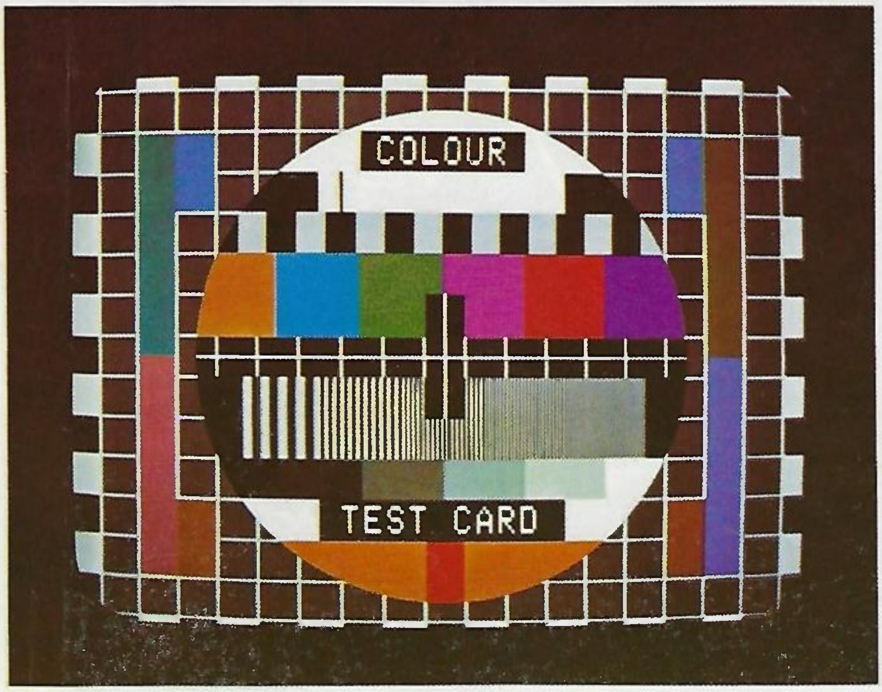
THE

Telecommunication Journal OF AUSTRALIA



THIS ISSUE INCLUDES

TELECOMM. SOCIETY CENTENARY

COLOUR TELEVISION

COMPUTERS IN TELECOMM. PLANNING

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L.L.E. DESIGN GUIDE

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1974

THE TELECOMMUNICATION JOURNAL OF AUSTRALIA

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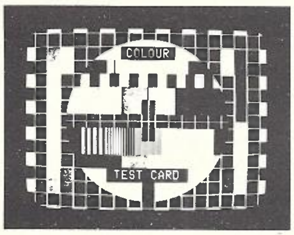

COVER
COLOUR TEST
PATTERN

The Telecommunication Journal of Australia

The Journal is issued three times a year (February, June and October) by the Telecommunication Society of Australia. The object of the Society is to promote the diffusion of knowledge of the telecommunications, broadcasting and television services of Australia by means of lectures, discussions, publication of the Telecommunication Journal of Australia and Australian Telecommunication Research, and by any other means.

The Journal is not an official journal of the Postmaster-General's Department of Australia. The Department and the Board of Editors are not responsible for statements made or opinions expressed by authors.

Residents of Australia may order the Journal from the State Secretary of their State of residence; others should apply to the General Secretary. The 1974 subscription rates for both Telecommunication Journal of Australia and Australian Telecommunications Research are shown on the inside back cover of this issue. All rates are post free. Remittances should be made payable to the Telecommunications Society of Australia.

Editors of other publications are welcome to use not more than one-third of any article, provided credit is given at the beginning or end, thus, "The Telecommunication Journal of Australia". Permission to reprint larger extracts or complete articles will normally be granted on application to the General Secretary.

Information on how to prepare and submit manuscripts and contributions for the Journal is available from members of the Board of Editors and their outposted representatives.

Membership fees and subscription orders should be addressed to:

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The Telecommunication Society of Australia, Past, Present and Future.

R. W. TURNBULL, M.B.E., F.I.E. Aust.,

Chairman, Council of Control, Telecommunication Society of Australia

The centenary of the Telegraph Electrical Society is being celebrated by its successor—The Telecommunication Society of Australia—in August, 1974. This topical article records for posterity the contributions to the Society by past and present members; gives an insight to the current organisation of the Society; and reflects on the challenges for telecommunications in the future.

INTRODUCTION

It is now written in history that one hundred years ago in August 1874, a small group of some thirty-eight enthusiasts in the Post and Telegraph Department of Victoria formed the forerunner society to the present day Telecommunication Society of Australia.

It is appropriate that in this, our centenary year, we should take stock of our achievements, salute the stalwarts of the past and reflect on the challenges of the future. A glimpse of the beginnings and the subsequent course of events appears in a complementary article by Mr. J. Sander in this journal.

The original Telegraph Electrical Society, Melbourne, flourished strongly in the decade following its inception but as the years progressed, the enthusiasm of its sponsors was not maintained. It was eventually superseded in 1908 by the Postal Electrical Society of Victoria, which comprised both Telegraph and Telephone Branches. This form of the Society continued effectively until 1923 when again interest flagged and a further reconstruction of the Society occurred in 1932.

At about this time, there also existed lecture societies in New South Wales and South Australia. The technical papers delivered before each Society were printed and distributed to members, and a limited number forwarded to other States. The Postal Electrical Society of Victoria initiated action to have the various papers published in a periodical — The Telecommunication Journal of Australia which first appeared in 1935.

In 1959, a further reorganisation of the Society took place to make it truly representative nationally with a change of name to "Telecommunication Society of Australia". The Society currently has nearly 6,000 Australian members and subscribers and approximately 800 overseas subscriptions to its journals from over 40 countries. It is interesting to note that in 1874, membership of the Telegraph Electrical Society was open to "any gentleman intimately connected with the practice of Telegraphy in this or the neighbouring colonies". Today, the membership has been widened to include any Australian resident with an interest in telecommunications.

With the growth of the Australian Post Office, the establishment of the Overseas Telecommunications Commission (Australia) in 1946 and the development of the Australian telecommunications manufecturing industry, people with an interest in telecommunications are now found in these and many related organisations.

THE ORGANISATION OF THE SOCIETY

The Society has a Constitution which lays down the aim of the Society and the rules adopted for the conduct of its operations.

The object of the Society is to promote the diffusion of knowledge of the telecommunications, broadcasting and television services of Australia by means of lectures, discussions, publication of the Telecommunication Journal of Australia and Australian Telecommunication Research.

The Society achieves these objects through a formal organisation comprising a Council of Control and six State Committees.

THE COUNCIL OF CONTROL

The Council of Control has 12 members. It is given the task of maintaining the policies of the Society, administering the Society publications for national and international distribution and sale, and for consolidating the Society's accounts.

The Society is reliant to quite a large extent on the co-operation and financial support of the Australian Post Office and it is appropriate therefore that the Chairman of the Council is nominated by the Director-General. The Post Office regards the Society as a valuable medium for education, training and publicity in telecommunications.

Since the Society's reconstitution in 1959, and following the retirement of Mr. I. M. Gunn of the former Postal Electrical Society of Victoria as inaugural Chairman in 1959/60, the following chairmen have been appointed:

		Year of Office
Mr. F. P. O'Grady,	Deputy Director-General	1960/61
Mr. C. J. Griffiths,	First Assistant Director-General, Engineering Works Division	1961/62, 1966/67, 1967/68
Mr. E. Sawkins,	Engineer-in-Chief	1962/63
Mr. B. F. Jones,	Deputy Director-General	1963/64
Mr. L. M. Harris,	First Assistant Director-General, Engineering Planning and Research Division	1964/65, 1965/66
Mr. A. F. Spratt,	First Assistant Director-General, Management Services Division	1968/69, 1969/70, 1970/71
Mr. I. M. Gunn,	First Assistant Director-General, Engineering Works Division	1971
Mr. N. M. Macdonald,	First Assistant Director-General Engineering Works Division	1971/72, 1972/73
Mr. R. W. Turnbull,	First Assistant Director-General Engineering Planning and Research Division	1973/74, 1974/75

All twelve members of the Council of Control must be officers of the Central Administration of the Post Office. However, six of the Councillors are selected by the different State Committees so that each State has a representative who can put forward the particular State's view on policy matters.

