a number of problems in the field are being investigated at the Research Laboratories. Work is being carried out in the Laboratories on concepts and equipment for C.C.T.V. conferencing, digital coding of T.V. picture material and digital and analogue transmission systems for T.V. signals.

Trials under way or about to commence include C.C.T.V. conferencing between Melbourne and Sydney, digital T.V.-telephone signals in Melbourne, and the study of user acceptance in relation to visual communications facilities.

C.C.T.V. CONFERENCE FACILITY



C.C.T.V. CONFERENCE ROOM

The application of closed circuit television in conjunction with a loudspeaking telephone system to provide a conference facility between two or more geographically separated sites promises to reduce the need for travel, together with its many direct and indirect expenses and inconveniences. In 1969 the Research Laboratories established an experimental C.C.T.V. conference facility between two Headquarter's buildings with a view to:

(a) Investigating the conceptual, technical and organisational problems involved in establishing such a facility.

(b) Determining the extent of public demands for such a facility.

The present C.C.T.V. conference facility has evolved from the original experimental system. Each

SINGLE QUAD CARRIER CABLE

conference room is capable of accommodating six active participants (and some non-active participants). Means for the transmission of graphics, comprising 35 mm slides, documents and information on a blackboard are provided.
Following initial evaluation in mid-1970 by A.P.O. staff, representatives from a number of private organisations have appraised the system. Reactions have been generally favourable, and indicate that the facility in many instances is a satisfactory substitute for a face-to-face conference environment. In view of the favourable results, a further conference terminal has been established in the Sydney G.P.O. This became operational at the end of June, 1972, and will allow experience to be gained with C.C.T.V. conferencing in a truly operational environment.

T.V. TRANSMISSION OVER SINGLE QUAD CABLE

There is an ever present need to provide full bandwidth television links over relatively short distances (up to 10 km) for requirements such as links between outside broadcast points and T.V. studios, links between commercial enterprises (e.g., banks), etc. In Australia, this type of link is generally provided over standard (2.6/9.5 mm) coaxial cable. The A.P.O. has developed and arranged commercial production of a high quality single quad carrier cable predominantly intended to carry 120 FDM carrier telephone channels. This cable is considerably cheaper than standard coaxial cable, but its attenuation is about three times greater. A T.V. transmission system developed in the Laboratories for use on this cable meets the performance specification applicable to the Australian Video (A.V.) system on standard coaxial cable.
As the cable has two balanced pairs, and one pair may be used for each direction of transmission, crosstalk limits the maximum link length under these conditions to about 1.2 km. The equipment has been designed for two-way transmission.
As normal video signals are unbalanced to earth, it is necessary to convert them to balanced form for transmission and to revert back to unbalanced form on reception. This led to the development of a novel balanced send amplifier and a differential receive amplifier having a very high degree of input balance. The system includes a simple equaliser with one control per equaliser section, and on longer links, a relatively simple mop-up equaliser. The majority of the equipment developed is suitable for use over other types of balanced cable, provided that necessary changes are made to the equaliser and the impedance matching networks.
Although this system is not suitable for the longer lengths possible with the coaxial A.V. system, the more economical full bandwidth performance over shorter distances should prove attractive to customers of the A.P.O.

DIGITAL CODING OF MONOCHROME T.V. PICTURES

In a digital transmission network, a basic problem is to transmit economically a satisfactory visual signal in digital form. As in PCM speech transmission, a signal representing the picture material, whether for facsimile, T.V. or other applications, is sampled and digitised before transmission. Efficient coding schemes which produce only a small number of bits per picture sample are being considered for T.V. telephone applications. It is expected that the techniques will be applicable to other digital visual communications systems.

The main emphasis has been concentrated on a T.V. telephony system with a nominal video bandwidth in analogue form of 1 MHz, and a display format of 275 lines/frame and 60 frames/sec. C.C.I.T.T. and Australian standards for T.V. telephone services have yet to be finalised, and the work done in the Laboratories is useful in connection with the formulation of these standards.

Earlier work in the Laboratories and elsewhere has established the usefulness of differential pulse code modulation (DPCM) coding for visual transmission. Quite good picture quality can be obtained with only three bits per picture sample which corresponds to a transmission rate of 6 M bit/sec. This is about half the rate which would be required if elementary analogue to digital conversion were used, and is approximately equal to the capacity of a second hierarchy digital transmission system. By exploiting the statistical redundancy in the DPCM coded signal, the resultant bit rate may be reduced to about 4 M bit/sec. (2 bits/sample). This process, known as variable word length statistical recoding, replaces the fixed length code words for the samples with other words of various lengths, such that those words which occur most often have the least number of bits.

Simulation studies have established that a moderately simple adaptive statistical recoder can maintain high coding efficiency over the range of picture material likely to be encountered in a practical system. A coder which adapts on a line by line basis and is able to follow statistical variations within a picture as well as those which occur between pictures is expected to be in operation shortly.

In addition to the statistical redundancy which can be reduced by variable word length encoding, picture material is known to contain a great deal of psychophysical redundancy, that is details and structures which are imperceptible to a human observer. By removing these, it is possible to reduce the transmission bit rate still further. The nature and extent of this redundancy is not well known, so experiments in this field are being carried out.

A simple psychophysical recoder has been designed, and will be incorporated into the coding system presently under construction.

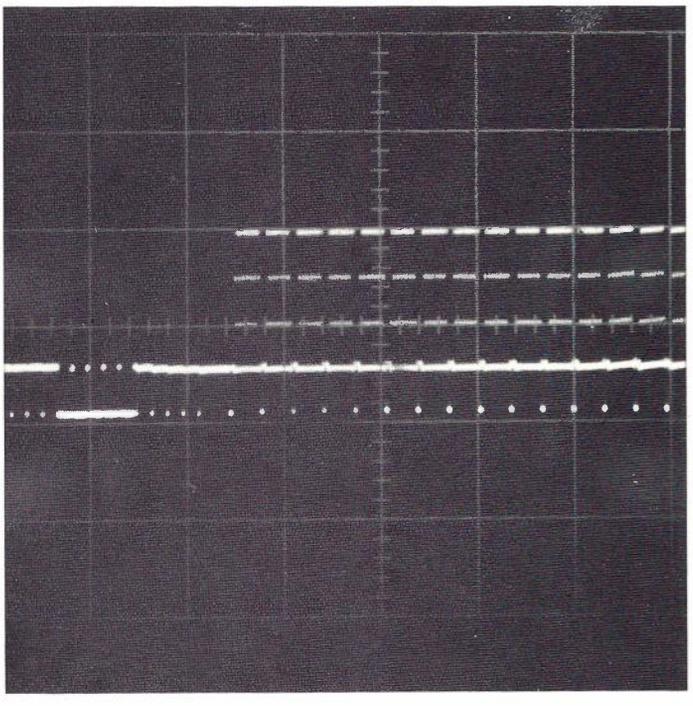
In collaboration with outside industry, a small number of DPCM coders and decoders using multichip thin film hybrid circuits are being produced. These basic coders will be suitable for use with the statistical and psyohophysical recoders being developed in the Laboratories.

TRANSMISSION SYSTEMS FOR T.V. TELEPHONE

In addition to the coding of a picture signal, there are other aspects which must also be considered during the design of a visual communication network.

The horizontal and vertical synchronisation of the picture display at the receiver is achieved in normal analogue T.V. systems using synchronisation information contained in the structure of the composite video waveform, but transmission of such a signal is wasteful in terms of digital channel capacity. Schemes for more efficient transmission of picture synchronisation information have been devised, and one such scheme has been implemented in an experimental system. This has been used in transmission trials over PCM bearers,

SOUND- IN -VISION WAVESHAPE



and has been found to have excellent performance even with a high rate of transmission channel errors. The same transmission trials also established that parallel first hierarchy PCM bearers were feasible for T.V. telephone transmission. This feature is very useful because when efficient coding is used, the transmission bit rate of a T.V. telephone lies between that of proposed first and second hierarchy PCM bearers, and a simple connection to a standard bearer is not practicable.

The coding and transmission systems under development also allow the transmission of auxiliary data which is multiplexed into the picture information bit stream. This auxiliary data channel can be used to provide additional services, such as facsimile, or "sound in vision".

SOUND IN VISION

A sound in vision system where the sound and vision are both transmitted in the one signal has been developed for use in the C.C.T.V. conference facility. Elimination of the separate audio channel or channels substantially reduces the system cost and ensures a higher degree of security.

The system utilises fifteen of the blank lines allocated for the vertical retrace at the receiver T.V. monitor. The audio information in a digital form is inserted in the video signal during each of the fifteen lines, using four levels, so that two bits of information are present on the video signal for each clocking interval. The system provides for two audio channels of reasonable quality — approximately 50 dB signal to residual noise and 1% distortion at 800 Hz. The audio signal has a fixed 20 ms delay relative to the video signal since a buffer information store is required before mixing of the two signals. Synchronisation of the transmitter and receiver is obtained by phase locking to one edge of the horizontal sync. pulses on the video signal.

The system has obvious uses outside T.V. conferencing, and the quality of the audio signal could be improved by using more sophisticated coding than the delta coder used at present. However, this would increase the cost of the system, and does not appear justifiable for C.C.T.V. conferencing.

DEVELOPMENT OF A LONG LINE TELEPHONE

A long line telephone has been developed which offers the prospect of substantial savings in expenditure on subscriber line construction. A major feature of the design is the means of controlling sidetone in a telephone with enhanced microphone and receiver sensitivities.

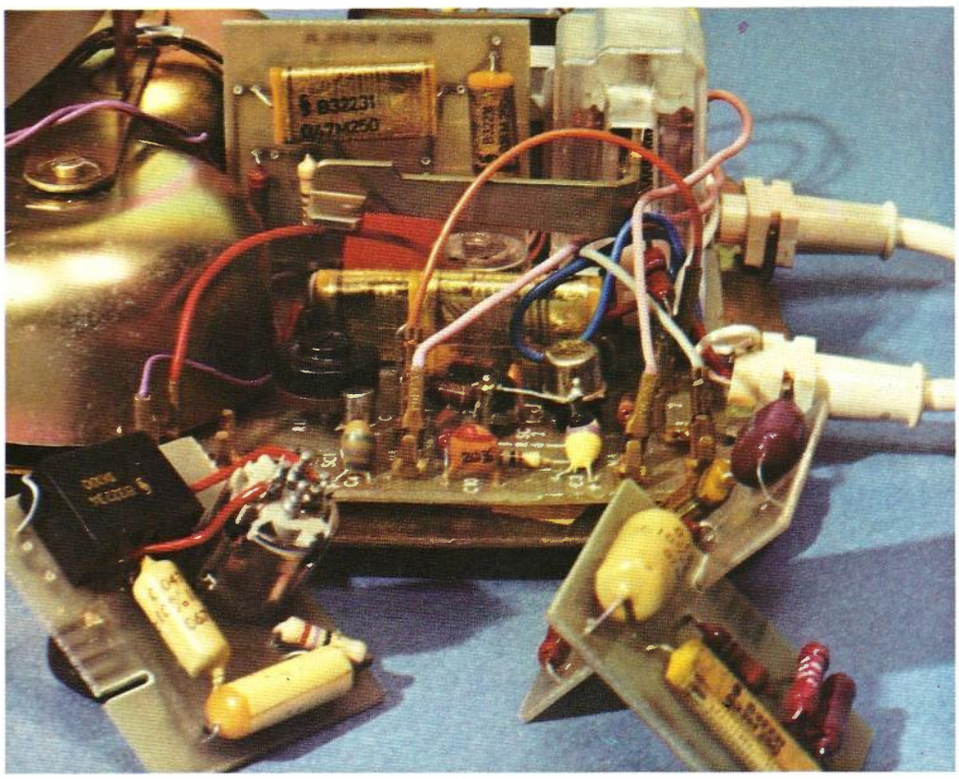
The normal means of controlling sidetone in a telephone is to incorporate the microphone and receiver of the telephone in a bridge circuit which is balanced when the impedance of the telephone line is matched by an internal network in the telephone. Because a variety of different lengths and types of line plant is normally employed in the construction of a telephone line, the standard 801 telephone has a compromise matching network for sidetone control, together with automatic sensitivity adjustment to suit different line lengths.

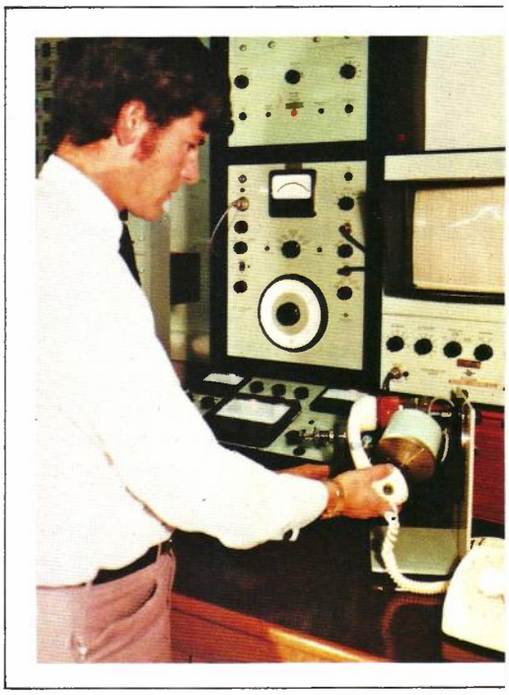
In the long line telephone (known as the 804 telephone) the greater sensitivities in the microphone and receiver paths preclude the use of a simple compromise sidetone balance network for all cables, and the type 804 design makes use of an appropriate range of plug-in balance network cards. As a consequence of this, certain restrictions are placed on the composition of the telephone line when providing service with the 804 telephone.

On the other hand, it has been possible to provide a balance network card which allows the 804 telephone to be used on inductance loaded subscriber cables. This technique has previously been greately limited in application because the compromise sidetone network in the 801 telephone was designed for unloaded cables, and the higher impedance of loaded cables gives rise to excess sidetone.

A limited field trial of the 804 telephone is under way in Victoria and New South Wales. So far the reaction of telephone subscribers has been favourable, and steps are being taken to launch a large scale trial with 6000 telephones.

The 804 telephone is expected to play an important part in the upgrading of telephone communication services in rural areas. As a consequence of the new rural policy announced by the Government in 1970, the A.P.O. will construct a telephone line up to 24 km in length without subscriber contribution to the capital cost. The 804 telephone is capable of operating over cables well beyond this length.





LONG LINE TELEPHONE AND BALANCE NETWORKS

The most important acoustical requirements of good office accommodation are met by an environment which:

(a) Enables staff to converse within the office with other persons, or on the telephone, without strain or deliberate effort.
(b) Prevents staff in adjacent offices from overhearing such conversations.
(c) Prevents the intrusion of distracting speech and noise from outside the office.

In particular cases, some or all of these characteristics may be considered as essential requirements of the accommodation. In order that accommodation may be designed to meet specific requirements, it is necessary to have a basic knowledge concerning speech levels, noise masking and the interrelationship between such factors as speech and noise levels, distances and room characteristics.

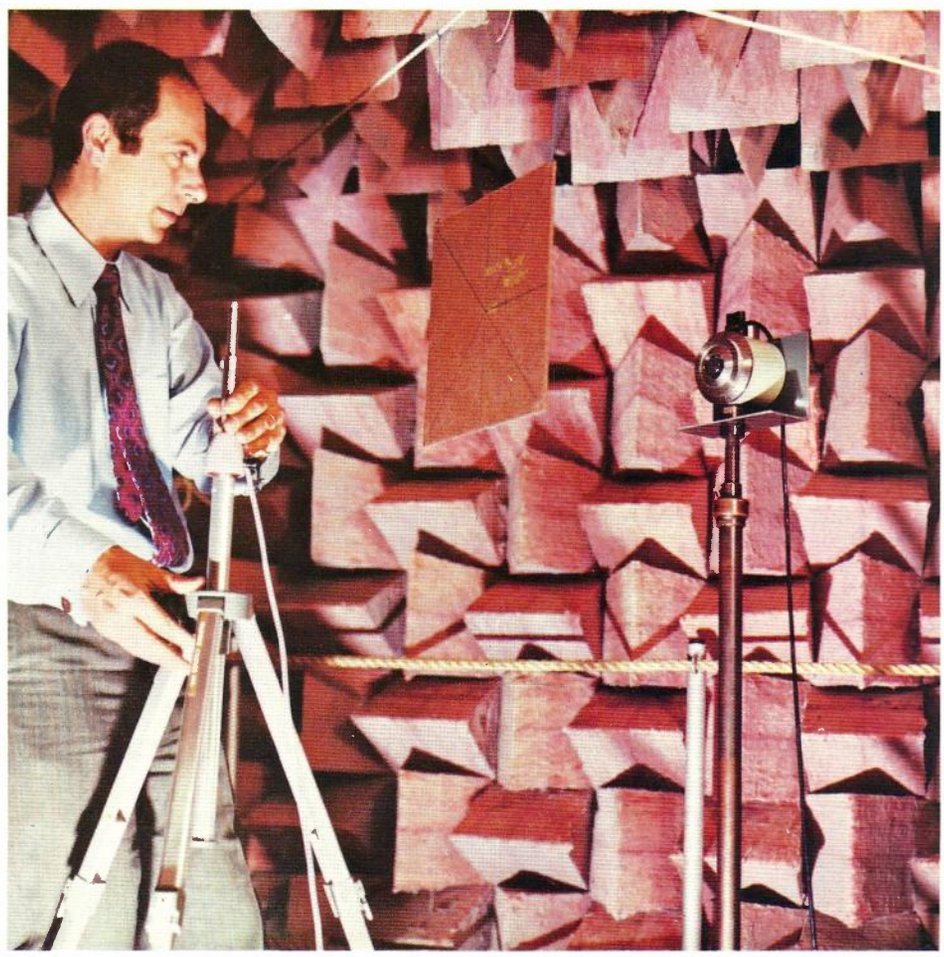
The Laboratories recently undertook the collection and assembly of basic data for the design of office accommodation from existing literature, and where necessary, from the results of specially conducted tests. The data included speech spectra and expected speech pressure levels for both raised and normal voices at various distances from the talker's lips under various conditions of ambient noise and room characteristics. The optimum noise spectrum for the complete masking of speech, for the most efficient masking of speech with the least annoyance to listeners, for understanding speech without excessive strain and the signal to noise ratios for complete freedom from strain in understanding speech, were also determined.

The calculation of acoustic losses in office environments was also considered. The specific cases dealt with included the losses due to ceiling height partitions, losses in open spaces, and the losses introduced by free-standing screens placed between talkers and listeners in open-space areas.

Some of this information was required for the design of modern landscaped offices in which fixed partitions are not used.

Much of the data was obtained from special laboratory tests conducted either in the Laboratories' anechoic (non-echoic) room or in acoustically treated quiet listening rooms, with the addition of artificial noise as required. Because all inter-related parameters were not necessarily evident at the same time in these tests, some practical application of the data will be necessary before its ultimate usefulness can be confirmed.