The first nominations made (1960/61) for State Councillors were:

Mr. N. A. S. Wood	:	N.S.W.
Mr. A. C. Wright	:	Vic
Mr. J. Pryor	:	Qld.
Mr. D. S. Watson	:	S.A.
Mr. E. L. Brooker	:	W.A.
Mr. A. N. Birrell	:	Tas.

Four of these Councillors, namely Messrs. Wood, Pryor, Watson and Birrell are still enthusiastically representing their respective States in the transacting of Society business, and the Society is grateful for their dedication over this period. Mr. W. Kemp replaced Mr. Wright in 1966, who was in turn replaced by Mr. E. A. George in 1970 as Victoria's representative. Mr. J. Sander (W.A. representative) replaced Mr. E. L. Brooker who resigned from the Post Office in 1969.

The other members of Council of Control are the immediate past Chairman; Editor-in-Chief, Telecommunication Journal of Australia; Editor-in-Chief, Australian Telecommunication Research; General Secretary; and Treasurer.

The Editor-in-Chief: Telecommunication Journal of Australia

The Editor-in-Chief and his Board of Editors have always played a very important role in the operation of the Society and it would be informative to digress here and consider the historical development of the Journal.

It has been mentioned above that the Postal Electrical Society of Victoria, following its formation in 1908, underwent a reconstruction in 1932. This was largely instigated by the late Mr. Sidney Herbert Witt who was a committee member dating from 1913, and who became the first President of the reformed Society, and Mr. A. R. Gourley who became Honorary Secretary.

In addition to rejuvenating the Society, the new committee embarked on the publication of a journal for national distribution — and the Telecommunication Journal of Australia was issued in June 1935.

In the Foreword to the issue, Mr. J. M. Crawford, Chief Engineer of the Post Office said . . .

"So, just as 64 years ago the Society of Telegraph Engineers in London, founded the great Institution of Electrical Engineers with its world-wide membership and authoritative Journal, and 27 years ago the Engineers of the British Post Office founded the Post Office Electrical Engineers' Journal, which today has also a world-wide circulation, so may our Victorian venture be a prelude to an All-Australian Communication Journal, which in due time will increase in value and become the authoritative record of the steady progress of Communication Engineering in Australia".

At that time the Board of Editors comprised a trio: Messrs. A. R. Gourley, J. A. Kline, R. M. Osborne, who for nine years teamed in the production of the Journal.

In June 1944, a new name, C. J. Griffiths, replaced that of A. R. Gourley on the Board of Editors and six sub-editors were appointed. By 1957, the sub-editors had grown to 14 to include State, London and Central Administration representation. The changes in sub-editors were too numerous to record here, but movements in the Board of Editors are shown in the following table.

	Period	Length of Service
Mr. A. R. Gourley	1935-1944	10 years
Mr. R. M. Osborne	1935-1946	12 years
Mr. J. A. Kline	1935-1947	13 years
Mr. C. J. Griffiths	1944-1956	13 years
Mr. S. T. Webster	1946-1949	4 years
Mr. R. W. Turnbull	1948-1953	6 years
Mr. N. M. Macdonald	1949-1964	16 years
Mr. J. L. Harwood	1954-1956	3 years
Mr. E. J. Bulte	1956-1959	4 years
Mr. A. N. Hoggart	1956-1958	3 years
Mr. V. J. White	1959-1961	3 years
Mr. R. C. M. Melgaard	1959-1965	7 years

By 1960, a need was seen to increase the number of editors on the Board and the concept of an Editor-in-Chief emerged. This was held by Mr. N. M. Macdonald until 1964 when Mr. V. J. White, previously an editor, took over. This situation existed until 1971 when the present Editor-in-Chief, Mr. G. Moot, was appointed.

The Journal commenced with two issues each year of some 25 pages but by 1940 there were three issues each year of some 60 pages. In June 1959, the standard "blue-grey" cover which had served for nearly 25 years, was replaced with the now familiar coloured symbol of the hand-conversor of the telephone and manufacturers were invited to submit advertisements for publication. In June 1973, a more modern print style and format was introduced, together with two-colour reproduction of articles. Currently, there are close to 100 pages in each issue of the Journal, and three issues each year are maintained.

The first issue of the Journal had a circulation of 400. Today, production exceeds 6,000 copies.

The Editor-in-Chief, Australian Telecommunications Research

As the name suggests, the Australian Telecommunication Research Journal is written on a higher academic plane than the Telecommunication Journal and provides researchers in Australian universities, industry and the Post Office with a specialised avenue for recording originality of effort. The initiative for the publication of this Journal came from the A.P.O. Research Laboratories in 1966, and publication commenced in 1967. Mr. H. S. Wragge of the APO Research Laboratories was appointed as Editor-in-Chief and currently holds this position. Generally, there are two issues each year of A.T.R. but in 1973, a special issue was published to commemorate the Golden Jubilee of the APO Research Laboratories and the Symposium "Whither Communications".

The Editorial Board of Australian Telecommunication Research aims to achieve a standing for the journal such that it will be used for recording original work within the Post Office, industries, universities, etc. in telecommunication fields. This goal is gradually being achieved through the efforts of the Editors and Corresponding Editors. In the second issue of A.T.R. in 1973, the majority of the articles were written by authors in Australian universities, and the trend is expected to develop.

The General Secretary

When the Postal Electrical Society was reconstructed in 1932, Mr. A. R. Gourley was appointed Honorary Secretary, a position which he held until 1942. Mr. W. H. Walker undertook the next 10 years of office to 1951. Mr. R. D. Kerr was Secretary from 1951 to 1958. Mr. R. G. Kitchenn was appointed in 1958 and was largely instrumental in developing the reformation of the present Telecommunication Society of Australia. Mr. Kitchenn administered the Telecommunication Society's affairs until 1972 when he was succeeded by the present Secretary, Mr. N. G. Ross.

The Treasurer

As well as dealing with Council of Control financial transactions, the Council of Control Treasurer consolidates the financial returns from the six State committees. Our Treasurers have been: Mr. W. J. B. Pollock 1960-63; Mr. F. Colson 1963-71; Mr. J. Raby 1971-present.

STATE DIVISIONS

In each State capital city there is established a State Division committee comprising twelve members of the Society resident in that State. At least eight of the twelve members must be officers of the Postmaster-General's Department, and both Third and Fourth Divisions of the Public Service must be represented to enable a balanced viewpoint of members to be developed. With the exception of the Chairman, who is nominated annually by the Director, Posts and Telegraphs, in the State, the committees are elected annually by the members at the Annual General Meeting. The current Chairmen and Secretaries are:

New South Wales:
Chairman: Mr. R. Langevad
Secretary: Mr. K. Hardy

Victoria:
Chairman: Mr. A. Morton
Secretary: Mr. W. Hockley

Queensland:
Chairman: Mr. F. M. Scott
Secretary: Mr. L. E. Bews

South Australia:
Chairman: Mr. K. Work
Secretary: Mr. P. Weir

Western Australia:
Chairman: Mr. R. L. Lowe
Secretary: Mr. G. White

Tasmania:
Chairman: Mr. M. H. Dunstone
Secretary: Mr. J. Hodgson

Within the State Division, Committees are given the power to establish Branches as sub-units. The primary purpose of Branches is to provide a facility to enable the exchange of views and experiences per medium of lectures, visits, etc., where there is a strong local area of interest.

The State Committees are responsible for execution of the Society's policy as formulated by the Council of Control, and for the achievement of the objects of the Society in each State. Again, a large number of enthusiastic people are involved, from committee men to agents, regulating Society affairs to give the utmost benefit to members. In addition to arranging lectures and demonstrations on telecommunication topics and organising visits and technical displays, the Divisions award prizes for scholastic achievement in telecommunications oriented courses.

OVERSEAS REPRESENTATIVE

The Society has an agent in London whose function is to facilitate the distribution of journals to subscribers in Europe and to transact other business on behalf of the Society. The position is usually held by the Liaison Engineer, Australian Post Office, and currently is Mr. R. Martin.

LIFE MEMBERS

The Constitution of the Society provides that the State committees may confer the honour of Life Membership of the Society on members who have given outstanding service to the Society in that State. In a Society which relies so heavily on the voluntary efforts of many, it will be appreciated that the standard of service must be high to qualify for the award. An Appendix to this article lists the Life Members of the Society since 1934, the date of the award and the reasons for granting the award.

LOOKING INTO THE FUTURE

The pages of its journals and the activities of the Telecommunication Society of Australia reflect the on-going development of telecommunication services in a nation traditionally aware of their great value. Advancements in science and technology have brought at ever increasing rate services which annihilate distance and are all pervasive. They are part of our way of life. Man has walked on the surface of the moon watched by millions and researchers live in laboratories in space.

In addition to the wide and immediate coverage of broadcasting and television, we are accustomed to efficient person-to-person communications by telephone, telex and data through the availability of a network which extends widely throughout Australia and overseas. Within Australia, the principal traffic streams are carried by microwave radio and coaxial cable systems and internationally by intercontinental telephone cables and satellite communication systems.

Notwithstanding the considerable overall growth and penetration of telecommunications in Australia, it is difficult to match the consistently heavy public demand for new services and there still remain areas in which rural and outback communities are not yet provided with up-to-date services. Many people in these areas are in contact through a network of outpost radio services the largest being the Royal Flying Doctor Service, which enables messages to be passed but does not provide for direct access to the public network of communications.

Having regard to these conditions, and the rapid growth of trunk traffic, studies are in progress to enable the potential value of a national satellite system for Australia to be assessed.

The rapidly developing field of electronics is about to be applied this year in automatic telephone switching and the first stored program controlled trunk exchange is shortly to be placed in service in Sydney. Installations will follow in other cities.

Perhaps the most notable application of electronics however, is the rapidly expanding use of computers. An established and growing part of the business and government scene is the provision of facilities for remote access to stored information and processing capability over telecommunication channels from data terminals and computers.

The potential value of direct visual communications is being explored through in-service trials of television conference facilities between Sydney and Melbourne. These trials were supplemented during the year by a successful technical trial between Sydney and London.

The potential demand for greater volumes of information to be communicated between organisations and people leads to the need for continuing research into higher capacity systems of communication. Among these, the recently developed optical fibre offers prospects of enormous capacity at relatively low cost. In the shorter term, coaxial cable distribution will enable the required services to be provided.

Concepts of future telecommunications in which almost any facility may be regarded as technically feasible inevitably raise questions of the potential impact on society. Benefits may appear to be attractive and rewarding but the unrestricted use of technology in this field may produce undesirable social effects. There is now a growing recognition of the need to consider the impact of the advancing telecommunication infrastructure in evolving the design of future cities so that the quality and modes of living will be enhanced.

Today's world is subject to great forces for social change. There is recognition of the problems of explosive world population growth, the need for conservation and more equitable distribution of limited global resources, and the need to care for the natural environment. The quest to improve the quality of life continues and there is much emphasis on social conditions and welfare.

In communications, there is a trend for the impact of the mass media on society to be matched more closely by the availability of private communications for individuals and groups of people within the community. Technical facilities for instance, may become available and provide new aids for educational, cultural, medical, legal, banking and general community interests. Care will be necessary to preserve human rights, such as the right to communicate and simultaneously the right to privacy. The psychological effects of future wired city and home-office concepts need careful thought to ensure that telecommunications will advance in step with the wishes of the people. A special planning group has been established in the Post Office and studies are already underway into these questions.

In 1874, the enthusiasts who established the beginnings of this Society were keenly aware that greater knowledge and a better understanding of the technology behind the morse key were necessary for progress. They responded to the need. So today, through the Telecommunication Journal, Australian Telecommunication Research and the lecture programmes of our Society, we are motivated by similar but broader objectives. There will still be the fascination of more advanced technology, but supporting this is the belief of the members that the services they provide are of great value to all people.

For many years, the Society has been active and its members served by devoted and capable leaders.

Unfortunately, many cannot be mentioned individually. But there is no doubt that telecommunications will continue to stimulate and challenge those engaged in this field of human endeavour. The Society will continue to play its part by so adapting its role that the members whether engaged in professional, technical or operational occupations will be assisted to extend their knowledge and understanding of telecommunications.

APPENDIX

Life Membership Awards for Outstanding Service

Name	Brief Statement of Service	Date Conferred
J. M. Crawford (dec)	As Chief Engineer A.P.O. sponsored the re-establishment of the Postal Electrical Society in 1932.	6.36
A. R. Gourley (dec)	Honorary Secretary of reformed Postal Electrical Society 1932-1942 and member Board of Editors of Telecomm. Journal from 1935-1944.	2.43
R. M. Osborne	An editor of the Telecomm. Journal from its inception in 1935 to 1946. Honorary Treasurer of the Postal Electrical Society 1932-1944.	17.7.46
S. H. Witt (dec)	A prime mover in the re-establishment of the Postal Electrical Society in 1932 and President of the Society in 1933 and 1942. Contributed many lectures and papers on telecommunications.	9.9.47
J. A. Kline	An Editor of the Journal from its inception in 1935 to 1947.	1.12.47
W. H. Walker	Succeeded A. R. Gourley as Hon. Secretary in 1942 and assisted in the organisation of the lectures and issue of the Journal up to 1951.	23.1.51
C. J. Griffiths	From 1934 to 1947 a member of the Committee of the Postal Electrical Society. A member of the Board of Editors of the Telecomm. Journal from 1944 to 1956. Chairman, Council of Control, Telecomm. Society 1961/1962, 1966/67, 1967/68.	14.4.53
C. Faragher	Foundation member of the Telecommunication Society of Queensland at its inception in 1949. As Director of State Administration A.P.O., from 1950-1957, he fostered the growth of the Society in the State and still takes an active interest.	4.10.57
R. D. Kerr	Honorary Secretary, Postal Electrical Society from 1951, to 1959. Contributed lectures and papers to the Society and the Journal.	9.2.59
V. J. White	An Editor of the Telecomm. Journal from 1959 to 1961. A Sub-Editor in 1963 and Editor-in-Chief from 1964 to 1971. Contributed several articles to the Journal.	7.3.61
J. W. Pollard	A Sub-Editor of the Telecomm. Journal from 1944 to the present time.	7.3.61
W. L. Jackson	Originally appointed a life subscriber prior to amalgamation of life subscribers and life members. Donated a reference set of journals to the Council of Control of the Telecomm. Society.	7.5.64
N. M. Macdonald	A member of the Board of Editors from 1949 and Editor-in-Chief from its inception in 1960 until 1964. Chairman, Council of Control, Telecomm. Society, 1971/72, 1972/73.	7.5.64
E. J. Bulte	President of the Postal Electrical Society 1958/59, Chairman of Victorian Division Telecomm. Society 1961/62, Editor of Journal 1956/59, Sub-Editor 1959 to present. Contributed many articles to the Journal.	18.3.65
D. P. Bradley	An Editor of the Journal from 1961 to 1965 and Sub-Editor from 1966 to 1973. Contributed several articles to the Journal.	16.11.65
R. C. Melgaard	An Editor of the Journal from 1959 to 1965 and Representative in Europe 1966 to 1968.	16.11.65
G. Black	Member of the inaugural committee of the NSW Division of the Society in 1960. Responsible for the establishment of strong interest in the Society amongst Telecommunication Division personnel which has been maintained over a 24 year period.	23.2.66
J. Mead	Journal Sub-Editor for Western Australia from 1946 to present. Secretary of the W.A. Division of the Society from 1960 to 1967. Member of committee of the W.A. Division from 1967 to 1969 and Chairman from 1969 to 1971. Still active in Society affairs.	2.3.67
M. J. Power	Inaugural Chairman of the NSW Division of the Society in 1960, and continued as Chairman continuously to 1973. He has also contributed several articles to the Telecomm. Journal.	5.2.69
C. R. Anderson	Foundation member of the Telecommunication Society of Queensland formed in 1949. Journal Sub-Editor for Queensland from 1949 to 1973.	5.2.74
P. C. C. Way	Served the Society in an executive capacity over a period of several years, both as the Wagga branch Secretary and as Secretary of the NSW Division. He has also contributed to the Telecomm. Journal of Australia.	3.2.71
G. E. K. Dixon	First Chairman of the Telecommunication Society of Queensland in 1949, and again in 1960 when the Queensland Society merged with the Telecommunication Society of Australia. Maintained an interest in Society affairs throughout the period leading to the award.	22.2.72
W. R. Treloar	Journal Sub-Editor for Victoria 1951-1973. Chairman of Victorian Division of Society during 1964/65. As member of lecture committee over a number of years, he was a major influence in the establishment and continuation of country lecture programs.	10.4.73
R. G. Kitchenn	Honorary Secretary of the Postal Electrical Society in 1958, and subsequently General Secretary of Council of Control of Telecomm. Society from its inception in 1960 until 1972. Prime mover in establishing the Society on an Australia-wide basis.	4.7.72
W. C. Harris	Foundation member of the Telecommunication Society of Queensland at its inception in 1949 and committee member from 1956. Treasurer from 1957 to 1960. Committee member of the Queensland Division of the Society from 1960 to 1964. Secretary of the Division from 1964 to 1974.	5.2.74
A. H. Freeman	Member of the Society since 1946. Contributed several articles to the Telecommunication Journal over the years, and more recently wrote Monograph No. 4—"Automatic Telephony in the Australian Post Office."	6.2.74