SCALED MEASUREMENTS OF ACOUSTIC SCREEN ▶



◀ MEASURING TELEPHONE PERFORMANCE

DESIGNATION OF BUTTONS ON PUSH BUTTON TELEPHONES

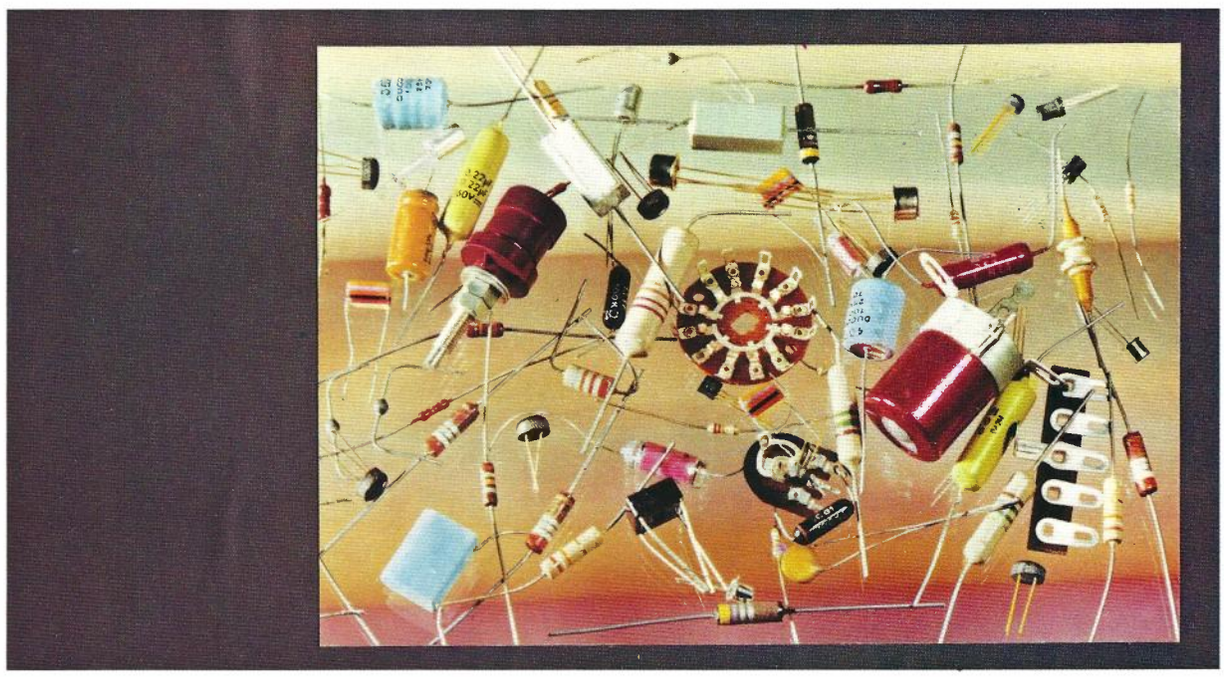
A recommendation is currently being formulated by the C.C.I.T.T. for the designations to be used for characters on the buttons of a new standard push button telephone keyboard suitable for use on international telephone connections. A decision has already been made that the keyboard will include 16 buttons, ten of which will be used for the digits 0 to 9, and two for the symbols * (star) and # (square). These 12 characters are already standard on push button telephones in current use in a number of overseas countries. It is intended to allocate alphabetical capital letters to the remaining four buttons. The total of 16 characters, compared to the present limit of 12, will provide improved versatility for expected future applications of data transmission from telephone subscribers' sets.

The proposal to include four alphabetical capital letters required a study of the likely confusion which could occur both visually and acoustically between the existing ten digits, the two symbols and the letters of the alphabet. Visual confusion can result whenever the characters are written, read, or punched out, and it is anticipated that there will be occasions when such characters will need to be transmitted orally over an international connection. Minimisation of visual confusion between characters is considered to be the more important criterion in the selection of the characters, and such tests have already been carried out in several countries with consistent results.

However, limited tests in a number of countries on acoustical confusion show language differences are likely to introduce difficulties in selecting four letters which are a good compromise, both visually and acoustically. The C.C.I.T.T. therefore sought to have acoustical confusion tests carried out in as many countries and in as many languages as practicable before making a decision on the selection of characters for the four remaining buttons.

In the acoustical confusion tests undertaken recently in the Research Laboratories, a telephone connection simulating the general conditions of an international call was set up and persons, representative of a range of typical international telephone subscribers, read lists of seven character sequences, comprising random combinations of two digits, four letters and one symbol, over the telephone connection to listeners who were required to write down the sounds which they heard. These were subsequently compared with the uttered sounds to ascertain the number of times confusion occurred. The results obtained in the Laboratories' tests showed that there was a high level of acoustical confusion with other letters, symbols or digits, for such letters as P, F, V, B, S, E, T and D, and a low level for such letters as W, J, Z, Y, R and Q. Between letters, major confusions occurred between P/T, F/S, B/E and D/E, and for letters and digits between H/8, I/5, X/6 and V/3. The results of the A.P.O. tests have been forwarded to the C.C.I.T.T.

PUSH BUTTON SIGNALLING TELEPHONE



COMPONENTS TESTED FOR RELIABILITY

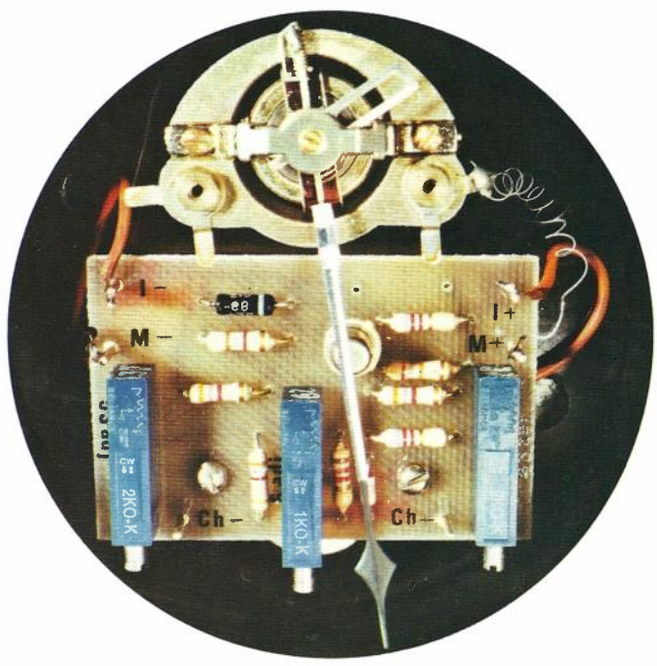
COMPONENT RELIABILITY INVESTIGATIONS

The reliability of a component is related to its ability to perform its required function under stated conditions for a specified period of time. In order to make predictions regarding the statistical life expectancy of a component, it is necessary to conduct tests which will be representative of the stresses to which this component will be exposed in actual service. However, to obtain results within a reasonable time span, it is often necessary to accelerate the tests, such as by an increase in the rate of operation or by increasing for instance the temperature, electrical loading or mechanical stresses. It is imperative that such accelerated test methods do not introduce failure mechanisms different from those normally encountered in actual operation, and consequently failure analysis using a variety of observational and analytical techniques is an essential part of all reliability investigations. Apart from revealing extraneous failure modes caused by over stressing, failure analysis provides valuable information to feed back to the manufacturer for eventual product improvement.

As many modern types of professional grade components have very long life expectancies, it is necessary to test substantial numbers, to obtain any failures at all inside a compartively short test period, and thus make predictions at a high level of statistical confidence. Because of the large numbers under test, and the profusion of parameters which often have to be measured at fairly frequent intervals, the need for a high degree of automation in operation, measurement, data logging and data analysis is obvious, and such equipment has been installed in the Research Laboratories over the past few years.

Amongst the components presently being investigated for life expectancy predictions are reed relays of the type to be used in the new stored program controlled trunk exchanges of the 10C type, and also those reed types utilised in the latest P.A.B.X. and intercommunication systems. Another study nearing completion is the comparative reliability of six different types of aluminium electrolytic capacitors under various test conditions related to their projected use. Assessment of telephone dials, high stability resistors and switching diodes are also in progress.

ELECTRICALLY SUPRESSED ZERO VOLTMETER



METER WITH ELECTRICALLY SUPPRESSED ZERO

A low cost d.c. voltmeter with a range of 48 to 53 volts and an accuracy of better than ± 0.25% has been developed principally for the calibration of telephone traffic meters (Erlangmeters).

The device consists of a standard permanent magnet moving coil meter, with an accuracy of ± 1%, in association with an electrical suppression circuit mounted on a printed wiring board enclosed in the meter case. The suppression circuit comprises a bridge configuration, two arms of which constitute a constant voltage source which is stable against input voltage variations in the range 45 to 60 V, while the other two arms form a resistive divider. The reference used is obtained from a two stage zener diode regulated supply whose final reference element has a temperature coefficient less than ± 0.005% per °C. The circuit includes a potentiometer which allows the generated reference voltage to be set to within ± 1% of its nominal 5 V value. Similarly, low end and high end potentiometers are provided for calibrating the instrument at 48 V and 53 V respectively.

The device exhibits good stability over the range – 7°C to + 71°C (20°F to 160°F) with indicated accuracy of better than ± 0.15%. On a theoretical basis the error due to bulk manufacture can be estimated from the manufacturers' data on components. When this error is taken into account an expected accuracy of within ± 0.25% should be obtained. The calibration is expected to remain stable over several months.

PRECISION ELECTRICAL MEASUREMENTS AT RADIO FREQUENCIES

The Research Laboratories, like many other large establishments engaged in activities at the forefront of technology, have found it necessary to provide facilities for the calibration of measuring equipment. The areas of investigation are in most cases on the fringes of the present state of technological development. In addition, the interest of the A.P.O. in the telecommunication field is so wide that the requirements of scope and range are very considerable.

The accuracy of the reference standards used by the Research Laboratories is traceable to either the Australian or an overseas National Standards Laboratory. The range of calibrations performed in the Laboratories extends from direct current to microwave frequencies. The Laboratories are registered with the National Association of Testing Authorities (NATA) for a wide variety of tests and are authorised to issue certificated calibration reports in accordance with the requirements of that body.

As a result of the increasing application of the higher frequencies in telecommunications and the trend to tighter tolerances in the performance of communication systems and equipment, the demand for precision calibration services at the higher frequencies has increased rapidly. In recent years considerable effort has been devoted to extending the range and accuracy of high frequency calibration services by developing specialised calibration techniques and by increasing the facilities through the acquisition of such standards as are commercially available. As a result, the Research Laboratories is one of the few laboratories performing precision calibrations of radio frequency power measuring equipment at frequencies up to 12 GHz with traceable accuracy. Because of the rapidity of the move to the higher frequencies most laboratories in the field have experienced difficulty in keeping abreast of the demand for calibration as the production of high accuracy standards lags behind the revenue producing plant.

The Laboratories are responsible for the establishment and maintenance of the A.P.O. standards of all electrical quantities. A system of calibration centres is being established to maintain an oversight of measuring accuracy throughout the A.P.O.'s entire range of operational activities and in the acceptance testing of equipment and material purchased. The Research Laboratories are committed to the oversight of these calibration centres by the calibration of the reference standards used and the precision bridges and other equipment, in order that a traceable system of measurement is in use throughout. In those areas of the A.P.O. where very expensive calibration equipment or a high degree of expertise is required, the Laboratories perform the calibrations, while development proceeds on suitable calibration methods for use in the individual State Calibration Centres.

TIME AND FREQUENCY STANDARDS

The A.P.O. maintains Time and Frequency Standards to ensure:

(a) The accuracy of the engineering measurements required for the operation of the national telecommunication system, in which frequency is a basic parameter.

(b) That its responsibilities in the administration of the Wireless Telegraphy Act, which regulates the occupancy of the radio spectrum, are properly carried out.

(c) The satisfactory performance of the time and frequency services which it provides.

(d) That expertise is available for application to developments or problems involving precise frequency or time.

The standard is authorised under the Commonwealth Weights and Measures (National Standards) Act 1960-1966, as a Working Standard of frequency and time interval for the Commonwealth, and the Senior Assistant Director-General, Research is appointed under the Act to maintain the standard and to verify subsidiary standards of frequency and time interval within the A.P.O.

RUBIDIUM VAPOUR ATOMIC CLOCK

The primary frequency generators in the standards installation are two caesium beam frequency standards. Back-up is provided by two rubidium vapour standards and four quartz crystal standards. Clocks are operated from all of these frequency standards. Duplication of function is an essential feature of the installation which must keep generating frequency and time scale to high precision without fail if the standard is to be preserved. The quartz oscillators are retained because they add reliability to the more complex atomic devices. The system allows the occasional transport of an atomic clock when accurate frequency or time is required at a distant place.

The accuracy of the caesium standards is quoted as 7×10^{-12} r.m.s. fractional deviation from normal, referred to the S.I. second. In practice this has remained within 3×10^{-13} of the United States Naval Observatory master clock since March, 1970, as shown by travelling clock comparisons. The better rubidium standard decreases in frequency at the approximate rate of 4×10^{-12} per month.

The time kept by the A.P.O. master clock is within a few microseconds of the international atomic time (I.A.T.) maintained at the Bureau International de l'Heure (B.I.H.). In addition, a notional Australian mean clock is maintained by suitably combining the performances of caesium clocks at selected laboratories in Australia with which precise comparisons can be made. These include the National Standards Laboratories, the Mount Stromlo Observatory and the Defence Standards Laboratory.

The installation is internationally calibrated against the standards of the National Physical Laboratory England and of the United States Naval Observatory (U.S.N.O.), principally by comparison with standard frequency radio transmissions and by travelling atomic clocks from the U.S.N.O. Calibration against the B.I.H. and the U.S. National Bureau of Standards is obtained by transfer, using these comparisons.

Signals from the A.P.O. standard are distributed widely throughout Australia for use by the A.P.O. and other establishments. Equipment and services controlled by, or calibrated against, the standard include the frequency standards at the A.P.O. Frequency Measuring Centres and the A.P.O. State Calibration Centres, carrier oscillators, speaking clocks, civil time services, radio time signals, and navigation time signals.

SPEECH LEVEL MEASUREMENTS

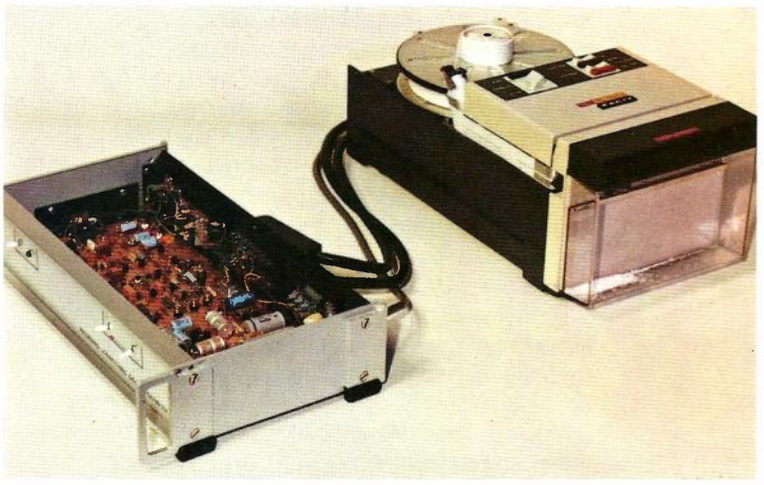
In the design and application of telephone transmission equipment, a knowledge of actual speech levels at various key points in the network is desirable. Speech levels are determined by a variety of factors, such as the loudness of the individual talker, length of local telephone line, and the condition and method of use of the telephone handset. Because of these factors, a statistical approach is used in the characterisation of speech levels. In the past, statistics have been obtained by repeated estimations of volume unit (VU) meter readings; a method which is tedious and liable to subjective errors. With modern instrumentation and computing facilities, a new approach to signal level measurements is possible, allowing more comprehensive and more accurate statistics to be gathered.

The C.C.I.T.T. is co-ordinating a programme of measurement of speech levels by participating administrations, with the aim of eventually standardising signal loading of multichannel carrier systems at the international interfaces. The A.P.O. is participating in this programme, as well as increasing its knowledge about speech signal levels in the network.

The Research Laboratories has developed a speech level meter. This instrument samples the instantaneous amplitude of speech voltage at a rate of approximately four samples per second. Samples are quantised to a logarithmic law and sorted into 20 slots spaced 2 dB apart. Quantised values are coded and punched onto paper tape.

Computer analysis of the tape then allows the computation of r.m.s. voltage, mean power (if the impedance at the measurement point is known), a statistical distribution of instantaneous signal voltage amplitudes, and an activity factor which gives a measure of the fraction of conversation time during which speech actually occurred.

A preliminary measurement programme at three metropolitan and two country telephone exchanges has been completed and submitted to the C.C.I.T.T. In all cases measurements were made for the local talker only, by using a speech flow direction indicator which senses the relative phasing of speech voltages and currents on the line giving results for only one direction of transmission. Measurement automatically commences at the set up of a call and ceases when the telephone circuit is released at call completion.



SAMPLING SPEECH VOLTMETER

Computer analysis simplifies the reduction of the vast amount of data collected in this way, and gives summarised results such as overall mean powers, distributions of signal voltage showing the probability of any specified level being exceeded, and overall activity factors. The threshold for the activity decision is spaced 15 decibels below the "mean power while active", requiring an iterative computation for the activity factor of each talker. Since the data must be rescanned several times in the course of the iterative process the input data which is punched on paper tape is temporarily stored on magnetic tape during the computations.

Although much interest still centres on voice frequency signal level measurements at the local exchange point in the telephone network, another instrument with extended bandwidth has been developed, which allows signal loading information to be collected at the supergroup point, where 60 voice frequency channels are combined. This reduces the need to consider activity factors and reduces measurement time considerably.

AUSTRALIAN PARTICIPATION IN THE TRIALS OF C.C.I.T.T. SIGNALLING SYSTEM No. 6

With the advent of satellite communication systems and processor controlled exchanges, the C.C.I.T.T. undertook in 1967 and 1968 to specify a new type of common channel signalling system known as the C.C.I.T.T. Signalling System No. 6. The system is designed specifically for use between processor controlled exchanges. Several countries including Australia have agreed to participate in these trials.

As part of this field trial, a series of tests was commenced between Melbourne and Sydney in December 1970 over a C.C.I.T.T. signalling system No. 6 link which had been established between Melbourne and Sydney especially for this purpose. In Sydney, this link terminates in a small processor controlled exchange operated by the Overseas Telecommunications Commission (Australia) and in Melbourne, in a small processor controlled exchange developed and provided by the Research Laboratories.

The initial tests were used both to validate the signalling link and its associated equipment and to identify a number of deficiencies in the specification, which was subsequently amended by the C.C.I.T.T. A further series of tests using the associated switching equipment to handle simulated traffic was commenced in November 1971.

This project has provided techno-economic information which will be of considerable use in assessing the suitability of a common channel signalling system when sufficient processor controlled exchanges are installed in the Australian network. It has also provided considerable insight into various aspects of processor controlled exchange operation, including the development, maintenance and modification of software systems.

INSTALLATION OF C.C.I.T.T. SIGNALLING SYSTEM No. 6

I.S.T. (INTEGRATED SWITCHING AND TRANSMISSION)

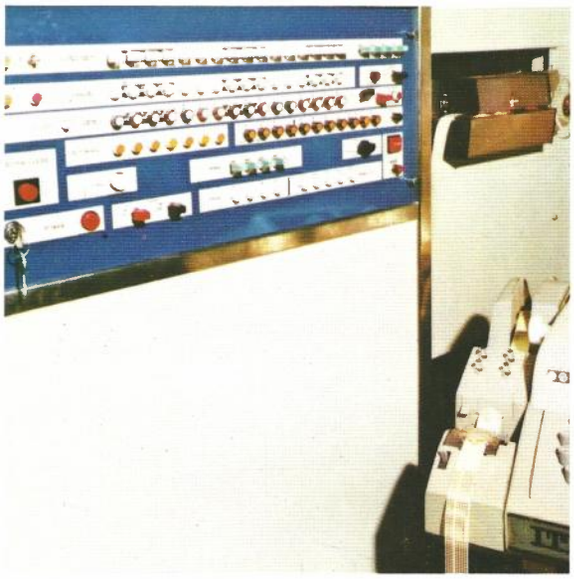
An I.S.T. telephone exchange, designed and built in the Research Laboratories, is currently undergoing exhaustive system testing prior to carrying live traffic in the Melbourne telephone network. In the field experiment, traffic from four conventional exchanges will be routed via the model I.S.T. exchange to test its capabilities under realistic working conditions.