R. W. TURNBULL, M.B.E., Dip. Elec. Eng., F.I.E. Aust. is the First Assistant Director-General, Engineering Planning and Research Division, at the Australian Post Office Headquarters, Melbourne. He is also a Commissioner and Vice-Chairman of the Overseas Telecommunications Commission (Australia).

Following his tertiary education at Sydney Technical College and Sydney University, Mr. Turnbull qualified as an Engineer in the Postmaster-General's Department in 1937, and progressed through the senior ranks to Superintending Engineer 1955: Assistant Engineer-in-Chief 1962; and Senior Assistant Director-General, Planning, in 1964. He has occupied his current positions with the A.P.O. and O.T.C. since 1973.

He was a member of Australian Delegations to Conferences of the United Nations and of the International Telecommunications Union in 1963, and was Federal President of the Second Division Officers' Association, Australian Public Service, in 1973/74.

Mr. Turnbull has had a long association with the Telecommunications Society of Australia and the Postal Electrical Society of Victoria, being a member of the Board of Editors of the Telecommunication Journal of Australia from 1948 to 1953, and Chairman of the Council of Control of the Society since April 1973. He has contributed many articles to the Journal since 1941.

Telecommunication Society of Australia — Centenary Postmarker

To celebrate the Centenary of the Telegraph Electrical Society, Melbourne, established in August, 1874, the Telecommunication Society has arranged for the special postmarker illustrated to be available on 1st August, 1974 at the Sydney General Post Office.

Whilst any stamped envelope may be franked with the special postmark on that day on request, the Society's New South Wales Division has produced a limited edition of 5000 specially designed commemorative covers for franking.

The covers will feature the seven cent stamp issued in November 1973, which celebrates the 50th anniversary of regular radio broadcasting in Australia, when Station 2BL Sydney first commenced regular transmission.

Method of distribution of the covers is being arranged individually by State Divisions of the Society.

Colour Television – Some Effects on Australian Post Office Plant

G. E. HATFIELD, B.E.E., M.S.E.E.

Colour brings greater reality to television. Colour however also introduces additional parameters which must be controlled in relaying and broadcasting. The relationship between visible effects on a picture and distortion of test signals is considered.

The Post Office is involved in entertainment television in carrying the signal on cables from studios to operating (switching) centres, in relaying the signal on broadband bearers, in broadcasting the signal from transmitters and in measuring and monitoring both the baseband signal and the radiated signal.

The influence of equipment on colour parameters is examined to help gauge the effect on some Post Office operations.

INTRODUCTION

On 1st March, 1975, colour will become a part of broadcast television entertainment in Australia. This paper discusses the differences between monochrome and PAL colour video signals and indicates the requirements imposed by these differences on the testing, performance and conversion of the television relay and transmitting plant of the Post Office. Basic colour principles are not included as this information is readily available in other publications, nor are the important ramifications on training, operational methods and organisation which would need an article in their own right.

VIDEO SIGNALS

The PAL colour video signal to be used in Australia differs from the existing monochrome video signal in a number of ways. There are two major differences. One is the colour information itself, carried during the picture period by modulation of a colour sub-carrier. The other is the addition of the colour synchronising information, or "burst", comprising 10 cycles of colour subcarrier frequency located in the back porch.

Other differences follow from these basic differences. Fig. 1 shows the video signal for fully saturated full brightness colour bars. It will be noted that both the picture signal and peak voltage swings are larger than for a monochrome signal. Fully saturated full brightness yellow and cyan go well beyond peak white, to 133.4 units (the black to white interval being defined as 100 units). Similarly fully saturated full brightness red and blue extend into the synchronising region by 33.4 units.

The main reason for using such a large amplitude is the need to minimise the effects of noise. Even so, the PAL colour signal is a little more susceptible to noise (by about 1 dB) than a monochrome signal. However, by making the following two changes, which increase the picture component of the video signal, the Australian system retains a performance in relation to noise similar to the present monochrome service:

- The video signal is now to use a 100:40 picture to synch ratio instead of the previous 70:30 ratio;
- The 5% set-up previously used has also been eliminated making black and blanking coincident.

The addition of colour information means that there are now more elements of the video signal which can be affected by distortion. At the same time increasing the picture amplitude makes the signal more susceptible to non linearity, or conversely increasing the picture amplitude requires that equipment be linear over a wider range.

DISTORTION — EFFECTS AND MEASUREMENT

General

Most people will have some impression of the effects of distortion on monochrome television. Colour adds some new effects.

Because of the interfaces with other organisations in relaying and in broadcasting, Post Office

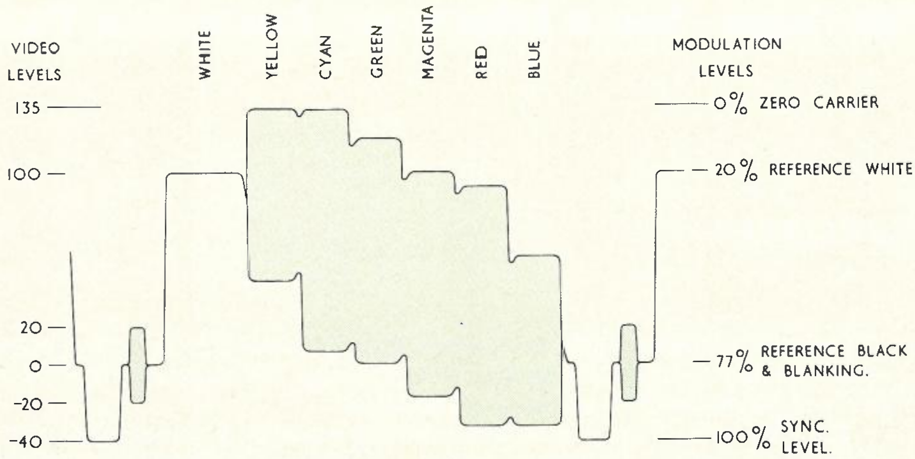


Fig. 1 — 100% Colour Bar Video Signal.

activities must necessarily be influenced by standards and measuring techniques adopted throughout the industry.