The I.S.T. exchange is interconnected with the rest of the telephone network via four 24 channel PCM (Pulse Code Modulation) transmission systems, which in the future may offer significant economies in utilising the existing junction cable network. The digitally encoded speech is switched through the I.S.T. exchange in digital form using a combination of time and space division switching implemented with solid state devices.

Another feature of the I.S.T. exchange is that it is controlled by a pair of processors (computer-like devices) that store a set of programs that automatically operate, monitor and to some extent maintain the exchange. The exchange and its processors are designed to be of high reliability, but if one processor should fail, the other processor will automatically assume full control of the exchange. The processor(s) will automatically direct the traffic through alternative devices if a switching device is diagnosed as faulty. The processors are capable of carrying out routine testing of the exchange, and of furnishing an extensive set of statistics on traffic passing through the exchange.

A further feature is the use of advanced semiconductor technology in the form of custom-built integrated circuits, developed by the Laboratories in co-operation with the local electronics industry.

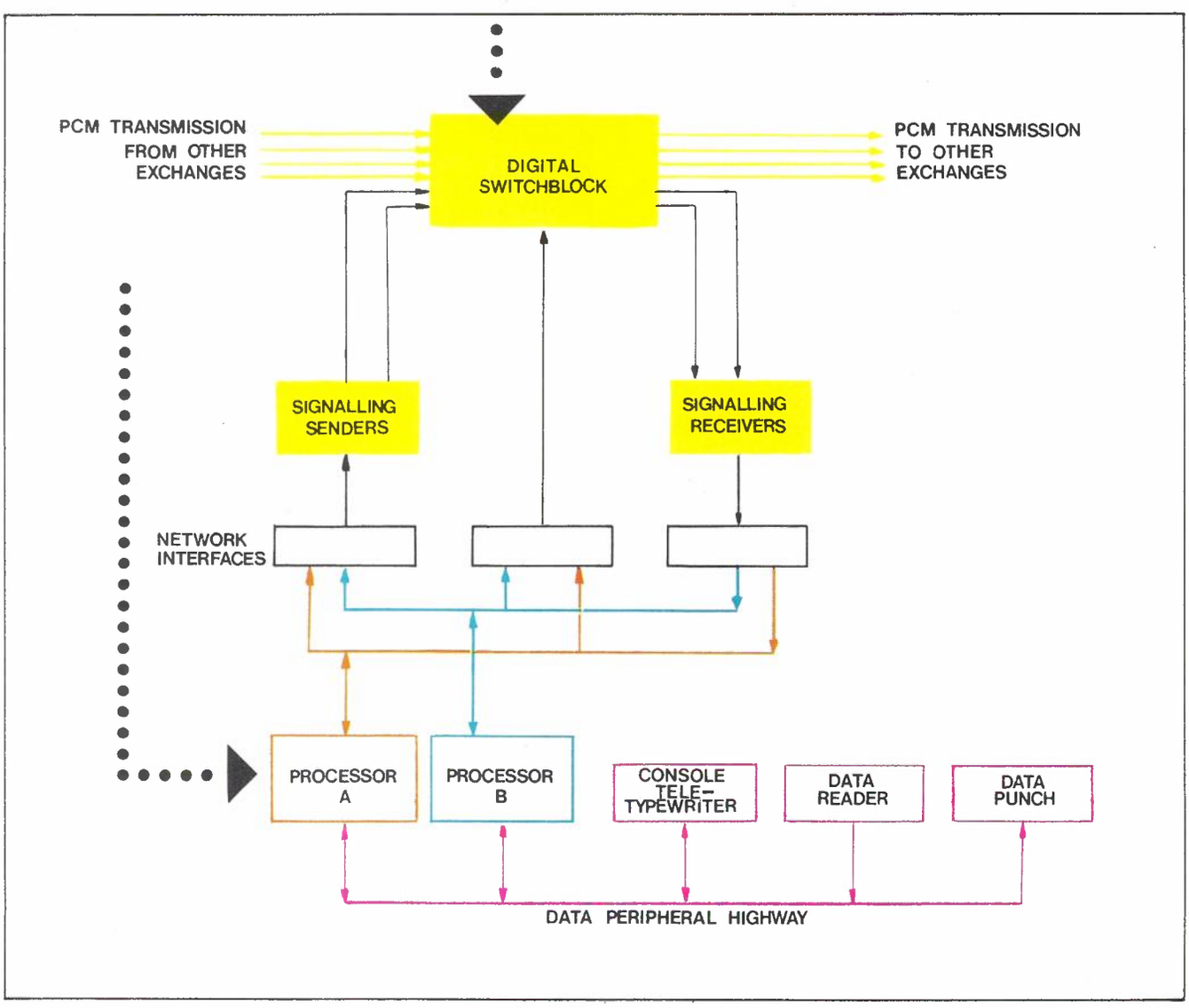
The next phase of the I.S.T. experiment is the development of local subscribers' switching stages akin to conventional concentrators to be remotely controlled by the parent I.S.T. exchange. These concentrators should enable subscribers to be supplied with advanced facilities in an economical way.



PROCESSOR

DIGITAL SWITCHBLOCK

I.S.T. CONFIGURATION



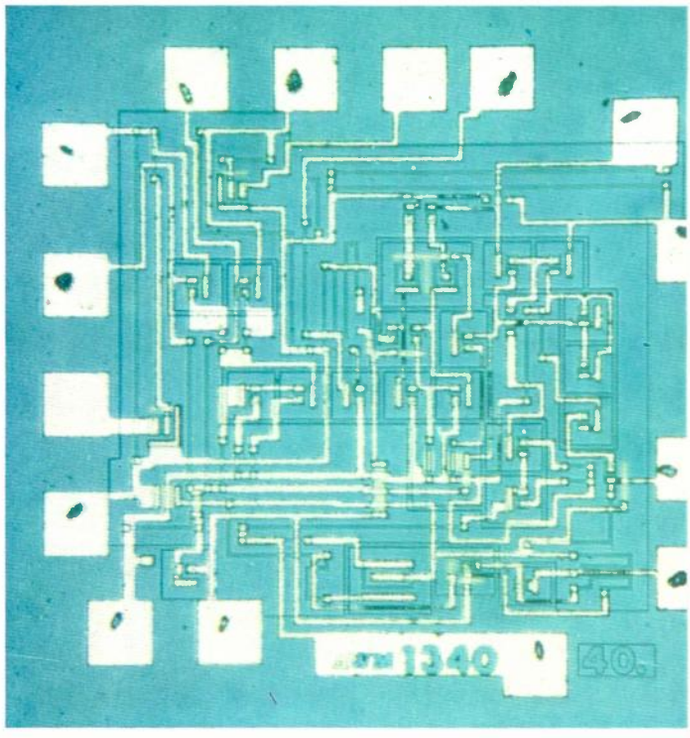
MICROELECTRONICS

Electronic circuits produced in micro-miniature form are the result of a relatively new technology known as microelectronics. Extremely complex circuits can be produced on a very small area of semi-conductor material and are marketed as integrated circuits (I.C.), medium scale integrated circuits (M.S.I.) or large scale integrated circuits (L.S.I.). These devices have made an important impact on system design, especially in the field of digital systems including stored program controlled exchanges. The Research Laboratories realised the technical and economic benefits to be gained from using these devices at an early stage and possess significant expertise in this field.

Two major projects in the switching and signalling field, namely the I.S.T. project and the C.C.I.T.T. Signalling System No. 6 project, use integrated circuits as basic building blocks. Simple medium scale and large scale integrated circuits covering a wide variety of functions and complexity have been used. Since commercially available devices were not suitable for the purposes of these projects, expertise was developed in the design of custom integrated circuits, and with the assistance of local industry, several custom designed I.C.'s were produced.

With greater use of I.C.'s new techniques in mounting these devices on printed circuit boards have been developed. Factors such as the excellent reliability of the I.C.'s, the high cost of printed circuit board edge connectors and the resolution obtainable by photo-etching techniques have encouraged the use of large printed circuit boards. At present a double sided circuit board about 25 cm by 25 cm is a commonly used size. However, a board 46 cm by 62 cm double sided using 8,000 through plated holes has been produced. Multi-layer printed circuit boards are also being used. These boards are of laminar construction, enabling both earth and battery planes to extend through the interior of the board, thus allowing greater control on the impedance of inter-connecting leads. The superior electrical characteristics of such a board are manifest in increased noise immunity and reduced propagation delay. In addition, packing density can be increased due to the reduced surface area of board used for inter-connection lines.

As the complexity of I.C.'s and the size of printed circuit boards increase, so the problems associated with the layout of components and their inter-connection patterns increase. When simple I.C.'s were first used on small printed circuit boards they were considered a technical novelty, and so it was considered appropriate for technical staff to produce the photographic masters of the printed circuit board. However the amount of work involved in laying out a large printed circuit board is considerable, and because of the now standard techniques involved, this work is better done by less skilled staff or by machines. The Gerber program controlled drafting machine at the Department of Supply has been used to produce a 46 cm by 62 cm printed circuit board master which accommodates 300 I.C.'s and 512 light emitting diodes. It produced this photographic master in fourteen hours, thereby saving many man weeks of human effort.

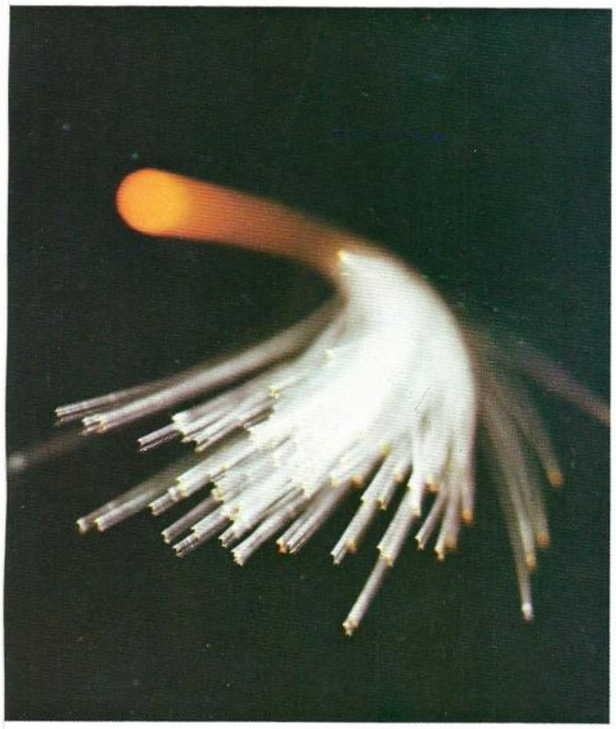


INTEGRATED CIRCUIT (MAGNIFICATION x 60)

The expertise developed has been of use in other areas within the A.P.O. Trouble shooting teams have on several occasions investigated problems in equipment purchased. The rapid correction of circuit faults has enabled important projects to proceed without the time consuming delays of returning equipment to the manufacturers.

Microelectronics are foreseen to play a major role in the equipment the A.P.O. will use in the future. The expertise being consolidated now will ensure that adequate assessment can be undertaken to ensure that a smooth introduction of microelectronics can proceed.

CROSS SECTION OF OPTICAL FIBRE (MAGNIFICATION x 200)



BUNDLE OF ILLUMINATED OPTICAL FIBRES

CIRCULAR WAVEGUIDES AND OPTICAL FIBRES

Considerable research and development has been undertaken in many countries during the last few years to exploit both conventional and novel transmission media at higher frequencies in an attempt to meet the rapidly increasing demand for transmission capacity.

Circular waveguide and optical fibre seem at this time to be the media most likely to offer economically viable very high capacity systems within the next ten years. With a circular waveguide of diameter about 50 mm operating in the millimeter-wave region (i.e., between about 30 GHz and 100 GHz or higher), a transmission loss of better than 3 dB/km can be achieved, with a consequent spacing between repeaters in the order of 20 km. Losses for optical fibres at visible or near-infrared wavelengths (i.e., between about 0.3 and 4 μm) as low as 20 dB/km have been achieved so that repeaters will need to be spaced not more than 3 km apart in a final system. The transmission capacity of either system is potentially much greater than foreseen requirements.

A liquid-core low-loss optical fibre capable of being manufactured in long lengths has been developed by the Tribophysics Division of the C.S.I.R.O. Melbourne. Several of these fibres have been made available to the Laboratories, and the successful transmission of analogue T.V. signals over a fibre of length 400 m was demonstrated in February, 1972. Since then, investigations have been directed towards determining the ability of the fibre to transmit high speed digital information, with a view to specifying a high capacity digital system suitable for the broadband network.

COMMUNICATION SATELLITES

Over the last ten years the capability of communication satellites has been increased by technological development to the extent that a single satellite can now carry more than 6,000 telephone circuits or 12 colour television channels, and there is still a considerable impetus for further advancement. This improvement has had the effect of reducing costs substantially. In the international communication service by Intelsat for instance, the annual charge for rental of a satellite channel today has dropped by more than one half since 1965, and further cuts are expected by the mid-1970s.

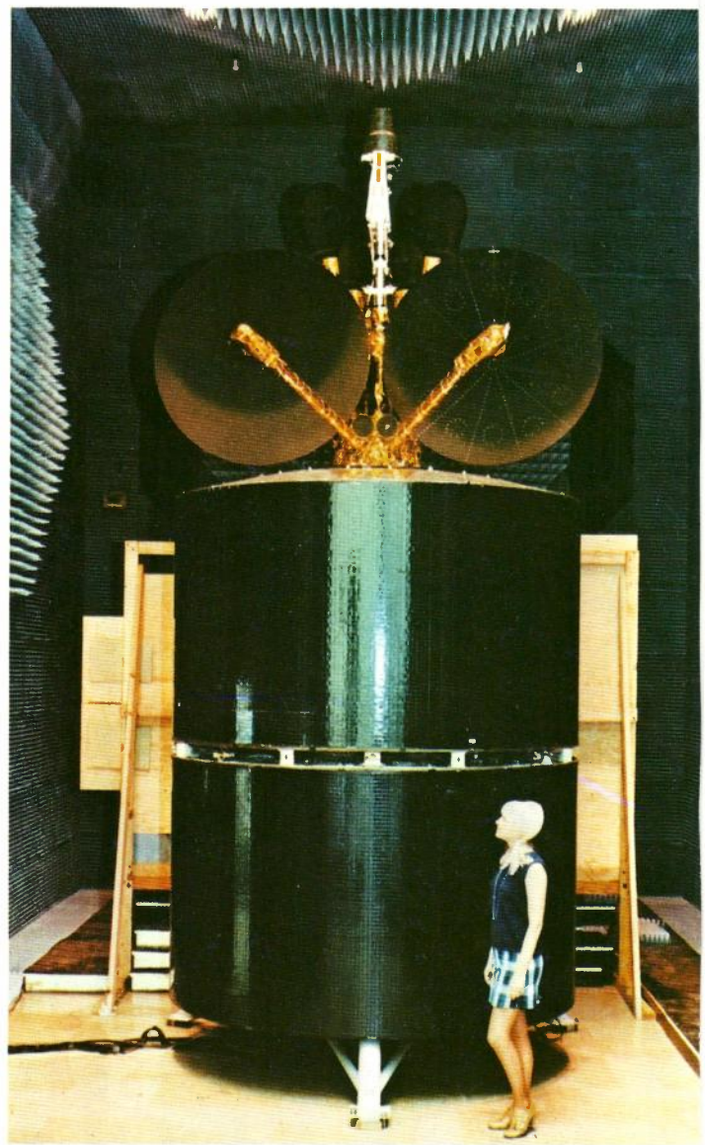
With this improvement in mind, studies have shown that it may be economically advantageous to implement an Australian national satellite communication system in the latter part of this decade. Such a system could include trunk telephony services, television relaying and other video services, data transmission and reticulation to subscribers in remote areas.

Before implementing a national system, comprehensive studies backed up by hardware investigations are required to establish system parameters which are optimum for specific national requirements.

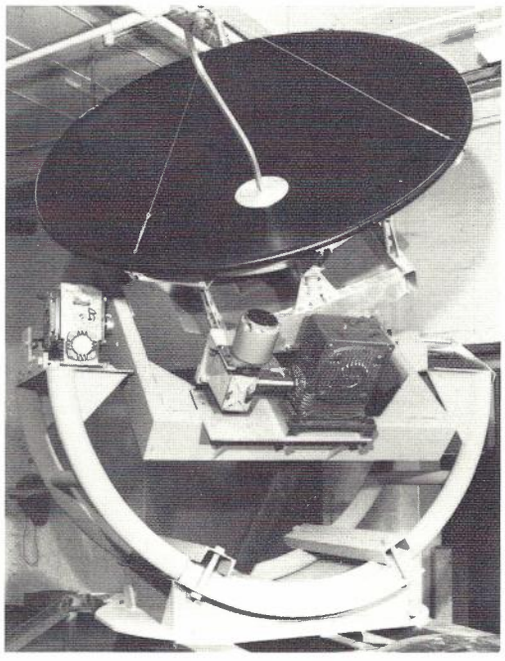
To facilitate these studies in preparation for an Australian system, a group of engineers from the Planning and the Research areas of the A.P.O. are working together as a Task Group.

One technical problem associated with the bands of frequencies above 10 GHz allocated to the fixed satellite service by the World Administrative Radio Conference for Space Telecommunications (held in Geneva in June, 1971) is caused by the effect of rain. Extra propagation losses during rainfall periods become increasingly serious as the operating frequency is increased. The factors controlling the amount of this extra attenuation are being investigated. The project will add to an understanding of the attenuating mechanism, provide factual data to assess the problem in Australia and permit future system design. Results are expected to start becoming available towards the end of 1972.

Because intense rainfall is more likely to be a problem in tropical areas, the first set of measurements will be carried out in a high rainfall area in the tropical part of Northern Queensland. The measurements are to be made by a solar radiometer which works by using the sun as a source of radio signals and the sky attenuation is deduced from the calibration and operating procedure. The



radiometer instrument consists of an antenna which tracks the sun and adjacent sky sequentially throughout the day and the signal collected by the antenna is measured in a sensitive receiver, tuned to the frequency of interest. The frequency bands of particular interest in this context are in the range 10.95 to 14.5 GHz.



SOLAR RADIOMETER

DATA TRANSMISSION SYSTEMS

◀ INTELSAT IV — THE MOST ADVANCED COMMUNICATION SATELLITE AT PRESENT IN COMMERCIAL OPERATION

Research Laboratories activities in the data systems sphere fall into two categories. On one hand there is the role of device and system evaluation carried out on a consultative basis for the various Branches of the A.P.O. concerned with the transmission of data. Such a role would be the norm when data facilities for a given function are readily available from commercial sources. On the other hand there is the developmental role in which prototype systems or sub-systems may be engineered to meet needs not serviced commercially. Such developmental effort would normally involve industry at some stage. An example from each category follows.

ACOUSTICALLY COUPLED DATA MODEMS

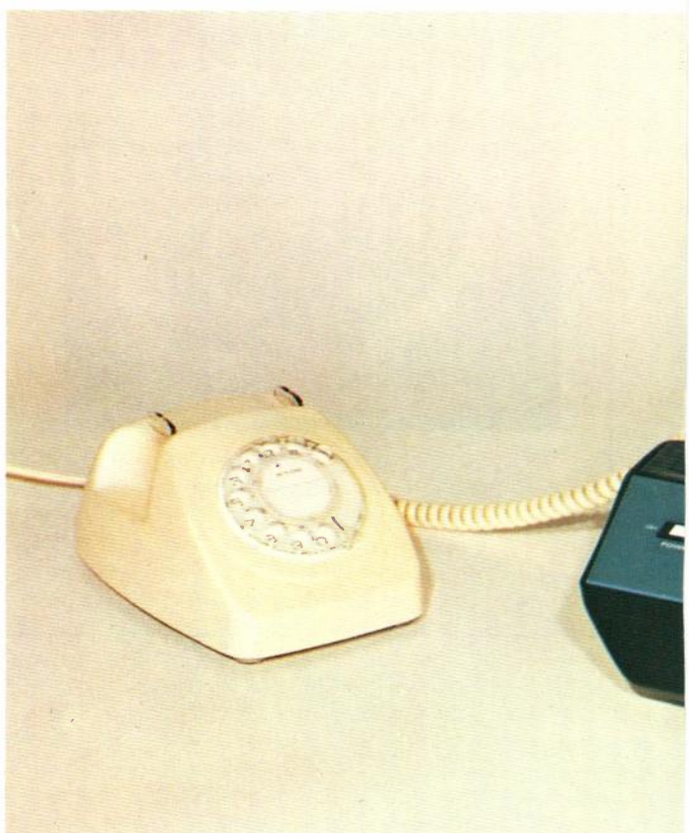
The Datel service offered by the A.P.O. provides digital data transmission facilities over the telephone network by means of a data modem hardwired to the telephone line, which may be either a switched or a private line. In some cases the necessity for installing a hardwired modem is inconvenient (e.g., a salesman demonstrating a computer on-line terminal) and the advantage of coupling the data signals acoustically to a conventional telephone is very apparent.