The test techniques discussed in this paper have been developed by a working party with members from the APO, ABC, ABCB, commercial operators, manufacturers, suppliers and the receiver industry. This working party was one of a number considering different aspects of colour television.

The following basic premises, equally applicable to both colour and monochrome television, were applied during the progress of these working parties:

- Any distortion of the video signal which causes a visible degradation should be measured and controlled.
- Test techniques should be related to visible (or audible) effects.
- Tests should give information directly useful in fault location.
- Where there are International tests these should be followed as closely as possible.
- There should be no tests which do not meet these criteria.
- Performance limits should be related to visible (or audible) limits.
- Performance limits should not be arbitrarily stringent.

Frequency Response

Any difference in amplitude between colour subcarrier and low video frequencies directly affects a colour television picture. Such differences are known as chrominance/luminance inequalities.

Amplitude Response

Any difference in response between colour subcarrier and low video frequencies is important as such differences affect the saturation of the colours. A loss of chrominance (high video) frequencies for example, gives muddy looking yellows and pasty faces.

Changes with average picture level are also important. If one is watching a singer and the background is changed from dark to light, or vice versa, it is most disturbing if the singer changes (going pale or dark skinned).

Group Delay Response

As with amplitude/frequency response and spot frequency differences between colour subcarrier and low frequencies are important. A difference shows up in the colour being to one side of the picture of the object to which it belongs.

In some early tests on existing equipment a picture of a small red car parked behind a large white truck was used. In the final picture there was a red blotch in the middle of the truck. This sort of effect is particularly disturbing in crowd scenes where colours and people can become jumbled together, and on pictures of girls where their bright red lipstick is smeared sideways onto a nice light face. It is unfortunate that these common colour transitions (red/white or red/yellow) are also the most critical. A delay of only 100 nanoseconds in the complete system can lead to effects which are readily visible from normal viewing distances, making this one of the more critical factors to be controlled for colour.

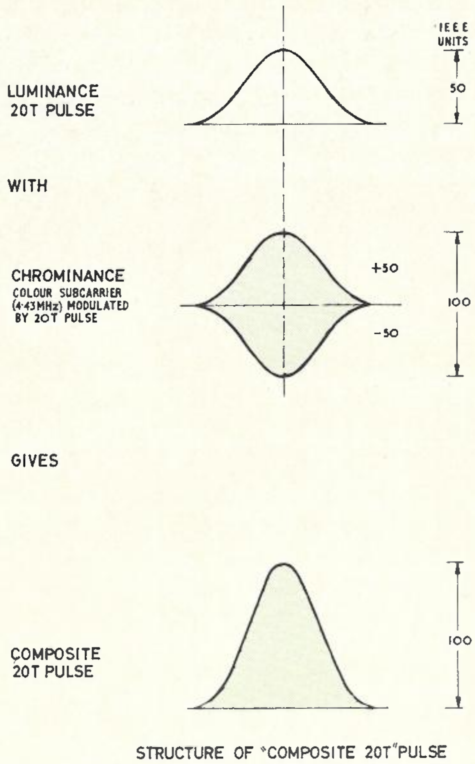


Fig. 2 — Structure of 20T Pulse.

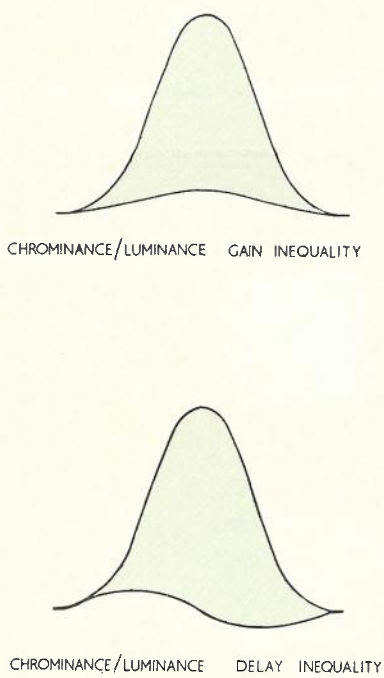


Fig. 3 — Single Distortions of 20T Pulse.

Chrominance/Luminance Inequalities

In colour as in monochrome it is preferable to examine direct waveform effects rather than frequency response. The two important parameters related to frequency are readily covered by a special test waveform; the composite 20T pulse. This is a waveform comprising matching luminance and chrominance components of equal peak amplitude as shown in Fig. 2. The composite pulse appears as a 20T envelope with a flat base.

Any difference in gain between chrominance and luminance means that one component becomes larger than the other which makes the baseline bulge or become hollow.

Delay of one component relative to the other causes a sine-wave shaped ripple in the baseline, the amplitude of which is related to the delay.

These effects are shown in Fig. 3. A combination of both amplitude and delay inequalities produces a ripple such as shown in Fig. 4, which also includes a monogram to determine the magnitude of the distortions.

Transient Response

Luminance

All modern television studio cameras use aperture correction to give pictures with sharp edges. This results in video signals having a high energy content up to and beyond the frequency limits of the system. To enable proper control of band limiting circuits, test waveforms sensitive to frequencies at the band edges should be used.

For colour television it is necessary to limit the luminance frequencies to about 3.5 MHz as any energy in the region of colour sub-carrier could be treated as colour information and result in false colours being displayed. Consequently colour pictures do not have quite the same resolution as monochrome, and luminance transient test requirements are eased.

Since there is high luminance energy only up to the 3.5 MHz region, luminance transient testing with a T pulse and bar will be satisfactory and it will no longer be necessary to test transmitters with a fast rise transition (50 ns). A 2T pulse and bar will still be used for routine measurements and mid-frequency effects.

Chrominance

For colour the chrominance transient performance needs to be examined. For example, consider a picture of a girl with bright red lipstick again. If there is a trailing smear on the chrominance transition, but not the luminance, the red will be a messy smear on the right of her mouth. Recent tests have shown this transient effect to be quite critical, like delay inequality already mentioned. It is in fact often hard to distinguish between the two effects on the screen. Fig. 5 indicates this effect, and also pre-ringing on the colour transition.

With the colour sub-carrier frequency being 4.43 MHz, and a chrominance band width of 1.3 MHz in the video signal, it is largely the cut-off region of 5.0 to 5.5 MHz which effects colour transients. The tight control needed over this region for colour also guarantees the performance for wide band monochrome signals.

From its construction it will be appreciated that the composite 20T pulse contains a chrominance pulse. This can be extracted by filtering off the luminance component with a high pass filter and examining the shape of the remaining chrominance pulse. It is rather more convenient and also less subject to error, to have a chrominance pulse without the added luminance. There is then no need to add a filter while testing.

A 20T pulse has a half amplitude duration of 2 μs, with its zero energy points at 0.5 MHz (luminance pulse) and at colour sub-carrier $\pm$ 0.5 MHz (chrominance pulse). As the chrominance signal has a bandwith of a little more than 1 MHz a 2 microsecond chrominance pulse is effectively a 4T chrominance pulse (as T = 500 μs for 1 MHz bandwidth) and is known as a 4Tc pulse.

The 4Tc pulse has zero energy at 4.93 MHz and thus gives little indication of effects in the cut-off region.

A2Tc pulse, with one of its zeros at 5.43 MHz (1 MHz from sub-carrier) and half energy at 4.93 MHz, is far more useful. While still not having as much energy content in the cut-off region as does the signal from a camera the 2Tc pulse appears to be an adequate signal to test cut-off effects.

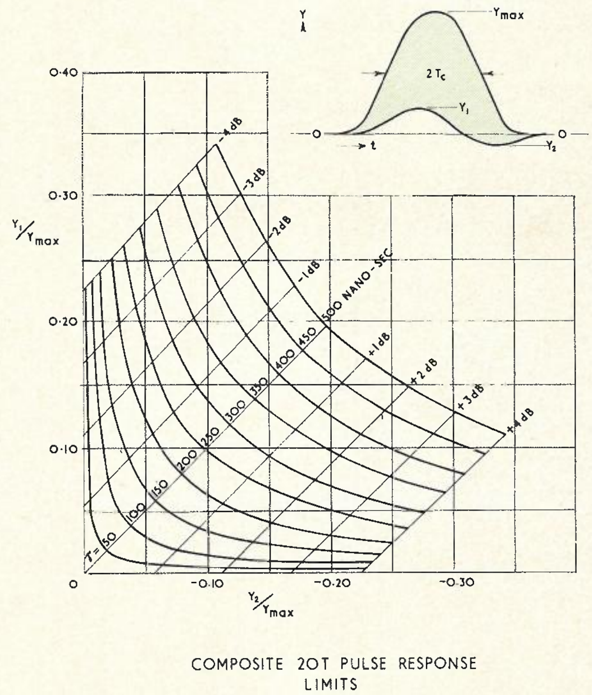


Fig. 4 — Composite Distortions of 20T Pulse.

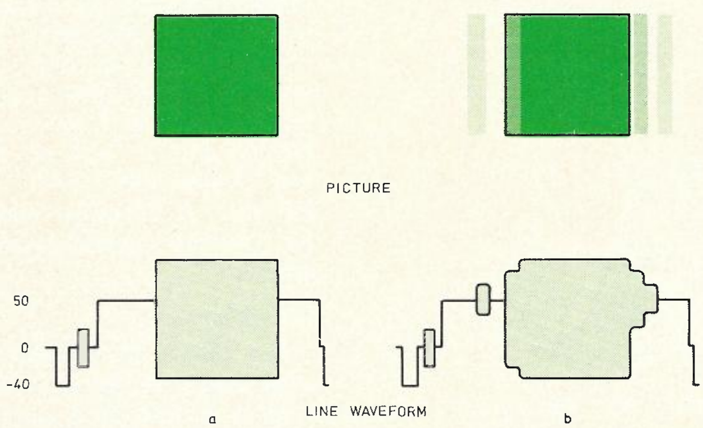


Fig. 5 — Colour Transient Distortion.

20T or 2Tc?

Having decided that a 2Tc pulse is required as a chrominance transient to observe effects occurring in the cut-off region, why not also use this for the composite pulse? The main reason is that distortion of the pulse shape makes it hard to determine inequality effects. This then makes fault finding more difficult and time consuming. For example the use of separate pulses with the two durations makes it much easier to separate a gain inequality (frequency response tilt) from a fault in a filter determining system cut-off.

Using both pulses, 20T and 2Tc, each for its own purposes is therefore recommended.

Bounce

This is also referred to as low frequency transient. This used to be a straight-forward test to ensure that the equipment dynamic range could handle all signal conditions, i.e. the signal did not swing so far that clipping took place. A transition between black and white was the worse case.

With colour a variety of signal situations may occur. A large amplitude chrominance signal may be present near black and not near white (red to white) or conversely near white and not black (cyan to black). Chrominance may also remain constant while luminance bounces between black and white regions (red to cyan), or chrominance may come and go while luminance remains constant (green to grey). This has obviously complicated testing considerations.

Equipment considerations do not even help, since chrominance appearing with a switch to black is the most severe condition for some equipment, for example transmitter output stages, while chrominance appearing with a switch to white is most severe for other equipment such as transmitter modulators. Constant chrominance and changing from black to white is most severe for yet other equipment such as FM bearers.

Obviously a compromise was called for here. A vast number of test signals was impractical and eventually a chrominance bounce test comprising a constant, 50 units luminance, with 125 units of chrominance switching on and off was adopted.

The sort of effect which can result from a bounce which causes the synchronising region to be clipped (or crushed) may be illustrated by considering a sudden picture change from a light bright scene to a deep rich red background. Crushing as a result of bounce occurring on the change would cause the red background to swing between the red and a pink until the bounce died down sufficiently for the signal to return within the dynamic range of the system.

Non-Linearity

Line-Time Non-Linearity

This is another straight-forward luminance test to ensure good tone (or brightness) gradation without information being lost by compression in any part of the picture. In effect the linearity of the system to changes in luminance level is tested.

One technique of evaluation uses a sine-wave, normally 1MHz, super-imposed on a sawtooth (or staircase). The colour test for differential gain is very similar, except that the super-imposed frequency is colour sub-carrier.

Differential Gain and Phase

These colour tests, as distinct from line-time linearity, are designed to reveal an inter-modulation effect; the influence of changing brightness on colour, rather than on the brightness gradation itself. Since colour television uses the phase as well as the amplitude of the colour sub-carrier, changes of both with luminance level must be examined. What is the effect? Think of the background to a scene, say the wall of a room, having an even colour and lit from one side. The effect of differential gain would be to cause one or more vertical stripes of reduced (washy) or increased (deeper) saturation.

Differential phase would give stripes of changed colour with NTSC colour signals which are at times carried on the transmission network. The PAL system averaging of colour information over two lines means that phase changes appear as reduced saturation, rather than as colour changes, while amplitude changes can increase or reduce saturation.

Consequently, both these colour parameters must be measured and kept under control. In most equipment other than FM bearers good differential gain virtually guarantees good line-time linearity, though there are also some qualifications concerning transmitters. It is expected that it will no longer be necessary to check line-time non-linearity at frequent intervals.

Chrominance Non-Linearity

The chrominance itself can suffer from non-linearity. Since the chrominance is a high frequency large amplitude signal any non-linearity affecting chrominance need not always correlate with lower frequency effects.

How does non-linearity of chrominance affect the colour picture? Consider a rich velvet curtain, say red, as a backdrop to a scene. The curtain may be lightly rippled and lit from one side so that the peaks are bright and the troughs are dark. A crushing of chrominance, or a phase shift, reduces the saturation and tends to make the peaks pinkish and dull.

This type of effect does not have the same appearance as a reflection from a highlight, in which case there is the high brightness associated with a low saturation.

While there is inadequate information on the effects of chrominance non-linearity, present indications are that considerable non-linearity can be tolerated. However, chrominance non-linearity should not be ignored as it was in other countries for many years allowing quite a few visibly disturbing effects to be seen by the viewing public.

Various tests have been considered for measuring the extent of chrominance non-linearity. The test signal which is being adopted in Australia comprises five steps of chrominance of constant phase on a constant luminance pedestal as shown in Fig. 6. The chrominance extends to 125 units, close to the maximum nominal value for chrominance of 126.4 units. This type of signal comprising a regular progression of amplitudes with constant phase and constant luminance make for easy interpretation and correlation between amplitudes and phase shift.

Intermodulation: Chrominance Into Luminance

Large amplitudes of chrominance can also affect the luminance, affecting the picture on both colour and monochrome sets. This is detected by using the five step test signal above. When the chrominance is filtered off (simple low pass filter; e.g. RC network) the resultant luminance level should remain constant, but it may not due to non-linear effects.

When may a shift of luminance occur and with what effect? A rich velvet curtain will serve as an example again.

Any intermodulation may either increase the brightness of the troughs or decrease the brightness of the peaks which can make the curtain appear rather dull and without texture.

It is quite common for intermodulation and chrominance non-linearity to occur together. In fact the most common cause of intermodulation seems to be non-linearity at extremes of the picture signal amplitude range which affect one side of the chrominance only; for example crushing of the signal beyond black reduces chrominance and at the same time increases luminance. Notice that both effects act together to reduce the colour saturation making the overall situation worse than would either effect on its own.

The opposite can occur with one effect partially compensating the other. Crushing beyond white reduces chrominance and thus saturation. The resulting luminance loss partly, or even fully, restores saturation the resulting effect being a reduction of brightness (and contrast).

Crosstalk

Crosstalk results in a signal appearing both in its own circuit and also in a circuit other than the one for which it was intended.