Accordingly, after studying modems commercially available, the Laboratories acquired for testing a type having characteristics compatible with the current A.P.O. Datel modems operating up to 200 baud. When used with an 801 telephone handset, 200 baud data signals can be acoustically coupled in both directions with a low telegraph distortion and error rate.

However two sources of deterioration are of concern. Firstly the power output of the carbon microphone is a function of the feed current being applied to it and in practice variations of up to 8 dB can be expected depending on the length and make-up of the cable from the subscriber to the exchange. Secondly the carbon microphone used in the normal telephone is susceptible to carbon "packing" if used in horizontal position and this may result in variations in level with time of up to 15 dB.

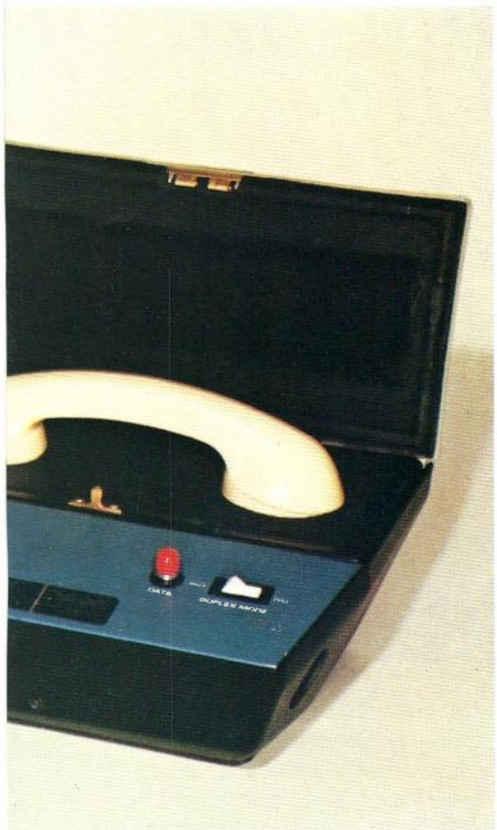
The microphone in the A.P.O. telephone appears more susceptible to packing (when mounted horizontally) than microphones used for instance in the U.S.A. or the U.K. With the modem and handset mounted vertically, minimal packing and loss of level occurs.

Data transmission tests carried out at 200 baud in the laboratory using both local and interstate circuits, indicate that the performance of the acoustically coupled modem and telephone is not significantly inferior to that of a hardwired data modem, except when a combination of high loss, low microphone feed current and carbon packing loss reduces the received level below the detector's threshold.



ACOUSTIC DATA COUPLER

As a result of this work, the Laboratories have recommended that acoustic coupling of low speed data signals be permitted on the Australian telephone network provided that the handset is positioned to minimise the carbon packing effect.



WIDEBAND DATA TRANSMISSION

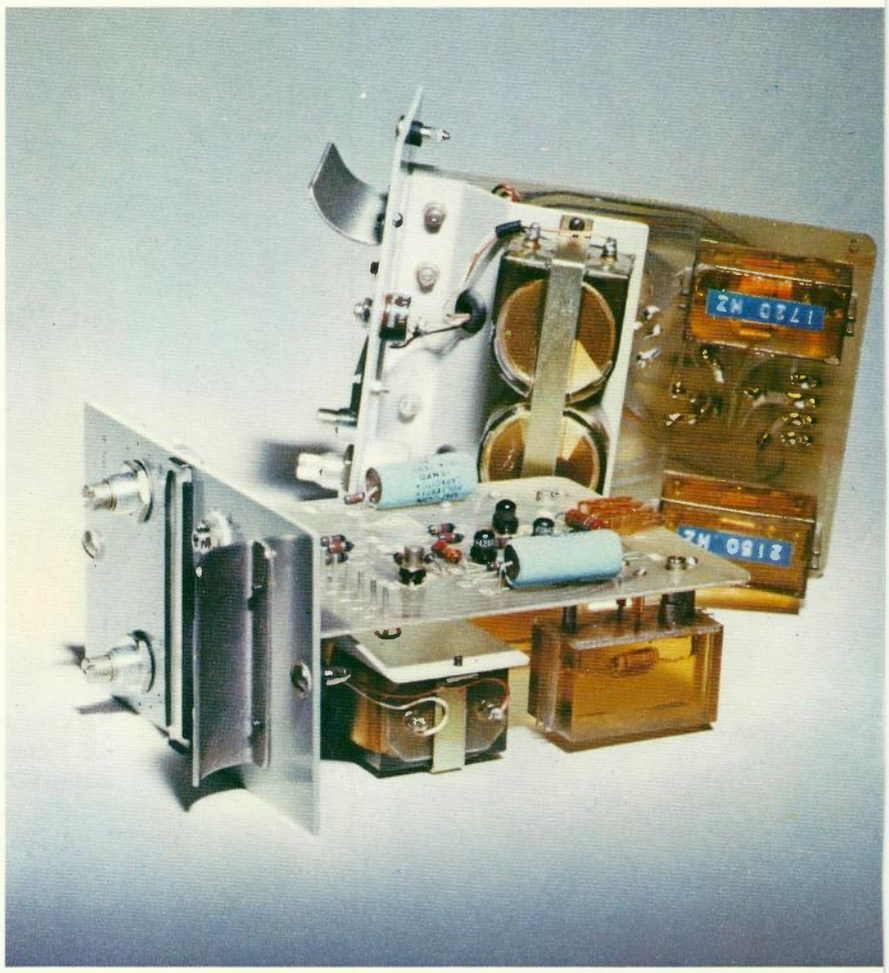
The development of a 20 M bit/s data system for working within the super-mastergroup bandwidth of the FDM system hierarchy has been undertaken for two main reasons:

(a) To provide a digital bearer for the trunking of T.V.-telephone, T.V., data and other non-speech signals which lend themselves to more efficient transmission in the digital mode than in the analogue mode.

(b) To provide a means of utilising the FDM network for the higher order PCM multiplex systems at a time when the overall network is in transition to fully digital mode operation.

Digital mode transmission for T.V.-telephone operation is attractive for two reasons. The first pertains to the saving in channel capacity utilisation, and the second the ease in formulating a T.V.-telephone transmission plan in which the total allowable signal impairment can be allocated to the subscriber reticulation area where existing V.F. plant may be utilised at MHz frequencies. The transmission quality then becomes essentially independent of the route followed, the number of links traversed or the distance involved.

The initial phase of the super-mastergroup data system development comprises the implementation of a 12 M bit/s prototype. Work towards this goal is already well underway with a system nearing completion.



Linear circuit techniques are applied to the solution of a broad range of circuit design problems arising both from within the Research Laboratories and from Departmental operations as a whole. The majority of the circuits dealt with are filters, attenuation and delay equalisers, and impedance matching networks which must meet some prescribed frequency or pulse response within specified tolerances, and which are either not commercially available or unnecessarily expensive or difficult to procure in the time available.

An example of a filter recently designed and built to meet a special A.P.O. requirement is a crystal bandstop filter which has a stop-band width of 250 Hz at a centre frequency of 361.5 kHz to be used, together with a complementary crystal bandpass filter, for in-traffic noise measurements within the basic supergroup of wideband carrier systems to assist in equipment maintenance. Another example is a set of two voice-frequency bandpass filters to be used in a measuring system for determining the degree of echo suppression on international telephone circuits. These filters have a passband of 500 Hz to 2500 Hz, and to meet special performance requirements one filter has been designed as a two-section active network, and the other as a four-section passive network.

Nowadays digital computers are extensively used in the design of the networks mentioned above, and a number of special computer programs have been written for this purpose. In this context various mathematical methods for minimising deviations from specified network performances have been examined, and where necessary modified to suit particular requirements. In the course of this work some useful contributions have been made by the Laboratories' staff to the development of improved optimisation techniques.

VARIABLE GROUP DELAY & ATTENUATION EQUALISER

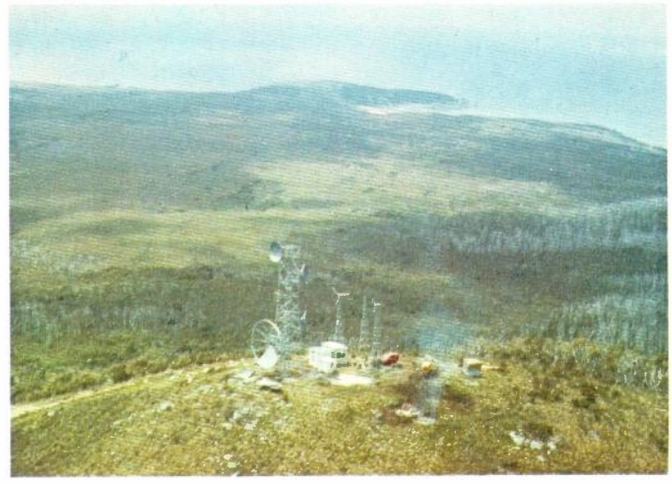
To comply with the growing demand for the transmission of data over carrier telephone channels, a variable group delay and attenuation equaliser has been developed to enable the available channel width to be used more efficiently, and thus increase the maximum rate of data transmission over such circuits. Previously, specially designed fixed equalisers were installed for each case with the disadvantage that with a change of channel, the equalisers usually became inadequate and had to be replaced by different equalisers. The time required to design and manufacture the replacement equalisers was a potential source of customer dissatisfaction. The variable equaliser is aligned in situ and can be realigned immediately when the channel is changed. Variable equalisers in accordance with the Laboratories design are being manufactured locally at a cost well below the purchase price of commercially available variable equalisers of similar types.

PROPAGATION MEASUREMENTS ACROSS BASS STRAIT

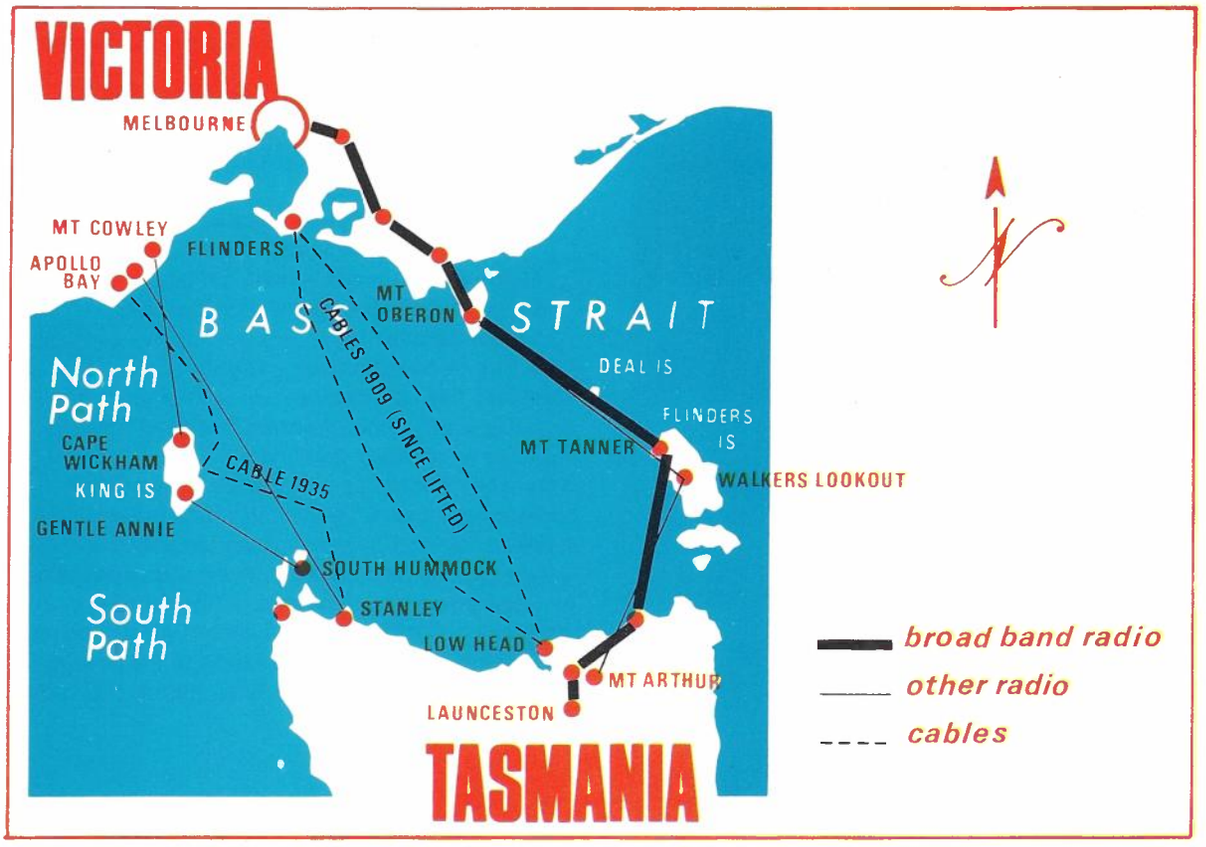
In 1859, only nine years after the world's first submarine cable in open sea was realised, laying of a cable across Bass Strait commenced. The cable linked Cape Otway (Victoria) and Low Head (Tasmania), via King Island and Three Hummocks Island, a small island near the Tasmania coast.
In late 1971, 2 and 4 GHz radio propagation measurements on the "South Path" between these same islands were concluded, and in early 1972 associated measurements on the "North Path", between King Island and Mt. Cowley (Victoria) were completed. It is proposed that these paths together with a short path from Three Hummocks Island to Tasmania will provide a new broadband route to the Australian mainland across the western end of the Strait.
Over the century between laying the first cable and the most recent propagation measurements, the Research Laboratories have been associated with many telecommunication systems which have bridged Bass Strait. These include later telegraph cables and the 1935 telephone cable for which 9-channel extension equipment was produced in 1954. Several radio systems have also been employed across the Strait, and the major link is now provided at the eastern end by a microwave broadband bearer via Flinders Island. All radio systems required radio propagation measurements by the Laboratories in advance of their installation. The measurements now cover seven frequency bands between 40 and 4000 MHz.
Bass Strait radio paths offer particular propagation problems because the sea distances involved necessitate path lengths above average, and because Bass Strait exhibits unusual and complex meteorological conditions. Anomalous long distance propagation of T.V. and radar signals occurs frequently over these waters.

Earlier measurements at the eastern end of the Strait showed that microwave signal levels could fall seriously below their normal "free-space" values for protracted intervals. Such signal depressions were observed over several years, generally in the September-November period. For the worst such interval, the median signal level was 22 dB below the free-space level over 18 hours, and for 11 minutes remained more than 40 dB below that level.
In planning the recent 2 and 4 GHz measurements on the western route via King Island the major concern was that similar "median depressions" would occur on the 120 km "North Path", a risk accentuated by the 580 m height differential between the antennas at the two ends of the path.
Atmospheric layering at intermediate heights appeared possible, with resultant ray "trapping" phenomena.
The 90 km "South Path" crosses waters where earlier 450 MHz measurements had suggested marked subrefraction could occur. This causes "inverse-bending" of the radio rays towards the sea surface, and may also produce serious depressions of signal level. Whether originating in super-refractive or sub-refractive conditions, such signal depressions can cause serious degradation of system performance. Diversity reception arrangements offer little protection against this variety of fading phenomena.
Many practical problems had to be solved before the propagation measurements could be conducted efficiently. Because of the isolation of Three Hummocks Island, where the installation had to be serviced by light aircraft, high reliability was required for the measurement transmitters and associated power plant. Fully solid-state transmitters were produced for this task with telemetering facilities added which encoded data on transmitter power level onto the radiated carrier. Sites were powered from wind generators (Three Hummocks), adjacent mine and lighthouse plants (King Island) and diesel motor generator set (Mt. Cowley). The normally unattended installations were operated continuously and serviced at ten day intervals.
No critical fading has been recorded on either path and satisfactory overall system performance should be achievable on the route. It appears possible that this route could offer better propagation performance than the present route via Flinders Island.
The South Path offers higher clearance over the sea than utilised in the earlier 450 MHz measurements, and no gross effects attributable to sub-refraction have been observed. With low receiving aerials on King Island, some foreground shielding differentially attenuates sea reflected rays, compared to the direct ray. This is the probable reason why these aerials produce a more stable but lower median level signal than would be expected from more elevated aerials. The overall signal variations on this path were not severe. There were some months in which the 2 GHz levels did not drop more than 15 dB below their free-space value.
On the North Path, no median depressions comparable to those measured earlier have been recorded, but foreground effects occur which reduce the effective gain of the transmitting antenna at Mt. Cowley. This antenna operates over a falling scrub-covered foreground, via a narrow sector cleared through the forest. Field sampling across the antenna aperture with a crane supported smaller antenna showed considerable variations in illuminating field. The data collected is being used to derive siting criteria for the proposed system antenna.
Such protracted measurements on paths offering particular propagation hazards, are now declining in importance. The emphasis in future radio propagation studies is moving towards the problems of ultra high capacity systems, operating above 10 GHz. But Bass Strait and its challenge remains, and further requirements for transmission measurements will arise as the growth of Tasmanian traffic continues.

THREE HUMMOCKS ISLANDS, OFF THE TASMANIAN COAST



MEASURING THE FIELD DISTRIBUTION — MT. COWLEY, VICTORIA



PARABOLIC ANTENNA FEED HORNS

In microwave communication systems, the parabolic reflector antenna is the most popular device to launch the radio waves into space. This type of antenna works on the principle that the parabolic reflector is illuminated by spherical waves with centre of origin at the focal point of the parabola. The reflector reflects the waves and concentrates most of the energy in a narrow beam along the main axis of the parabolic reflector. Electromagnetic horns, called feed horns, are usually employed as the source of the spherical waves.

FEED HORN FOR PARABOLIC ANTENNA

The efficiency and other characteristics of an antenna depends on the "illumination function" which in turn depends on the properties of the feed horn.

Line of sight communication usually demands antennas with high gain and low standing wave ratios to ensure the best qualities of signals. Specific radiation patterns with low sidelobes are generally required to prevent mutual interference between neighbouring microwave systems.

In order to improve the channel capacity and use the available frequency band efficiently, transmission with two orthogonal polarisations is being investigated. In this case, antennas with very low cross polarisation are desirable. Very wideband or multiband antennas are of interest as they can provide some economic savings in microwave communication installations.

In the search for antennas with the above properties, investigations are being made to find an electromagnetic feed horn which possesses the following characteristics:

- The radiation pattern is uniform and easy to control.
- It produces little spillover in illuminating the parabolic reflector.
- It has a symmetrical radiation pattern with respect to the antenna axis.
- The phase centre is well defined.
- It is suitable for polarisation diversity applications.
- The bandwidth is very broad.

Currently the Laboratories are investigating the possible application of corrugated feed horns in microwave reflector antennas.