The high frequency chrominance signal has a much larger amplitude than the high frequency

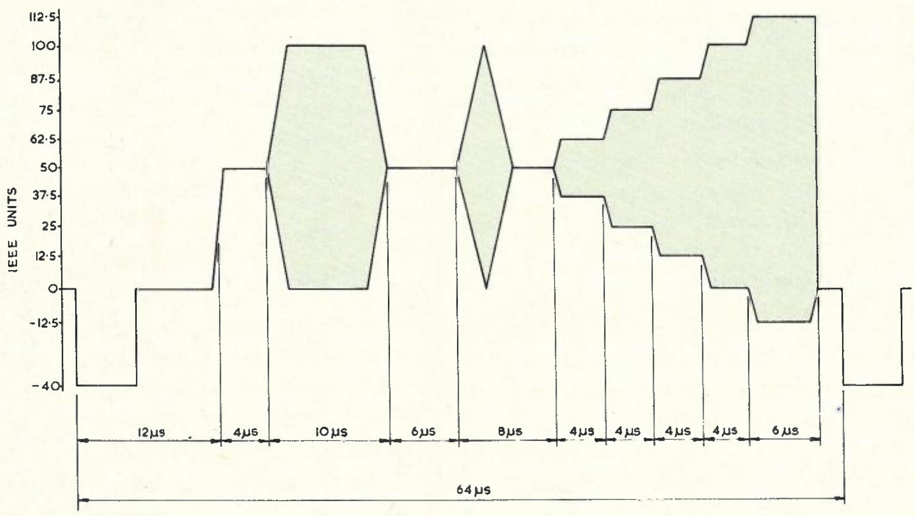


Fig. 6 — Chrominance Transient and Linearity Test Signal.

component in monochrome, and is thus more visible for a given degree of crosstalk. If one circuit is not carrying a signal, crosstalk results in an unwanted signal.

Crosstalk may appear as high frequency noise if there are two signals in different paths and the signals are not synchronised. However, the frequencies of synchronising pulses are more closely controlled for colour and the crosstalk with colour signals is more likely to produce either a coherent pattern, or to result in a low frequency beat. These effects, especially the latter, are rather more disturbing than high frequency noise.

EQUIPMENT CONSIDERATIONS

General

The various types of distortion referred to are important because of their visibility to the viewer. How do they affect APO operations? This depends on the particular types of equipment used by the Post Office in switching, distributing and radiating the television signals.

Some forms of degradation are limited to a few types of equipment, while some are common to most areas.

The delay line PAL method of averaging phase distortions results in a system which is tolerant to quite large phase errors, up to some 40°. It is however quite probable that some simple PAL receivers which rely on eye averaging, or "by-pass" PAL receivers which largely negate any averaging, will reach the Australian market. These receivers are much more sensitive to phase variations. This factor will mainly affect specifications of tolerances for transmitters.

For much of the transmission network the tighter tolerances needed for NTSC colour will need to be maintained to ensure adequate quality for the interchange of satellite programmes with other countries.

Bandwidth

The radiated video bandwidth remains nominally 5 MHz, with the sound carrier 5.5 MHz from the vision carrier.

The colour difference signals are encoded after filtering to a nominal (3dB) bandwidth of 1.3 MHz. The filter for the colour difference is required to have greater than 20 dB attenuation at and beyond 4 MHz. The chrominance signal as encoded is double sideband and consequently the video signal extends to some 6 MHz or more.

Bandlimiting (say to the nominal 5 MHz) means that the chrominance signal becomes a vestigal sideband signal occupying the frequency band of colour sub-carrier + 0.6 MHz — 1.3 MHz. This makes the chrominance signal more susceptible to various forms of distortion, depending on the system. Vestigial sideband NTSC signals are liable to be affected by any differences between the major and minor sidebands. The PAL signal is generally considered to be susceptible only to phase differences between the major and minor sidebands, and even in this aspect to be less sensitive than an NTSC signal.

Because of the increased susceptibility to distortion of even the PAL system when it is carried as a vestigial sideband signal it is preferable for the video signal to be carried double sideband (some 6 MHz) over the transmission systems, band limiting taking place only in the broadcast transmitter.

The Technical Standards of the Australian Broadcasting Control Board require that deliberate reduction of the upper sidebands prior to the transmitter be avoided.

Clamping

As most transmission systems are ac coupled, clamping is necessary at some point in the chain to ensure that the dc component is radiated. It is quite possible for clamping to occur only at the transmitters, provided that the transmission system can handle the variations in peak voltage excursions (such as bounce) presented to them. However, it does appear that clamps will be necessary in the transmission system with colour signals.

Both blanking level (back porch) clamps and synchronising tip clamps are used in television. Colour does not affect synchronising tip clamps, though the possible use of systems carrying the sound in the synchronising pulse region in the forseeable future is a factor to be considered. Colour does however significantly affect back porch clamp design since the colour burst is included in this time interval.

While it may appear simplest to avoid back porch clamping, it is necessary to include at least one back porch clamp at the transmitter; to ensure that the blanking (and black) level modulation depth remains constant despite variations in the incoming picture to synchronising pulse ratio.

Colour imposes two basic requirements on back porch clamps:

- The burst must not be distorted in amplitude or phase.
- The clamp must not be affected by the burst.

If the burst has an odd number of half cycles then, because of the PAL phase switching, there can be a line by line change in the mean level of the burst. A similar situation can occur using a short clamp with a duration of a few half cycles. A clamp operating during the burst must have a low sensitivity to such a variation. The desired insensitivity may be achieved by using a long clamp which extends in to the blanking region on both sides of burst, or by using a clamp responding mainly to changes with a rate below 7.8 kHz.

Alternatively, if the burst has been passed through an appropriate Gaussian filter the end cycles have a low amplitude, and thus a low dc level, so that there is only a small change in the mean level of the burst.

It may be noted that simple clamps using a frequency conscious impedance change, such as a blocking circuit tuned to colour subcarrier, can readily meet both the stated criteria but many do not.

Failure to meet the criteria can be due to unsuitable impedances or unsuitable frequencies at which changes of impedance occur, and to inadequate allowance for the reactive component of impedance.

Two path systems are also used, where the chrominance is filtered off through one path, clamping is applied to the luminance path, and the two paths are then recombined. The mean level of the burst will go through the clamped luminance path unless the filter frequency is very low.

It is possible to use a narrow clamp pulse situated between the burst and the start of the picture. During the vertical synchronising pulses this period is at synchronising tip level. Consequently such clamps need to sense the presence of vertical synchronising pulses and alter the timing for their duration. This makes for a relatively complex clamp. Even so clamps of this form have been used commercially and one has been designed and used by the APO as part of the colour evaluation programme.

Because of their narrow clamping pulse such clamps are generally more susceptible to noise than clamps using broader pulses. Their timing is also more critical, to the extent that if such a clamp in a transmitter is placed after the group delay precorrection networks for the receiver and for the transmitter itself, there is a possibility of chrominance from the picture interval being shifted into the clamp timing interval.

Impedance

In monochrome television impedance was mainly important at low frequencies (or near carrier frequencies) and 2T return loss testing was one commonly used method. For colour the impedance near colour subcarrier is also important, and return loss should also be measured at this frequency. A 2Tc (or 4 Tc) pulse may be used for this purpose.

What are the effects of impedance errors?

Variation of impedance match with frequency between two items of equipment can vary the apparent frequency response and thus cause chrominance to luminance gain inequality, or it can give rise to a delayed echo.

Ghosting

A poor match at colour subcarrier frequency can cause a chrominance echo or ghost, the phase of which will depend on the phase of the impedance and the length of line. This may occur in the absence of a luminance ghost and the effect depends on both the chrominance and on the luminance at the time the chrominance ghost occurs. This is another area where there is insufficient information, but a 4Tc return loss specification of the same order as that for the 2T pulse seems at least safe. An illustration of chrominance ghosting is shown in Fig. 7.