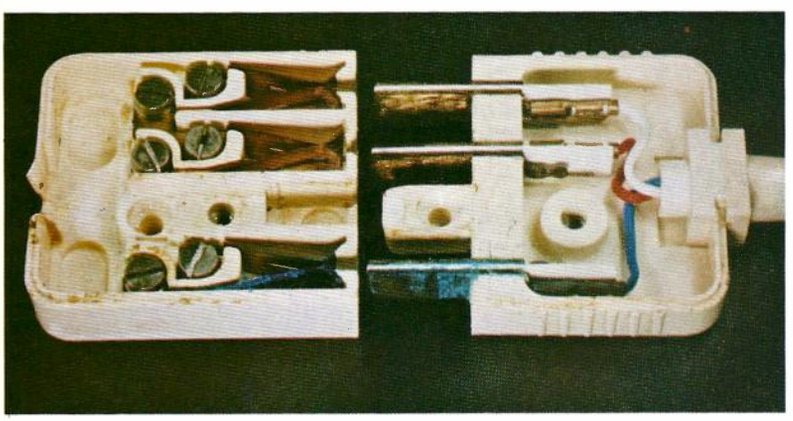
This type of horn has a cylindrically symmetric radiation pattern, a bandwidth which is almost an octave wide and relatively weak sidelobes. Although corrugated feed horns have found wide applications in large ground stations and radio-astronomy parabolic reflector antennas, little is known about their suitability for the illumination of the smaller microwave communication antennas in the order of 4 to 12 ft. in diameter.

UNDERGROUND CABLE ATTACKED BY TERMITES

INSECT RESISTANT CABLE

Past laboratory work carried out on Nylon 11 which showed that it had complete immunity from termite attack has now been substantiated by over four years of practical field experience involving many hundred kilometres of Nylon 11 jacketed cables. Because Nylon 11 is amongst the higher priced nylons, other members of the nylon family have been investigated and whilst the types 6, 6.6 and 6.10 have shown satisfactory resistance to termite attack, they may be susceptible to attack from ants because of their poor resistance to formic acid. A 50% aqueous solution of formic acid and odourous components constitute the venom secretion of a family of ant prevalent in Australia.
Nylon 12 is similar to Nylon 11 in having a lower amide group concentration than the 6, 6.6 and 6.10 varieties and is unaffected by formic acid. Since its price is slightly lower than that of Nylon 11, Nylon 12 has been specified and used as an alternative nylon grade for cable sheaths since early 1969, and again there has been no incidence of insect attack. Work is still continuing with the aim of obtaining a cheaper and if possible locally produced protective polymer and at present several rigid P.V.C. formulations plasticised with polymeric flexibilisers, as distinct from solvent plasticisers, are under evaluation.

CORROSION OF TELEPHONE PLUGS AND SOCKETS

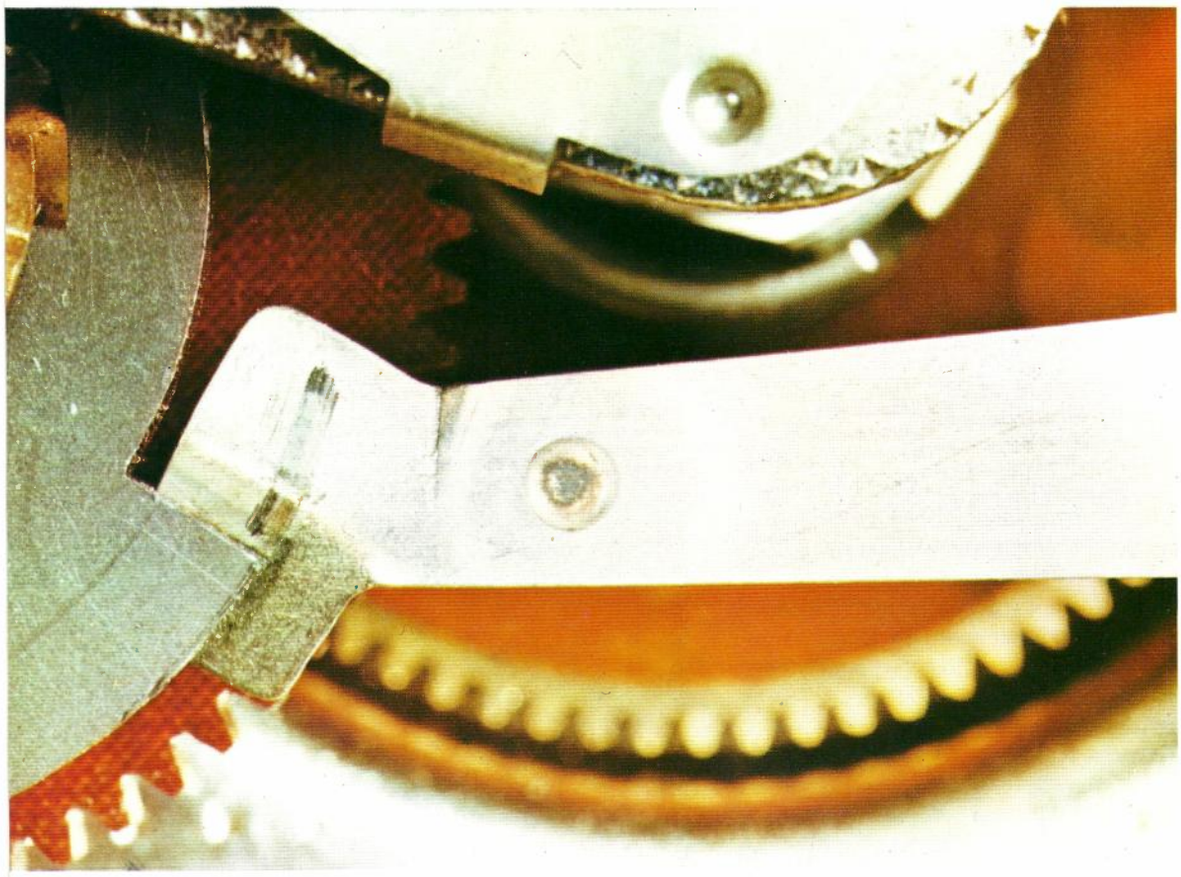


CORRODED TELEPHONE PLUG AND SOCKET

A number of corrosion faults in the plug and socket associated witht 800 type telephones have occurred, particularly in the more tropical parts of Australia. It has been shown that this corrosion, which can occur in a matter of a few weeks, is not confined to any particular set of surroundings, and there appears to be no correlation with associated materials of construction, housekeeping practices or the actual location of the plug and socket within a room. Whilst the presence of corrosion initiating substances, on or near the plug and socket, such as floor polishes, waxes, insecticides, etc., could at times have led to an acceleration of the corrosion process, experimental work indicated that these contaminents by themselves could not be the sole, or even the main, cause of the widespread failure incidence reported from the field. It was concluded that the only common factor which could cause such rapid and profuse corrosion was the presence of moisture, caused most frequently by condensation, which gained ingress to the plug and socket via the butt-joint between the two parts and was consequently trapped in the many moulding cavities existing in both parts. With a 50 volt potential present between metallic pins separated only by relatively thin insulating spaces and parts of the socket body covered by a moisture film, corrosion would be expected to occur rapidly. Experimental studies also indicated that the major problems caused by this corrosion were the formation of high resistance films on the plug-socket contact interfaces, and that the lowering of the insulation resistance between pins due to the presence of hydrated corrosion products only occurred at a later stage.

In order to investigate changes in construction and materials in the existing moulded shapes which would alleviate the problem until a redesign could take place, it was necessary to devise an accelerated test method which would produce in the Laboratories, corrosion similar to that experienced in service. A test based on temperature cycling over water, which produces regular condensation, was found to be satisfactory as it produced the typical corrosion pattern on standard type plug and sockets in a matter of a few days.

Consequently many different contact materials, as well as variations in insulation material and shape, have been investigated. In addition other means of connection and methods of corrosion protection were studied. Some of these tests are still continuing, but the results to date have clearly shown that whilst no metal can be considered fully corrosion resistant when used as pins or springs in the present design, the use of either Monel metal or nickel plating should lead to a significant increase in the life expectancy even under the very worst conditions. The spraying of the metallic parts of the standard design with an aerosol "CRC 226" gave excellent results, and may offer a solution to the problem until the new design is available.



FAULTY DIAL CONTACT (OTHER CONTACT REMOVED FOR CLARITY)

DIAL CONTACT FAULTS

A study was made during the year to determine why large numbers of dials in 800 Series Telephones were causing noisy operation. The immediate cause of the fault was found to be due to high resistance impulsing contacts obtained almost exclusively from one contractor and from a well defined period of manufacture. Various theories regarding the cause of this high resistance were studied using accelerated test methods. The test sequence which was eventually able to reproduce the failure phenomena quite rapidly suggested that the fault was due to the transfer of silicone oil lubricant from the dial mechanism to the impulsing contacts. Under normal conditions, a fine black-brown powder is produced between these contacts as they arc. This powder is generally pushed or blown away during contact operation and by repeated arcing, and causes no problems. It is thought that under certain conditions, sufficient silicone oil can migrate to the contacts to bind this powder into a coherent mass which compacts as the contacts operate and eventually tends to keep the contact domes apart. Dials operating continuously do not become faulty, indicating that a rest period is required during which silicone oil can impregnate the powder produced during the previous operations of the contact and make it sticky.
The presence of silicone oil in the deposits of high resistance contacts was detected by means of infra-red spectro-photometric analysis. Similar trouble may not occur with petroleum based lubricating oils because these oils are more readily decomposed during arcing and hence do not produce binding of the powder to the same extent as the silicone oils which have higher decomposition temperatures.

LIGHTNING SIMULATION

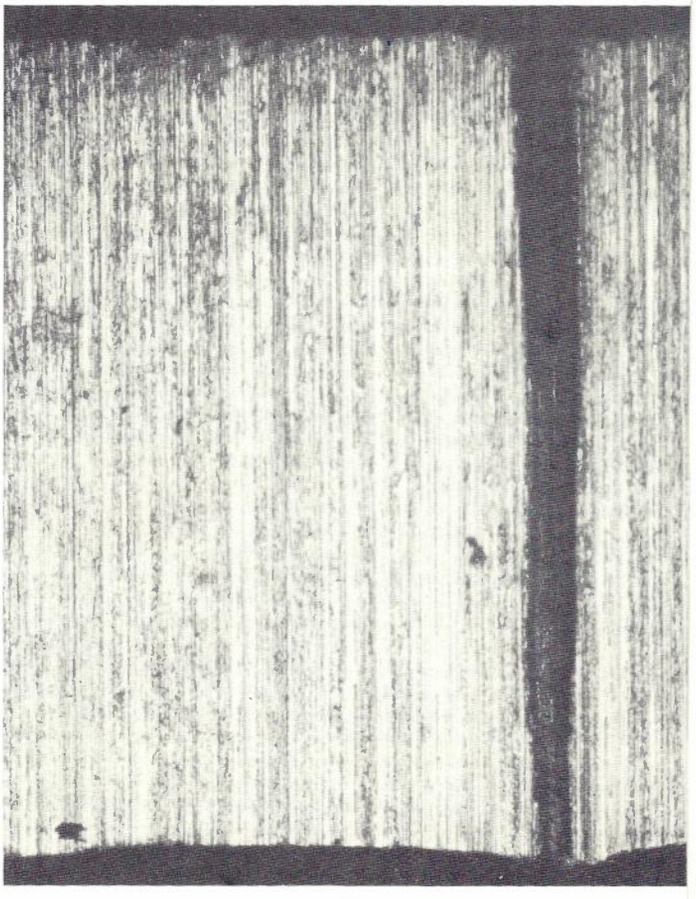
The Research Laboratories have available various surge generators for simulation of lightning phenomena. The largest of these is a 16 kJ capacitor stack which can produce impulses with peak potentials up to 1.4 MV. At the lower potential of 175 kV it can provide peak currents of up to 40 kA. Under these conditions, the peak power can very briefly rise up to 7 GW. The waveshape is varied by the inclusion of appropriate resistors and capacitors in the discharge circuit. A number of other generators with variable waveshapes but much lower potential and current capabilities are also available.

Recent applications of the large generator have included an investigation into the cause of minute pinholes being found in small diameter, plastic-jacketed, lead-sheathed underground cable. Combinations of various waveshapes, peak potentials, peak currents, treatment of the cable and means of application of the potential are being used in an attempt to reproduce the minute holes in the laboratory.

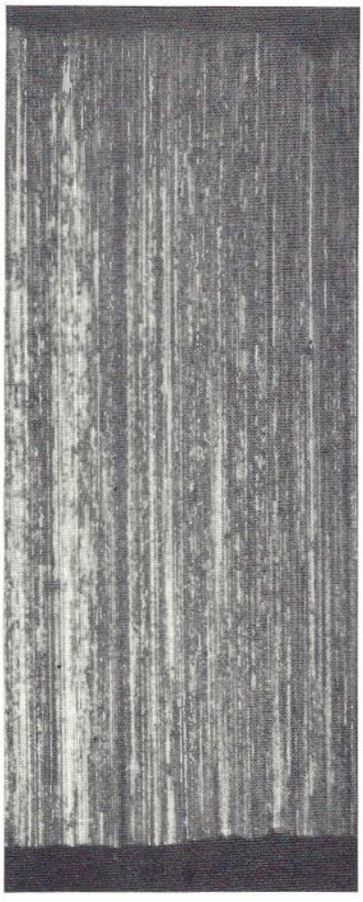
Breakdown tests of power and communications cables to ascertain the breakdown potential and to assess the type of damage after breakdown are important applications of the large generator. An impulse often used in such tests has a standard value of rise time of 1 microsecond and a total time to half value of 50 microsecond (known as a 1/50 wave).

The smaller generators are used when a relatively low potential is to be applied and an estimate of break down damage is not required. A small portable generator was used to study, in conjunction with theoretical analysis, the ability of various types of underground cable conductor to attenuate impulses that may reach them from a lightning strike to an aerial line. This generator had a peak potential of only 200 V, with shapes ranging from a 2/20 wave to a 20/200 wave. This study indicated the magnitude of attenuation and change in shape of various types of pulse.

Another application of the simulated lightning facilities is in the testing of lightning arrestors. Studies are presently being made of arrestor performance with a view to obtaining basic data for the formulation of improved protection practices.



EXTERNAL VIEW OF HOLE



CROSS SECTION OF .07 MM DIAMETER HOLE IN CABLE SHEATH

Thin layer chromatography (T.L.C.) is a valuable technique for the analyst. It consists of a physical method of separation in which the components of a mixture in a chosen solvent are selectively absorbed from a solution onto a stationary substrate. The substrate usually consists of an oxide such as alumina or silica spread very thinly and uniformly on a glass or metal plate. The separation or partitioning takes place as the solvent traverses the substrate by capillary action, the identity and concentration of each constituent being determined by subsequent colour development. The plate and solution are kept in an enclosed glass tank.

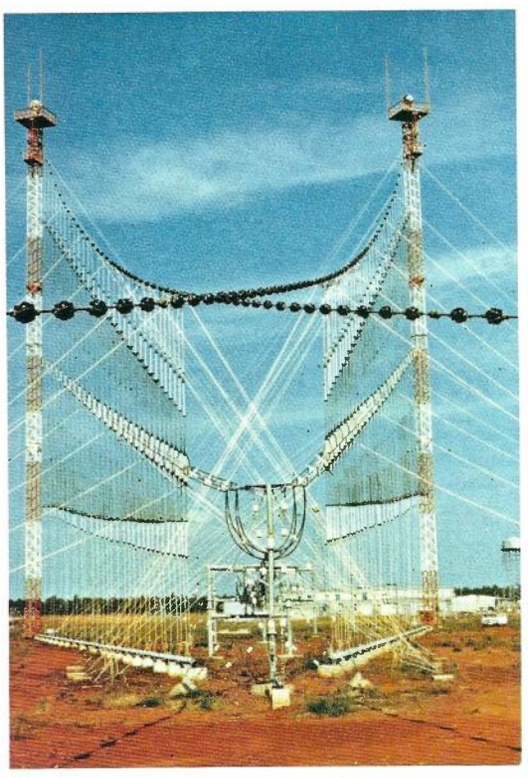
THIN LAYER CHROMATOGRAPHY

This procedure has proved most rewarding in the qualitative analysis of antioxidants in polymers used in cable production. T.L.C. has also been successfully applied to the separation of dyes and pigments used in stamp cancelling inks, the analysis of antioxidants and additives in oils, and many other problems.

T.L.C. offers, in many cases, a quick qualitative method of analysis for complex and inorganic mixtures which would normally involve lengthy preparatory procedures when using the techniques of gas liquid chromatography, spectroscopy, nuclear magnetic resonance, etc. In fact T.L.C. often provides the preliminary step for these more exacting methods. Quantitative determination of the unknown substances is achieved by comparing the intensities of the resolved coloured areas produced by treatment with appropriate reagents, with those obtained from known standards under identical conditions, through the use of either visual assessment or instrumental scanning procedures.

T.L.C. has several advantages over the related technique of paper chromatography. One of these is the ability to separate colourless substances, where the inert nature of the substrates, which are free from organic matter, permit the use of corrosive chromogenic reagents for the location of the components.

T.L.C. also has advantages over gas-liquid chromatography (G.L.C.) especially in the analysis of oils, dyes, etc. The G.L.C. methods often involve extensive clean-up procedures and lengthy preparations to obtain the lower boiling derivatives. Frequently, temperature programming must be used and the high temperatures involved can cause breakdown of the components being analysed. With T.L.C. no elevated temperatures are used and all that is necessary is a solution of the sample in a low boiling liquid, e.g., chloroform or ether and application of a few microlitres of the solution to a T.L.C. plate (prepared plates and coated aluminimum sheets are freely available) coated with a suitable substrate and development with a polar or non-polar solvent and finally if the components are not coloured, visual determination by use of one of the many chromogenic reagent sprays available.



RADIO AUSTRALIA AERIALS — COX PENINSULA

DETECTION OF PLUMING ON HIGH POWER HF AERIALS

The Radio Australia booster station at Cox Peninsula near Darwin N.T. comprises three 250 kW HF transmitters and five aerials. Electrical discharges known as plumes erupt from the aerials at irregular intervals. These discharges, if allowed to persist, can damage the aerial by melting sections of the discharging dipoles. An early investigation of the cause and characteristics of these discharges resulted in certain modifications being made to the original aerials. These modifications reduced the frequency of occurrence but did not eliminate the discharges completely. A quick remedy could not be found, and as a result a "palliative" solution which virtually does not interfere with the scheduled operation of the station was adopted. This palliative involves the detection and subsequent extinction of the discharges by switching off the transmitter for a period of a few seconds.

Previous experience with short range detection of indoor r.f. arcs with ultra violet sensors suggested that the plume discharges might be detected with such devices.

Tests conducted to determine the intensity and spectrum of radiation from discharges generated in the laboratory showed that certain ultra violet sensors should be able to detect the U.V. radiation from the discharges at a considerable distance even during rain, and that it was possible to discriminate against solar radiation. As other means of detection appeared to offer little chance of success, it was decided that a U.V. detection system should be installed. The installed detection system provides sufficient sensitivity at distances of the order of 500 m for the surveillance of the five aerials and most of the transmission lines. The detection system may well be effective at distances in excess of 500 m, but no attempt has been made to ascertain whether this is so. The detection system indicates on which aerial a plume is occurring. The two existing detectors are in the process of being supplemented by an additional nine detectors and a logic and display system, which will extend the sensors' cover, provide certain system-fail safeguards, remove certain restrictions on flexibility of aerial use and permit the operator to rapidly pinpoint the discharge location.

Eventually it is hoped to link the detection system with the computerised transmitter controls, so that the power fed to the aerial concerned is automatically interrupted when a plume occurs and the discharge extinguished. The time from the occurrence of a discharge to the interruption of RF power is so short that it is acceptable at least on an interim basis.

The U.V. detection system has so far behaved faultlessly, and it is expected that this system, when fully implemented, will enable the station to operate without risk of damage by radio frequency discharges.

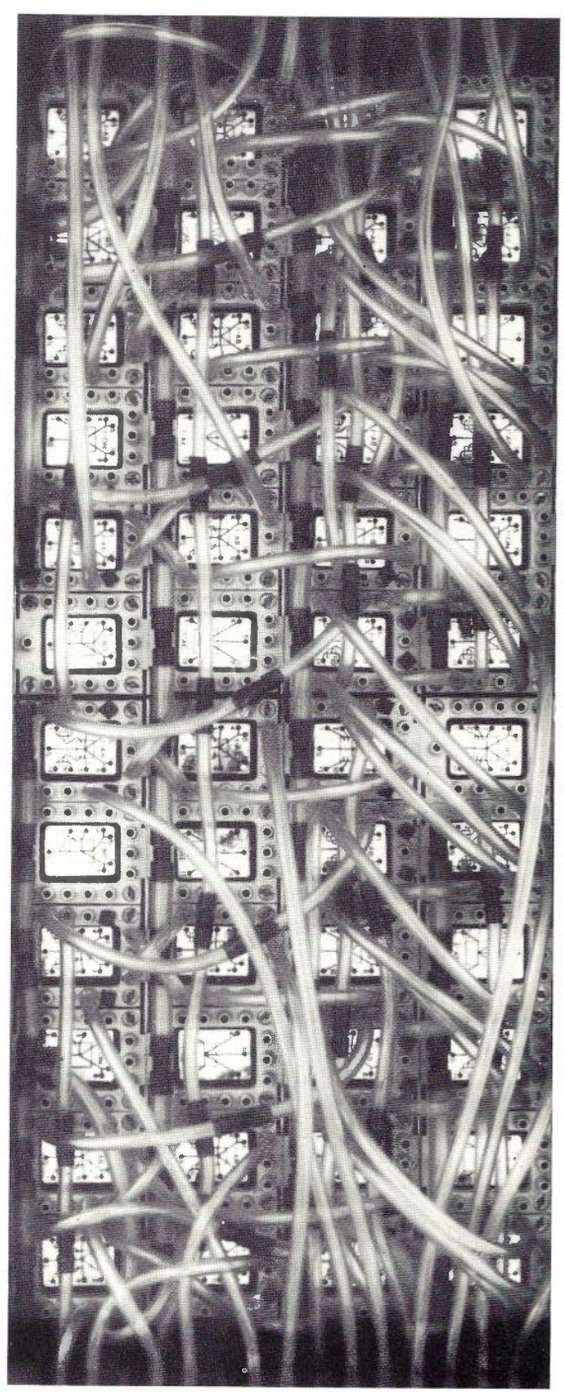
FLUIDICS IN MAIL HANDLING

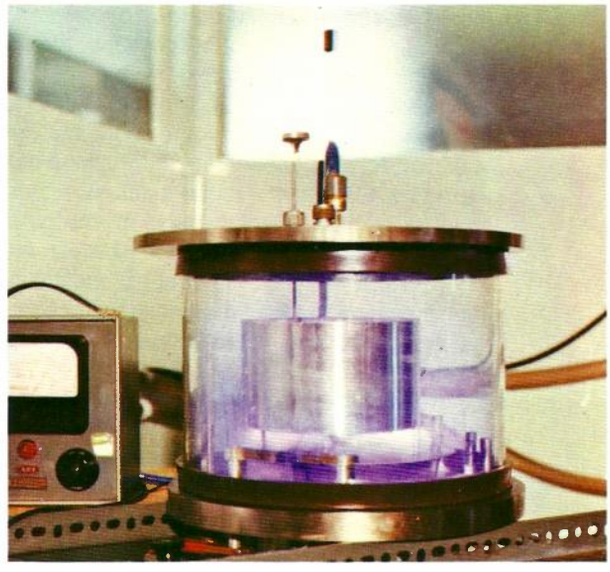
During the past decade a new technology has developed utilising the action and interaction of fluid (usually air) jets to perform digital and analogue logic and control functions; the name "fluidics" has been adopted. Pure fluidic devices have no moving parts and the transient response is much faster than conventional spool and diaphragm devices. All conventional logic functions may be carried out, and some of the features of these devices — high reliability, ease of maintenance, safety, immunity to dust, shock, vibration and temperature variation — suggest their suitability for use in several areas of automatic mail handling processes, particularly for machines which depend on air for their operation.

To evaluate the feasibility of using fluidic logic control in a mail handling environment, a sequential control circuit is being developed for the bag opening machine at Brisbane Mail Exchange. This machine consists of a row of eight bag opening bins above a conveyor belt running in a trough. Mail in the bins is released by pneumatically operated sliding doors, and in peak periods mail from one bin may fall onto mail released from a preceding bin, sometimes causing a serious blockage. The control circuit will register the opening of any bin in a shift register, so that other bins are inhibited from opening during the period when mail is below them.

The use of fluidics to perform actual letter handling functions is also being investigated. Such functions as separating, diverting, counting and pick-off may be carried out using only air jets and associated logic control, thus eliminating moving parts in these areas, greatly reducing equipment maintenance and mail damage. One problem currently being investigated is that of multiple letter pick-off (from a stack) prior to electronic code reading of letters, resulting in mis-sorted letters. A "multiple letter detector" is being developed which has no moving parts and relies on four air jets to separate letters against two guide plates. Fluidic logic sensors are incorporated into two of the jets and will signal the occurrence of more than one letter at a time in the stream. The possibility of replacing the currently used vacuum belt pick-off with a fluidic type is also being investigated. The main problem when designing such air systems is the variation in letter weight; if this problem can be overcome then the resultant savings in maintenance and reduction of letter damage will be significant.

FLUIDIC CONTROL CIRCUITS





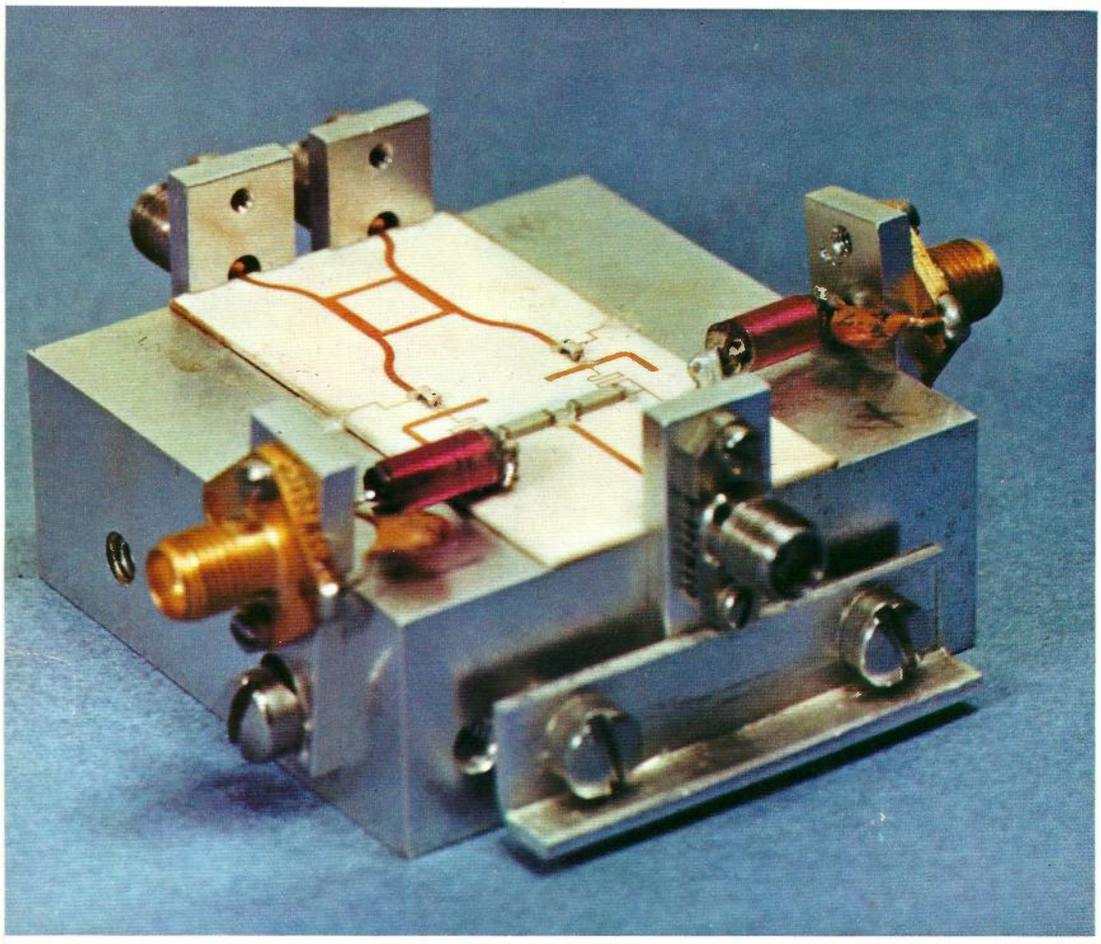
THIN FILM EVAPORATING JAR

MICROWAVE INTEGRATED CIRCUIT FACILITIES

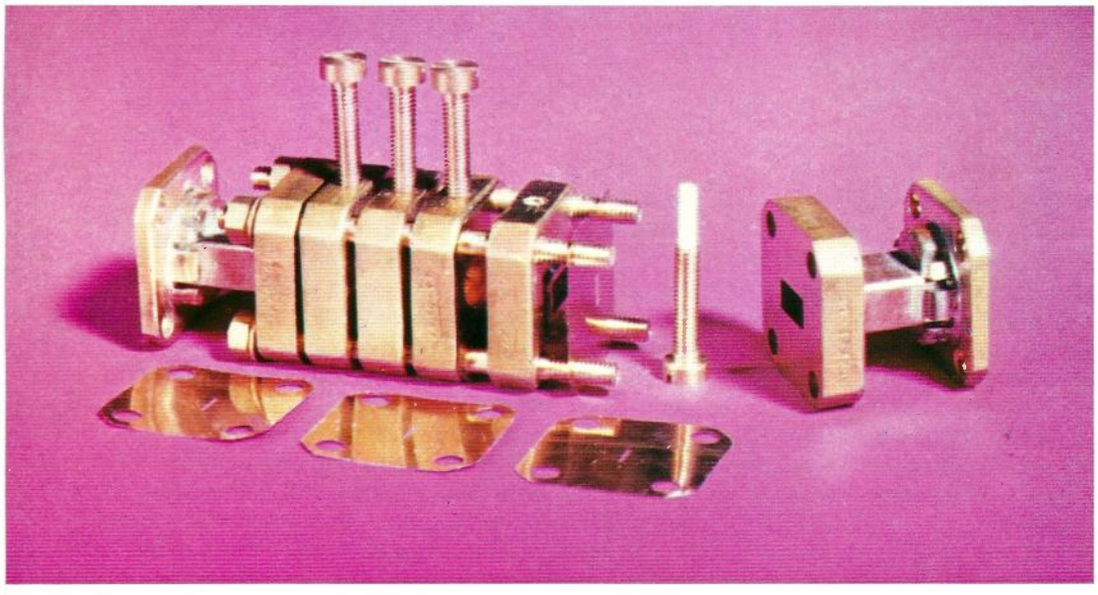
Following the availability of highly successful solid state microwave devices, there is an increasing emphasis on microstrip configurations to make optimum use of the potential of these devices, with consequent reductions in size and fabrication cost of microwave subsystems. The circuits also have increased reliability and reduced power consumption.

Microwave integrated circuit (M.I.C.) facilities and techniques are sufficiently well established to be usefully employed in equipment such as that required for propagation measurements. A precision M.I.C. facility has been established and is being used to satisfy operational equipment requirements. However, many of these circuits are presently designed using empirical or approximate formulae and a computer aided design and simulation program is in progress to solve some of these problems. In particular, accurate calculations are being made of the effects of deliberate discontinuities in microstrips. The precision M.I.C. facility is being used to prepare circuits which can be used to test these theoretical results. In this way it is hoped to eliminate much of the uncertainty involved in preparing M.I.C.'s, and so produce more accurate circuits at lower cost. Current research is aimed at extending the frequency range for M.I.C.'s beyond 20 GHz, which involves new circuit design concepts and materials research.

The precision M.I.C. facility can also be used to advantage in other areas. Using the photolithographic techniques developed for M.I.C.'s, it is possible to produce accurate irises as required in a design of special waveguide filters for use at 35 GHz.

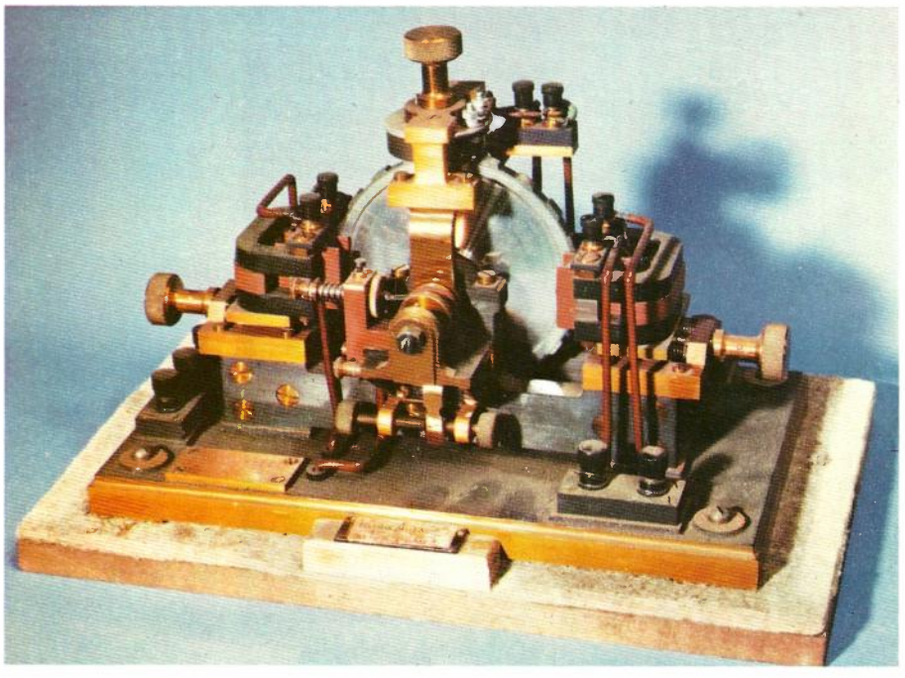


35 GHz FILTER (APPROX FULL SIZE)



4 GHz MIXER (APPROX TWICE FULL SIZE)

A.P.O. MUSEUM

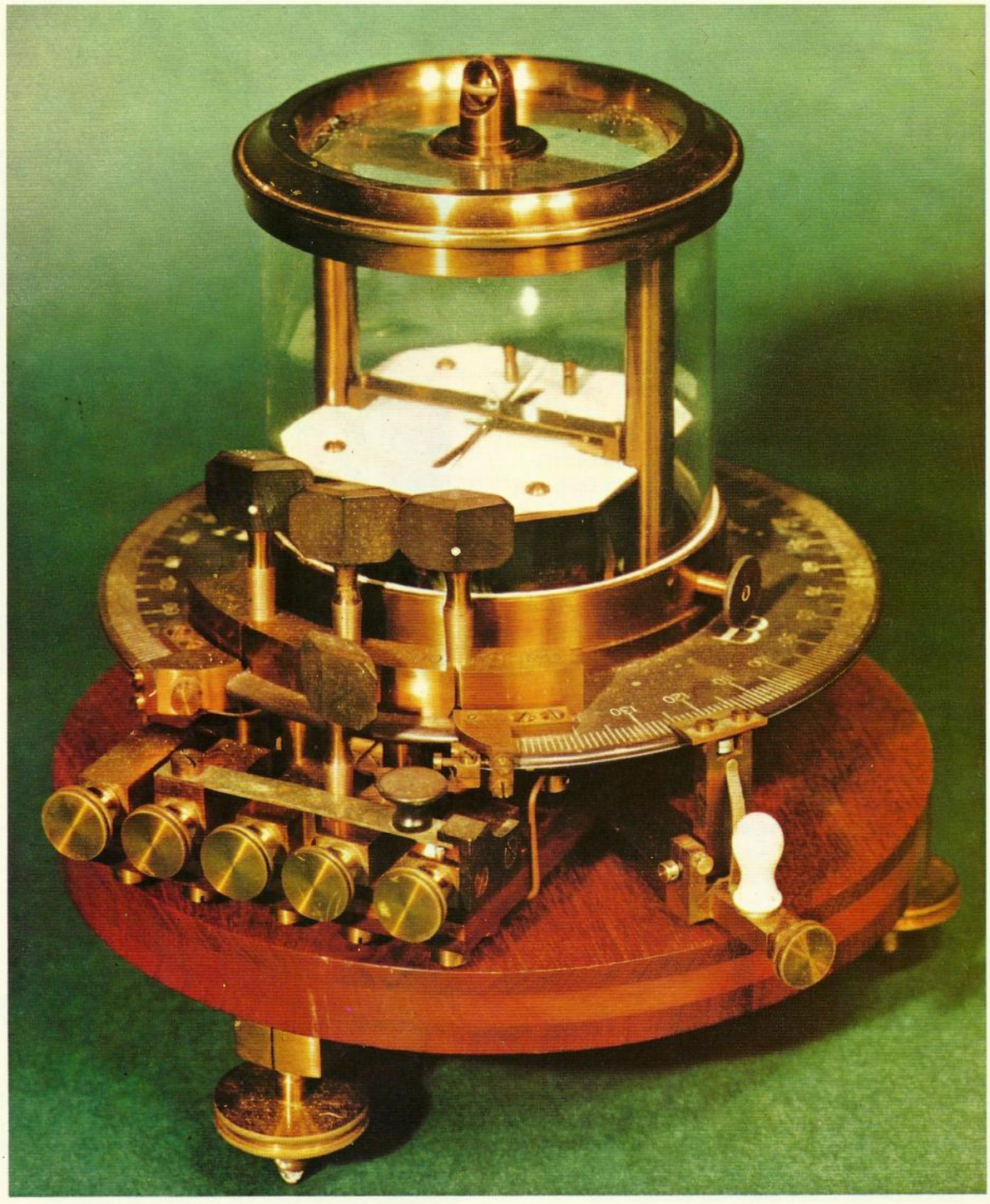


PHONIC WHEEL

The progress of technology in recent decades is dramatically illustrated by contrasting the operational and measuring equipment discussed in previous pages with items of equipment collected by the Research Laboratories with a view to the establishment — it is hoped not in the too distant future — of a proper A.P.O. Museum. The vintage items include measuring instruments, carrier equipment and other telephone apparatus. Carbon microphones and phonographic equipment relate to the early period before the A.B.C. was responsible for radio broadcasting hardware.
Some notable items include submarine cable and carrier equipment recovered from communication installations linking Tasmania to the mainland. For many years communications across Bass Strait have drawn heavily on Research Laboratories' resources.

Perhaps the items in the Museum which most illustrate the rapid advances in technology are some of the first transistors ever to be made. It is a sobering thought to remember how heavily modern technology relies on the transistor, which has only been available for a little over two decades.
Although the collection falls a long way short of being a complete representation of A.P.O. history, more and more contributions from interested people are regularly coming forward. Through these contributions, it is hoped to preserve a part of Australia's heritage for the education and enjoyment of later generations.

GALVANOMETER



THE ENGINEERING LIBRARY

The A.P.O.'s Engineering Library service is administered by the Laboratories. The Library provides an information service as support to the functions of the engineering and scientific staff engaged on research, planning, design, installation, operation and maintenance of telecommunications throughout Australia. Administration of the Library service is guided by the advice of a Library Committee comprising senior officers from each Engineering Branch in Headquarters. There is a main library and five branch libraries in the Department's Headquarters, and a library in each State Administration. The major services from the Library are current awareness, which includes selective dissemination of information (SDI), circulation of periodicals, accessions and conference lists, literature searches, compilation of bibliographies, general reference work and a translation service. Studies are being made with a view to improving the Library services. Some of the main areas receiving attention are:

(a) Increasing application of the computer and other mechanical equipment to library housekeeping and to information storage and retrieval.

(b) Commercial tape services although primarily for SDI (selective dissemination of information) are now being adapted for retrospective searching.

(c) Increased use of telecommunications equipment in the transfer of information.

(d) The use of microforms for storing documents.

During 1971 a mechanised loan system was designed to replace the existing manual system. For the new system, which became operational in May, 1972, publication and borrower details are recorded on punch cards, which when fed through the .eader attachment on an automatic typewriter, produce the loan transaction cards.

The system has increased efficiency in the loans service with advantages for both borrowers and library staff. These advantages include the increase in work space resulting from the re-organisation of the loan records along with improved methods of sorting and filing the cards, the production of overdue notices as an integral part of the system and the ability to process more loans each day. The creation of a new record indicating all publications held by any borrower at any time provides more adequate control over the location of material.

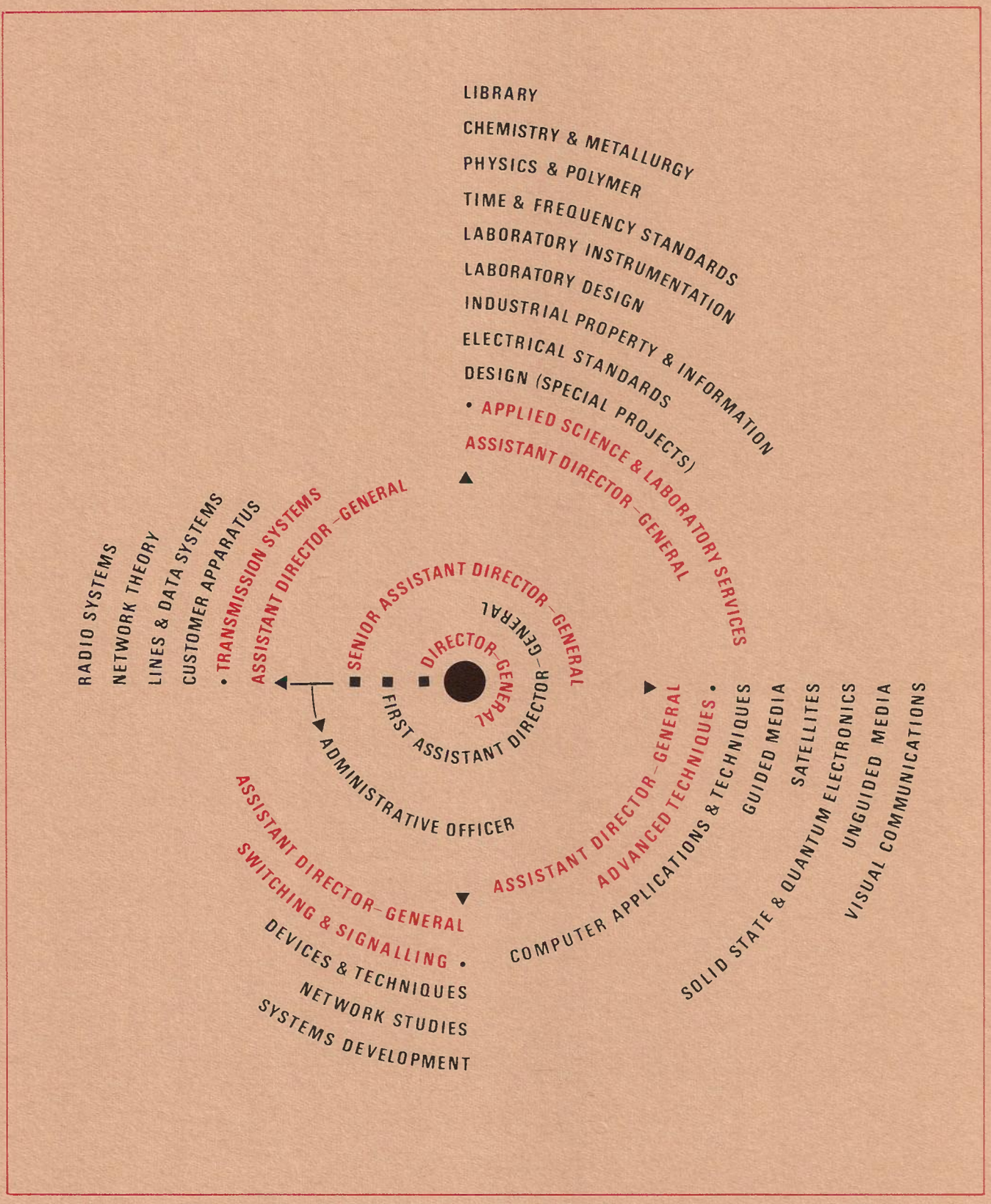
MECHANISED LIBRARY SERVICES

The Laboratories and its Staff

ORGANISATION

The Australian Post Office (A.P.O.) is a Department of the Commonwealth of Australia. The chief executive is the Director-General, Posts and Telegraphs who, assisted by Headquarters staff, controls, supervises and directs the individual State Administrations. The Research Laboratories is a Sub-Division of the Planning and Research Division of Headquarters. The head of the Laboratories carries the title of Senior Assistant Director-General and is responsible to the First Assistant Director-General, Planning and Research Division, who in turn is responsible to the Director-General.

The organisational structure of the upper levels and the occupants of positions at the end of the review period are shown on the charts.


LIBRARY
CHEMISTRY & METALLURGY
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LABORATORY INSTRUMENTATION
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INDUSTRIAL PROPERTY & INFORMATION
ELECTRICAL STANDARDS
DESIGN (SPECIAL PROJECTS)
• APPLIED SCIENCE & LABORATORY SERVICES
ASSISTANT DIRECTOR–GENERAL
RADIO SYSTEMS
NETWORK THEORY
LINES & DATA SYSTEMS
CUSTOMER APPARATUS
• TRANSMISSION SYSTEMS
ASSISTANT DIRECTOR–GENERAL
SENIOR ASSISTANT DIRECTOR–GENERAL
DIRECTOR–GENERAL
FIRST ASSISTANT DIRECTOR–GENERAL
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ASSISTANT DIRECTOR–GENERAL
SWITCHING & SIGNALLING •
DEVICES & TECHNIQUES
NETWORK STUDIES
SYSTEMS DEVELOPMENT
ASSISTANT DIRECTOR–GENERAL
ADVANCED TECHNIQUES •
COMPUTER APPLICATIONS & TECHNIQUES
GUIDED MEDIA
SATELLITES
SOLID STATE & QUANTUM ELECTRONICS
UNGUIDED MEDIA
VISUAL COMMUNICATIONS

PROFESSIONAL AND SENIOR STAFF

**Note that names given are those of actual occupants of the positions (appointed or acting) as at the end of the review period.*

Senior Assistant Director-General: P. R. Brett, B.Sc., F.I.R.E.E.

TRANSMISSION SYSTEMS BRANCH

Assistant Director-General: S. Dossing, M.Sc.E.E. (Hons.), M.E.E., F.I.E. Aust.

Staff Engineer: A. J. Gibbs, B.E. (Elec.), M.E., Ph.D., M.I.R.E.E.

Customer Apparatus Section

SECTION HEAD: D. A. Gray, B.E.E., Dip. Mech. and Elec. Eng., M.I.E. Aust.

PRINCIPAL ENGINEER

Koop, E. J., B.E. (Elec.), Fell. Dip. Elec. Eng., M.A.A.S.

SENIOR ENGINEERS

Duke, P. F., B. Tech., Ass. Dip. Maths.

Kett, R. W., Dip. Comm. Eng., A.M.I.R.E.E.

Metzenthen, W. E., Fell. Dip. Comm. Eng., M.E., M.I.R.E.E.

ENGINEERS

Blackwell, D. M., B.E. (Elec.)

Casley, G. M., B.E. (Elec.), M. Eng. Sc., D.I.C., Ph.D., Grad. I.E. Aust.

Goding, I., B.E. (Hons.)

Goldman, J. P., Ass. Dip. Rad. Eng., Ass. Dip. Comm. Eng., Grad. I.E. Aust.

Wellby, P. J., B.E. (Hons.), B.Sc.

SENIOR TECHNICAL OFFICER

Wood, R. J.

Lines and Data Systems Section

SECTION HEAD: R. Smith, B.E. (Hons.), M.E., M.I.E.E., A.M.I.R.E.E.

PRINCIPAL ENGINEERS

Fowler, A. M., M.I.E. Aust., M.I.R.E.E.

McGregor, I. M., B.E. (Elec.), M.E.Sc., Ph.D.

SENIOR ENGINEERS

Melton, L. R. A., B.Sc., M.I. Inf. Sc.

Smith, B. M., B.E. (Hons.), Ph.D., M.I.E.E.E.

ENGINEERS

Bylstra, J. A., B.Sc., M.Sc.

Dempsey, R. J., B.E. (Elec.)

Lewis, J. A., B.E. (Hons.), A.M.I.E.E.

Quan, A., B.E. (Hons.), M.E., A.M.I.E.E.

Semple, G. J., B.E.E. (Hons.), M. Eng. Sc.

Tyers, P. J., B.E. (Hons.)

SENIOR TECHNICAL OFFICER

Yelverton, W.

Network Theory Section

SECTION HEAD: E. H. Rumpelt, Dip. Ing. (Hons.), Dr. Ing.

ENGINEERS

Kelso, D. R., B.E. (Elec.), M. Eng. Sc., Grad. I.E. Aust.

Mallia, S., B.E. (Elec.)

Radio Systems Section

SECTION HEAD: O. F. Lobert, B.E.E., M.I.E. Aust., A.M.I.E.E.

SENIOR ENGINEERS

Lawson, I. C., B.E.E.

Sargeant, V. K., B.E. (Hons.), Dip. Elec. Eng., M.I.E.E.E.

ENGINEERS

Blair, R. H., B.E. (Hons.), M. Eng. Sc.

Harris, R. W., B.Sc. (Hons.), B.E. (Hons.)

Hicks, P. R., B.E. (Elec.)

Martin, G. T., B.E. (Hons.), M.E.

APPLIED SCIENCE AND LABORATORY SERVICES BRANCH

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Staff Engineer: L. H. Murfett, B.Sc.

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Sheridan, D. E., Dip. Elec. Eng., Dip. Mech. Eng.
Tjio, H. S., B. Mech. E., Ass. Dip. Electron. Eng.
ENGINEERS
Battlay, P. I. J., B. Mech. E.
Day, R. J., Dip. Elec. Eng., Dip. Mech. Eng., Grad. I.E. Aust.
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Mangalore, C., B.E. (Mech.), Grad. I.E. Aust.
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Westbrook, P. A.

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Pinczower, E., Dip. Elec. Eng., M.I.E. Aust.
Pyke, R. W., B.E. (Elec.), Dip. Elec. Eng., Grad. I.E. Aust.

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Stevens, A. J., B.E. (Elec.), A.M.I.E.E.
Wylie, F. R., B.E., M.I.E.E.E.
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Hamilton, A. N., B.E. (Hons.)
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Thomas, V. E., A.M.I.R.E.E.

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Mitchell, G. G., B.Sc. (Hons.), M.Sc.
Noble, S. H., B.Sc. (Hons.), M.I.E.E., A.Inst.P.
Sadler, N. J., B.Sc., M.I.R.E.E., F.R.A.S.

Environmental Physics Division
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Charles, S. J. (Miss), Ass. Dip. App. Phys.
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Western, R. J., Dip. App. Chem.

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CHEMISTS
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Miles, D.T., M.R.S.H., F.C.S., A.R.I.C.
Petchell, F. M., Dip. App. Chem.

Electro Chemistry and Corrosion Division

SENIOR CHEMIST

Der, J., B.Sc., A.M.R.A.C.I.

CHEMISTS

Gwynn, P. J., Dip. App. Chem.

Slavik, Z., Dip. Ing., A.R.A.C.I.

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Keir, K. E., Dip. Met.

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Jenkins, G. K., B.Sc., B.E. (Hons.), M.E.

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ENGINEER

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Satellites Section

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Balderston, J. M., B.Sc. (E.E.), M.Sc. (E.E.), I.E.E.E., A.C.M.

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Junghans, H., Dip. Ing.

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Belfer, M., B.E. (Elec.)

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Hubregtse, J., Fell. Dip. Comm. Eng.

Sabine, P. V., B.Sc., B.E. (Hons.)

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Wills, H., Ass. Dip. Rad. Eng., A.M.I.R.E.E.

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SECTION HEAD: J. H. Reen, B.E.E., M.I.E. Aust.

PRINCIPAL ENGINEER

Jenkinson, G. F., B.Sc., M.I.R.E.E.

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Sastradipradja, S., B.E. (Elec.)

ENGINEERS

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Howard, S. E., B.E. (Elec.)

Ja, Y. H., B.E., Ph.D.

Ridge, I. T., B.E. (Elec.), Grad. I.E. Aust.

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Barnard, S. A.

Lucas, J. E. W.

Visual Communications Section

SECTION HEAD: G. Rosman, B.E.E., M. Eng.

SENIOR ENGINEERS

Brueggemann, H., B.E. (Elec.)

Lavery, W. J., B.E. (Hons.), M. Eng. Sc.

ENGINEERS

Craick, J. K., B.E. (Elec.) (Hons.), B.Sc.

Demytko, N., B.E. (Elec.) (Hons.), B.Sc.

Grant, J. A., B.Sc. (Eng.) (Hons.)

SWITCHING AND SIGNALLING BRANCH

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Devices and Techniques Section

SECTION HEAD: I. P. Macfarlane, B.E. (Elec.) A.R.M.T.C. Elec. Eng.

ENGINEERS
- Jones, P. S., B.E. (Elec.), M. Eng. Sc. (Elec.)
- Wise, J. B., B.E.

SENIOR TECHNICAL OFFICER
- Erwin, J. B.

Network Studies Section

SECTION HEAD: F. J. Symons, B.E. (Hons.), D.I.C., A.M.I.E.E.

SENIOR ENGINEERS
- Champion, G. J., B.E.
- Gerrand, P. H., B.E. (Hons.), M. Eng. Sc., Grad. I.E. Aust., M.I.E.E.E.
- Hunter, M. A., B.E. (Hons.), A.M.I.E.E.

ENGINEERS
- Black, D. L., B.E. (Hons.)
- Even-Chaim, A., B.Sc., M.I.E. Israel

PHYSICIST
- Flavin, R. K., B.Sc., M.Sc.

Systems Development Section

SECTION HEAD: A. Domjan, B.E.E., A.M.I.E. Aust.

PRINCIPAL ENGINEER
- Mattiske, D. D., B.E., M.I.E.E.

SENIOR ENGINEERS
- King, D. J. E., B.E. (Hons.), M. Eng. Sc., A.M.I.E.E., M.I.E.E.E.
- McLeod, N. W., B.Sc., M.I.E. Aust.
- Vizard, R. J., B.E.E., Dip. Elec. Eng.

ENGINEERS
- Baker, A. S., A.M.I.E.E.
- Chan, M. C., B.E. (Hons.)
- Gale, N., B.E.
- Mazzaferri, F., B.E. (Hons.)
- Tjia, S. M. (Miss), B.E. (Elec.)

SENIOR TECHNICAL OFFICERS
- Curley, K. A.
- McEvoy, W.
- Wolstencroft, N.

SENIOR CLERICAL STAFF

Administrative Officer: R. D. Coath
- Chippendall, C.
- Chirgwin, M. A.
- Conroy, A. B.
- Evans, M. (Mrs.)
- Forster, D. (Miss)
- Guilliard, K. H.
- Hill, P.
- Nolan, L. B.
- Scates, E. J.
- Walker, N.

■ Members of the Laboratories contribute articles regularly to Australian and overseas professional and technical journals as well as presenting papers to learned societies. Reports are also issued on work undertaken within the Laboratories, and 77 were distributed during the year.

PAPERS

Abeyasekere, D.	"An Introduction to the Algorithmic Albert-Synge Antenna Equation", Proc. I.R.E.E., March, 1972.
Brueggemann, H., Kidd, G. P., Mackechnie, L. K., and Seyler, A. J.	"An Experimental Adaptive Echo Canceller for Long Distance Telephone Circuits", Jnl. Asia Elect. Union, No. 3, 1971.
Brueggemann, H.	"Proposal for a Feedback Stabilised Analog Matrix Multiplier", Aust. Tele. Res., November, 1971.
Davies, W. S., Anderson, A. P., Dawoud, M. M., Galanakis, D. E.	"Note on Transistor Fed Active Array Antennas", I.E.E.E. Trans. AP19, No. 4, July, 1971.
Domjan, A., and Chan, R.	"Digital Multifrequency Code Generator", Aust. Tele. Res., May, 1972.
Duke, P. F.	"Subjective Evaluation of Delta Modulation Performance", Aust. Tele. Res., November, 1971.
Gerrand, P. H.	"Minimum Junctor Quantities for a Non-Blocking I.S.T. Exchange", Aust. Tele. Res., November, 1971.
Getrev, I. E., and McGregor, I. M.	"An Integrated Class-B Hearing-Aid Amplifier", I.E.E.E. Journal of Solid State Circuits, December, 1971.
Gray, D. A., Rumpelt, E., and Ward, M.	"A Variable Group Delay and Attenuation Equaliser for Voice/Data Circuits", Telecomm. Journal of Aust., October, 1971.
Hullett, J. L., and Craick, J. K.	"Adaptive Statistical Encoding of DPCM-Coded Video Telephone Signals", Electronic Letters, May, 1972.
Hullett, J. L., and Lavery, W. J.	"A Coding System for the Digital Transmission of T.V. Phone Signals", Aust. Tele. Res., November, 1971.
Ja, Y. H.	"The Effect of a Temperature Gradient in a Single Crystal on E.P.R. Line Shape and Width", Aust. Jnl. Phys., 1972.
Kidd, G. P., and Ravenscroft, I. A.	"An Improved Commutating Channel Separator for Millimetric Waveguide Systems", Elect. Letters, August, 1971.
Koop, E. J.	"The Measurement of Volume Reference Equivalent", Telecomm. Journal of Aust., October, 1971.
Lavery, W. J., Hullett, J. L., Fowler, A. M., and Semple, G. J.	"Digital T.V. Phone Transmission over Parallel P.C.M. Bearers", Aust. Tele. Res., May, 1972.

Macfarlane, I. P.	"Pulse Generator and Flip-Flops", I.E.E.E. Trans. on Instrument. and Measurement, May, 1972.
Martin, G. T.	"Measurement of Speech Signal Levels Within the Telephone Network", Aust. Tele. Res., May, 1972.
Mattiske, D. D.	"Traffic Calculations for an I.S.T. Exchange", Aust. Tele. Res., May, 1972.
Murphy, J. V.	"Intermodulation and AM/PM Distortion in FM/FDM Radio Systems During Two Path Propagation", Proc. I.E.E., January, 1972.
O'Rourke, A. H.	"Subscribers Services in Remote Areas via Satellite", Jnl. Asia Elec. Union, No. 3, 1971.
Rosman, G.	"Wideband Balanced Modulator Uses Transmission Line Transformer", Proc. I.R.E.E. (A.E.C.), July, 1971.
Rumpelt, E., and McGregor, I. M.	"Design of Filters for a Small Station Satellite System", Aust. Tele. Res., November, 1971.
Smith, B. M.	"A Note on the Idling Pattern of a Delta Modulated Control System", Aust. Tele. Res., November, 1971.
Symons, F. J. W.	"Data Flow and Data Formats in the Computer Control of an Electronic Telephone Exchange", Telecomm. Journal of Aust., February, 1972.

LECTURES AND TALKS

Abeyasekere, D.	"Computer Aided Linear Antenna Analysis", Symposium, Footscray Inst. of Technol., September, 1971.
Blair, R. H.	"Error Rates Caused by Noise in Microwave Digital FM Systems", Radio Res. Board Symposium, Adelaide, Feb., 1972.
Cahill, L.	"Computer Aided Design of Non-Linear Electronic Circuits", Victoria Inst. of Colleges Seminar, September, 1971.
Craig, E. R.	"A.P.O./NASA Satellite Experiments 1969/70", I.E. Aust. Electrical and Comm. Eng. Branch, Brisbane, September, 1971.
Der, J. J.	"Identification of Corrosion Faults in Lead Sheathed Cables", Australian Lead Development Assoc., July, 1971.
Duke, P. F., and Koop, E. J.	"The Telephone Handset Speaking Position", 6th International Symposium on Human Factors, Stockholm, June, 1972.
Fowler, A. M.	"Specifying Electroplated Finishes for RF Applications", I.E. Aust. Materials Conf., Perth, August, 1971.
Gale, N. J.	"A Computer Controlled Circuit Tester", I.E. Aust. Electronic Instrum. Conf., Hobart, May, 1972.
Gibbs, A. J.	"Generalised Minimum Mean-Square-Error Automatic Equalisation", University of Newcastle, October, 1971.
Gibbs, A. J.	"Application of Hardy Spaces to Analogue and Digital Signal Processing", University of Newcastle, May, 1972.
Gibbs, A. J.	"Generalised Transversal Equalisers", University of Newcastle, May, 1972.

Gray, D. A.	"Noise in Communication Systems", Royal Melb. Inst. of Technol., Melbourne, September, 1971.
Kidd, G. P.	"Transmission Waveguides as High Capacity Transmission Medium", I.R.E.E. (Melb. Div.), May, 1972.
Mackechnie, L.	"A Fast Set-Up Automatic Adaptive Equaliser", I.E.E.E. Electronic Conference, Chicago, October, 1971.
Mackechnie, L.	"Receivers for Channels with Intersymbol Interference", I.E.E.E. Internat. Symposium on Inform. Theory, U.S.A., January/February, 1972.
McGregor, I.	"Computer Aided Circuit Analysis", Victoria Instit. of Colleges Seminar, September, 1971.
McLeod, N. W.	"Fault Detection in a Processor-Controlled Telephone Switching System", I.E. Aust. Electronic Instrum. Conf., Hobart, May, 1972.
Seyler, A. J.	"Wideband Transmission", I.E. Aust. (Tas. Div.), October, 1971.
Snowden, D. R. C.	"Basic Aspects of Digital Transmission by Microwave Radio", Radio Res. Board Symposium, Adelaide, February, 1972.
Teede, N. F., and Horton, R.	"Current Trends in Microwave Components", I.R.E.E. (Adelaide Div.), May, 1972.
Trainor, R.	"Frequency and Time", Defence Stds. Lab., October, 1971.
Trainor, R.	"The A.P.O. Interest in the Ionosphere for Precise Frequency and Time Transfer", University of Sydney, May, 1972.
Warner, J. M.	"The Accuracy of Electrical Measurements made by Electronic Techniques", I.E. Aust. Electronic Instrum. Conf., Hobart, May, 1972.
Williamson, W. J.	"Preparation and Evaluation of Gallium Arsenide Surfaces for Gunn Effect Device", I.E. Aust. Materials Conference, Perth, August, 1971.
Williamson, W. J.	"Optical Communications — Pros and Cons", Aust. Telecom. Soc., Brisbane, June, 1972.

RESEARCH LABORATORY REPORTS

REPORT NO.	AUTHOR'S NAME	TITLE
6018 Add. 2	L. B. Nolan and T. D. Lindsay	Alphabetical, Numerical and Author Indices of Research Laboratory Reports (Nos. 6267-6540). Issued by the Physical Sciences Sub-Section.
6224 Add. 1	E. Rumpelt	Capacitor Set for Variable Group Delay and Attenuation Equaliser.
6308 Add. 2	W. McOrist	Deposits on the Impulsing Contact of BTM Type DIL 71816 Dials.
6432	A. J. Stevens	Decimal to Telex Translator for Data Logging Applications.
6476	I. Macfarlane	A Fixed Frequency Synthesiser — FFS-1.
6477	I. Macfarlane	A Digital Phaseable Clock and Time Code Generator — TSG-3.
6478	I. Macfarlane	A No Break Power Supply — NPS-1.
6479	I. Macfarlane	Distribution Amplifiers, Audio Notch Filter and Linear Phase Comparator — DAP-1.
6480	I. Macfarlane	A Supervisory Alarm System — SAS-2.

6541	A. J. Seyler	Annual Report — Advanced Techniques Section 1.7.69-30.6.70.
6543	N. F. Teede	Glow Discharge Sputtering.
6545	A. J. Stevens	Electrically Suppressed Zero Voltmeter (48-53 Volts).
6562	S. Noble	Reliability of Lamps Used in Crossbar Equipment.
6579	A. J. Stevens	h.p. 9100 Calculator — Data Logger Interface.
6584	D. R. C. Snowden	Lincompex — Use on Australian HF Radio Telephone Circuits.
6590	N. F. Teede	Recent Developments in Solid State Research, Overseas Visit Report.
6591 Add. 1	N. J. Sadler	Professional Grade Aluminium Electrolytic Capacitors — Climatic Tests.
6592	P. R. Hicks	Production Statistics for No. 13 Transmitters and 4T Receivers from March, 1968, to December, 1970.
6593	K. E. Keir	The Cleaning of Silver Contacts Under Workshop Conditions.
6594	I. A. Dew	Siemens Magnetic Core Transistor Relay for the ESK 700 and 4/30 P.A.B.X.
6596	I. A. Dew	Life Testing of Hamlin Mercury Wetted and Dry Reed Relay.
6597	H. Brueggemann	A.P.O. Experimental C.C.T.V Conference Configuration.
6599	H. J. Ruddell	Investigation of the British Post Office Epoxy Resin Putty Joint.
6600	A. Townsend	A Clock Scanning and Time Interval Measurement Unit.
6601	A. Townsend	Time Interval Counter.
6602	A. Townsend	A Program Clock Module for a Clock Scanning and Time Interval Measurement Unit.
6606	H. S. Wragge	Report on Overseas Visit — March, 1971, Meeting C.C.I.T.T. Special Study Group D.
6608	W. McOrist	DM-3 Telephone Dial (With Drive-Bar Governor).
6609	G. Martin	Signal Loading on Super Group Channels.
6610	G. M. Willis	Report on Overseas Visit, Feb.-March, 1971 (i) C.C.I.R. Interim Meeting of Study Group VII (ii) Visits to France and U.K.
6614	T. Elms	Repair to Radio Australia Transmitting Station, Shepparton, Corrosion of Aerial Matrix Switch Arms.
6618	I. R. Goding	Evaluation of Sample Transistorised Telephones — BTM Type and STC Type D.
6620	R. V. Coulthard and W. J. Lavery	A Dual Digital T.V. Picture Segment Selector.
6621	P. Moloney	Evaluation of Reactive Diluent "Epoxide" 8 for Use in Epoxy Resin Field Pack Systems.
6624	H. J. Ruddell	Report on Overseas Visit 26.5.71 - 9.7.71.
6626	W. McOrist	Evaluation of F.A.C.E. Telephone Dials — Initial Report.
6627	R. W. Kett	Report on Overseas Visit, May-June, 1971 — Development in Objective Testing of Telephone Instruments.

6636	D. Snowden	Overseas Visit, March-April, 1971.
6654	G. Kidd	High Capacity Circular Waveguide.
6656	I. Dew and W. McOrist	Evaluation and Life Test of Telefonbau Normalzeit Telephone Dials.
6658	I. J. Lloyd	Electrical Tests of A.E.I. 3-Electrode Gas-Filled Surge Arrestors, Type 16A.
6672	I. A. Dew	Life Test of Siemens E.S.K. Switching and Crosspoint Relays for the E.S.K. 700 and 400E P.A.B.X.
6680	T. Keogh	The Corrosion Resistance of Passivated Zinc Plated Components as Used in Telephone Exchange Equipment.

In addition 32 other reports were distributed on a limited or restricted basis.

STAFF AFFILIATIONS WITH EXTERNAL BODIES

Some of the staff of the Laboratories are active members of the governing bodies of educational establishments, learned and professional bodies and institutions. In addition, members of the Laboratories serve on various national and international committees.

NATIONAL

TRANSPORT AND COMMUNICATIONS ADVISORY COMMITTEE OF METRIC CONVERSION BOARD	P. R. Brett
VICTORIAN EDUCATION DEPARTMENT	
Higher Technician (Applied Science) Certificate — Course Development Committee	G. Flatau
VICTORIA INSTITUTE OF COLLEGES	
Committee on College Staffs	P. R. Brett
Course Development Committee	A. J. Seyler
Equipment Review Committee	A. J. Seyler
Standing Committee on Academic Policy	P. R. Brett
MELBOURNE UNIVERSITY	
Faculty of Engineering	P. R. Brett
MONASH UNIVERSITY	
Engineering Faculty Board	A. J. Seyler
ADELAIDE UNIVERSITY	
Electrical Engineering Department — Hon. Consultant for Post Graduate Studies	A. J. Seyler
CAULFIELD INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	H. S. Wragge
FOOTSCRAY INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	H. S. Wragge
SWINBURNE COLLEGE OF TECHNOLOGY	
Electrical Engineering Departmental Advisory Committee	L. Murfett
Master of Engineering Ad Hoc Advisory Committee	L. Murfett

STANDARDS ASSOCIATION OF AUSTRALIA (S.A.A.)	
Council	P. R. Brett
Executive Committees:	
Acoustic Standards	D. A. Gray
Telecommunications and Electronics Industry Standards	P. R. Brett E. F. Sandbach
Technical Committees:	
Acoustic Standards	D. A. Gray
• Instrumentation and Techniques for Measurement of Sound	E. J. Koop
Chemical Industry Standards	
• Adhesives	D. Waters
Electrical Industry Standards	
• Winding Wires	G. Flatau
• indicating and Recording Instruments	J. M. Warner
• Electrical Insulating Materials	G. Flatau
• Dry Cells and Batteries	G. Flatau
• Control of Undesirable Static Charges	G. W. Goode
Mechanical Engineering Industry Standards	
• Tensile Testing of Metals	K. G. Mottram
Miscellaneous	
• Pressure Sensitive Adhesive Tapes	G. Flatau
Metal Industry Standards	
• Zinc and Zinc Alloys	K. G. Mottram
• Galvanised Products	R. D. Slade
• Electroplated and Chemical Finishes on Metals	R. D. Slade
Plastic Industry Standards	E. F. Sandbach
• Phenolic Laminated Sheeting	G. Flatau
• Methods of Testing Plastics	G. Flatau
• Outdoor Weathering of Plastics	G. W. Goode
• Polytetrafluoroethylene	B. Chisholm
Telecommunications and Electronics Industry Standards	P. R. Brett E. F. Sandbach
• Capacitors	G. Flatau
• Resistors	D. McKelvie
• Printed Circuits	D. Sheridan
• Wires and Cables	G. Flatau
• Semi-Conductors	I. Macfarlane
• Environmental Testing	G. Flatau
• Reliability of Electronic Components and Equipment	G. Flatau
• Electro-Acoustics and Recording	E. J. Koop
THE INSTITUTION OF RADIO AND ELECTRONICS ENGINEERS	
Federal Council	A. J. Seyler (Pres.)
Victorian Division Committee	A. J. Seyler A. M. Fowler
THE INSTITUTION OF ENGINEERS, AUSTRALIA	
Research and Development Committee	P. R. Brett
Electrical and Communication Engineering Branch Committee, Victoria	D. A. Gray H. S. Wragge
Electrical and Electronics Board	H. S. Wragge
AUSTRALIAN ADVISORY COUNCIL ON BIBLIOGRAPHY SERVICES (A.A.C.O.B.S.)	M. Cuzens
A.A.C.O.B.S. — Victorian Regional Committee	M. Cuzens

INTERNATIONAL

The Laboratories participate in the work of a number of international committees and bodies, such as the International Telephone and Telegraph Consultative Committee (C.C.I.T.T.), International Radio Consultative Committee (C.C.I.R.), World Administrative Radio Conference (W.A.R.C.), Australia and New Zealand Association for the Advancement of Science (A.N.Z.A.A.S.), Bureau International de l'Heure (B.I.H.), International Electro-Technical Commission (I.E.C.), and the Asia Electronics Union (A.E.U.).

PATENTS

It is A.P.O. policy to establish a patent portfolio covering inventions made by its staff. The majority of new inventions arise within the Research Laboratories and the Laboratories is the appropriate place for the novelty and likely usefulness of new ideas to be assessed.
During the past year, patent action has been commenced in respect of five new inventions. A summary of current A.P.O. patents and patent applications is presented below.

SUBJECT	INVENTOR(S)	COUNTRIES
Joint Enclosure for Electric Cables.	J. H. Ruddell J. D. Feehan (Research)	U.S.A.
Method and Apparatus for Testing Subscribers' Instruments in situ.	J. F. M. Bryant R. W. Kett (Research)	Australia U.S.A.
Impulse Sender Mechanisms of Automatic Telephone Dials.	R. J. W. Kennell (Assgd. 1968) (Non-A.P.O.)	Australia
Automatic Telephone Dials.	R. J. W. Kennell (Assgd. 1968) (Non-A.P.O.)	Australia
Public Telephone Installation (Vandal Proof).	K. B. Smith A. A. Rendle (Subs. Equipt.)	Australia Britain Japan
Analogue Multiplier.	H. Brueggemann (Research)	Australia Britain Germany Japan U.S.A.
Vibrating Cable Plough.	E. W. Corless (Mech. & Elec. Serv.)	Australia Britain South Africa

PATENTS

SUBJECT	INVENTOR(S)	COUNTRIES
Tip Welding Means.	E. Bondarenko (Research)	Australia Britain U.S.A.
Semiconductor Light Detector.	N. F. Teede (Research)	Australia Britain Germany Japan
Apparatus for Routing Discrete Telecoms. Signals (I.S.T. Junctor).	A. Domjan (Research)	Australia Belgium Sweden Holland France Britain Germany Japan
Self Adaptive Filter and Control Circuit (Echo Canceller).	L. K. Mackechnie (Research)	Australia Germany Britain Japan Holland Italy France Sweden U.S.A.
Apparatus for Monitoring a Communication System and Detector (PETRA).	J. A. Lewis (Research)	Australia Britain Sweden
Control of Operation of a System (Faulty Circuit Isolator).	N. McLeod (Research)	Australia Britain U.S.A. France Germany Japan
Monostable and Bistable Devices (Edge Triggered Pulse Generator).	I. Macfarlane (Research)	Australia
Suppressed Zero Voltmeter.	A. Stevens (Research)	Australia
Broadband VHF Antennas.	R. P. Tolmie (Q'ld.)	Australia
Polarisation Diversity in Domestic Radio Receivers.	D. Rodoni (Radio) T. van Bemmel (Non-A.P.O.)	Australia
Cable Pair Identifier.	G. Devey (Victoria)	Australia
Detection of Digitally Encoded Multi-Frequency Signals.	A. Proudfoot (Research)	Australia

NEW LABORATORIES BUILDINGS

Plans to re-establish the Research Laboratories in new A.P.O. premises are continuing. The need for new premises is becoming more pressing as five of the eight leased buildings now occupied will have to be vacated in the near future. An earlier proposal to establish the Laboratories on two sites — at South Melbourne and North Clayton — has now been reconsidered in the light of feasibility studies. The long-term plans now envisage the progressive re-accommodation of the Laboratories on a single A.P.O. site at North Clayton, close to Monash University.

Preliminary site planning is complete and design of the first building stage is being undertaken by the Commonwealth Department of Works following detailed briefing by the A.P.O. and with the objective of making a submission to Cabinet and thence the Parliamentary Standing Committee on Public Works by late 1972. If this stage is approved, it is hoped that the first buildings will be ready for occupation by the Physical Sciences Sections by mid 1975.

The long-term planning for the Monash site cannot solve the tenure problems of two of the present city buildings, which have to be vacated within 12-18 months. Hence an inter-related short-term solution has been approved by the Postmaster-General. This solution envisages the leasing of new buildings near the Monash site. These buildings will accommodate half of the Laboratories for about ten years, commencing in late 1973.

That portion of the Laboratories still remaining in the city after the above moves will transfer to the Monash site upon completion of the second stage of building construction about 1978/79. Further building stages will then follow to permit transfer of the staff and facilities in the leased premises near the Monash site, and also to provide for expected growth.

VISITORS TO THE LABORATORIES

The Research Laboratories liaise closely with universities, the research establishments of other Commonwealth Departments, statutory authorities, and those of private industry. As part of this liaison, officers from the above establishments visit the Laboratories regularly for discussions and lecturing. These visits are reciprocated by Laboratories staff. In some cases, visitors are paid as consultants to contribute to the activities of the Laboratories when it is desired to make use of their expertise in a particular field.

Tours through the Laboratories and demonstrations have been arranged for specialist and non-specialist groups from professional societies, universities, other Government establishments and centres of tertiary education. Inspection tours have also been arranged for students at the secondary level.

During the year, overseas experts from universities and a number of civil and defence establishments and manufacturing concerns have visited the Laboratories for discussions, demonstrations and lecturing.

In addition, a number of visitors from overseas have been attached to the Laboratories for training purposes for various lengths of time to further their knowledge of telecommunications. This includes a number of Colombo Plan Fellows. These Fellows are usually attached for some months to the A.P.O., and most spend sufficient time in the Laboratories to participate in one or more projects.

OVERSEAS VISITS BY LABORATORY STAFF

In order to interchange experience, technical knowledge, opinions and ideas, a programme of overseas visits is arranged each year. These visits are generally to other administrations, universities, industry and the like. A number of visits have also been made to attend international conferences.

The following staff members have been on such overseas visits during the review period:

Craig, E. R.
Cuzens, M. I. (Miss)
Flatau, G.
Gibbs, A. J.
Kett, R. W.
Kidd, G. P.
Murphy, J. V
Sandbach, E. F.
Semple, G. J.
Seyler, A. J.
Symons, F. J. W.
Smith, B. M.
Vizard, R. J.

ASSISTANCE WITH STUDIES

The policy of the Laboratories is to encourage study by staff who have appropriate aptitudes. In the case of professional officers, these studies are usually with a view to obtaining higher degrees, or to obtaining post-graduate experience outside the Laboratories. In the case of non-professional staff, the studies may be aimed at obtaining professional or technical qualifications or furthering their experience. The encouragement may take the form of part or full time leave without pay, appropriate arrangements with universities and technical colleges, scholarships, etc. The following professional staff have enjoyed such encouragement during the review period:

WITHIN AUSTRALIA

Court, R. A. G.: Monash University, Vic.
Lewis, C. A.: University of W.A., W.A.
Morgan, R. J.: University of N.S.W., N.S.W.
Park, J. L.: Monash University, Vic.
Steel, J.: University of Melbourne, Vic.

OVERSEAS

Casley, G. M.: U.K.
Mackechnie, L. K.: U.S.A.

SPONSORED EXTERNAL RESEARCH AND DEVELOPMENT

To augment its own capabilities, the Laboratories have contracts with outside bodies, mainly universities, for research and development in specialised fields. Current contracts are listed below:

- Low Energy Sputtering of Indium Antimonide Thin Films
- Surface Acoustic Waves
- Integrated Digital Communication System
- PCM for Programme Transmission
- Transmission Equalisers for TV-Telephones
- Acoustic Sounding and Radio Propagation
- Coding of TV Signals
- Phase Variation in HF Standard Frequency Transmissions
- Self Adapting Hybrids
- Mathematical and Optimisation Techniques
- Very High Speed Pseudo-Random Noise Generation and Detection
- Solid State Technology for Microwave and Millimetre Wave Sources

In addition, the Laboratories have co-operated with other national and international bodies in the co-ordination of research programmes in order to achieve maximum results.