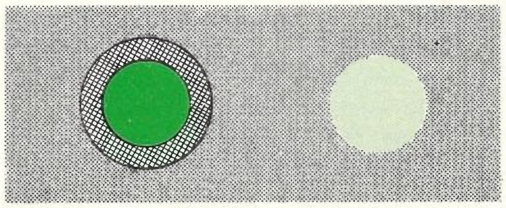


Fig. 7 — Chrominance Ghosting.

The opposite situation of a luminance ghost with no chrominance reflection can occur, and is generally slightly less obvious than the same ghost in monochrome. Complete signal ghosting can also occur either with video signals being transmitted over long cables, or with the radiated signal; for example from buildings. At the low levels of ghost which must be maintained in Post Office systems; e.g. for translators; the requirements for colour are no more stringent than for monochrome.

Impedance mismatches can also cause consequential effects, particularly in transmitters where a low source impedance output stage may be used. A reactive mismatch can affect the operation of such an output stage leading to phase errors which can be level dependent. Though there is little information on these aspects, such effects so far appear to be controllable by normal patching and line stretching techniques.

Cables

The impact of colour on cable transmission should be mainly in the need to maintain a tight control over chrominance to luminance gain and delay inequalities. Variations with temperature in cable attenuation and delay vs. frequency can be expected to be significant, particularly for wideband systems and especially where VSB transmission is used.

More extensive use of temperature controlled automatic correction is likely to be required to keep adequate control. However, it is probable that switched correctors to cope with long term (e.g. seasonal) changes will be sufficient for many existing cable systems.

If any cable systems limited to 5 MHz are retained they are likely to require improvement to the group delay correction of the 5 MHz band limiting networks. This is for both chrominance to luminance delay inequality and chrominance transient response. Even if such systems can be corrected for their own deficiencies it is preferable that they be eliminated since the resultant band limiting necessitates more stringent control of the rest of the transmission system than would otherwise be necessary, as was indicated above.

Baseband cables are a probable source of crosstalk, whether appearing as a coherent signal, a beat, or as noise. Crosstalk is most likely to occur where there are a number of cables in one duct or tray. The Television Operating Centres and cables between the TOC and broadband bearer terminals are thus the most susceptible areas of Post Office operations.

Switching

The Department is concerned only with limited switching, mainly at TOC's and in transmitter input equipment. Crosstalk of the chrominance signal and control of return loss at colour sub-carrier frequencies are the new factors which must be considered for switching colour.

FM Bearers

General

The chrominance signal imposes increased loading on FM Bearer transmission systems due to its high level and the increased (statistical) high frequency content of the video signal compared to a monochrome video signal.

Because high video frequencies are pre-emphasised for transmission over FM bearers, to counteract the effects of the triangular noise characteristics of FM systems, the large amplitude of the chrominance signal compared to high frequency monochrome information increases loading and results in a relatively high modulation index.

Loading

The increased loading is likely to be a problem mainly on wideband systems carrying telephony and television simultaneously. In this case some increase in intermodulation noise can be anticipated, and some particular frequencies in the baseband may be rendered un-useable. In Australia only coaxial cable systems are used for the simultaneous tranmission of telephone and television.

The extent of the problem will depend on the statistical occurence of high level chrominance signals. There is inadequate information on this at present, but local evaluation of the content of recent video signals has shown a considerably higher level of chrominance for statistically significant periods than manufacturers of transmission equipment would sometimes lead us to believe.

Though many manufacturers would like to limit the chrominance amplitude used in testing to the equivalent of the 75% amplitude EBU colour bars this would seem very unwise without better statistical evidence.

Deviation

The above remarks on loading also apply to considerations of the effects of larger deviation (or higher modulation index).

The relatively high modulation index for chrominance means that harmonics of the modulating frequency, particularly the second harmonics, are at a significant level and are important in their effect on signal distortions.

The second harmonic of colour subcarrier is 8.86 MHz, and there will be frequency modulation about this frequency. Consequently colour signals can upset the operation of bearer systems using control pilot frequencies, or sound sub-carriers, in the region of 8.5 MHz to 9 MHz.

Non-Linearity

Amplitude non-linearity is relatively straight forward, being directly related to the amplitude frequency linearity of the modulation and demodulation processes.

However, because of the high deviation and the importance of the second harmonic in the FM modulated wave, closer control of the higher frequencies than for monochrome is necessary.

Differential phase, and chrominance phase non-linearity, are more complex, and are related to the RF/IF group delay/frequency response. There is no simple relationship since the baseband phase linearity is affected by two different aspects of RF/IF group delay:

- The differences in RF/IF group delay between the frequencies of
  - — RF/IF carrier
  - — RF/IF carrier ± 4.43 MHz
  - — RF/IF carrier ± 8.86 MHz
- The detail of the shape of the group delay characteristic over the frequencies of deviation about the above five frequencies.

Fig. 8 indicate these areas which need to be controlled. It is of interest to note that the differential phase test is closely equivalent to the group delay test performed with a high search frequency.

Empirically two factors have been found to be

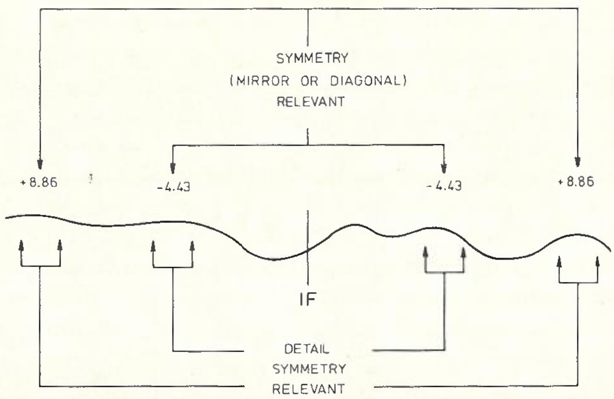


Fig. 8 — FM Bearer Group Delay Requirements.

significant to ensure good colour performance and stable operation for systems of 960 channel capacity or more:

- The symmetry (mirror or diagonal) of group delay at frequencies of carrier ± 4.43 MHz relative to one another, and at carrier ± 8.86 MHz relative to one another must be controlled rather more closely than is necessary for telephony requirements.
- Telephony intermodulation noise specifications need to be maintained. When these two requirements are met the system is almost certain to have good colour television performance.

The effects of bounce aggravate the above considerations, but again more information is needed on this aspect. For FM systems, the effect of a luminance bounce on chrominance information is expected to be the most severe condition. The deviation due to luminance bounce causes a shift in the RF/IF frequencies representing chrominance. Consequently the details of modulation linearity and the details of the group delay characteristic in the region of carrier, of carrier ± 4.43 MHz, and of carrier ± 8.86 MHz can affect the final baseband chrominance amplitude and phase.

Smaller capacity systems (e.g. 600 channel) raise more questions. Not only must the operational factors (pilots etc) mentioned above be considered, but the colour performance has been found in overseas countries to vary significantly. Variations are observed particularly in linearity and in large amplitude chrominance performance, and are generally considered to be largely due to effects in the region of frequencies of carrier ± 8.86 MHz region (or their removal). There is considerable doubt as to whether such systems can be economically maintained to meet colour requirements, particularly over long distances.

Broadcast Transmitters (and Translators)

General

The transmitting plant can be broken down into a number of areas, most of which are affected in one way or another. The transmitting installation is of course the last opportunity to minimise or eliminate some defects occurring in the transmission system. For instance on very noisy (emergency) signals it may be necessary to regenerate synchronising pulses in a stabilising (or processing) amplifier. For colour, the burst may then also need regenerating. It is essential that the new burst have the same phase as the original burst for the received colours to be correct. Similarly the amplitude of the new burst should be the same as the incoming burst for the received saturation to be correct, as many receivers use the burst amplitude to control a chrominance agc circuit.

Clamping, mentioned earlier, must be used at the transmitter to ensure that the black level is held at the correct modulation depth, since the modulation depth determines the video level in the receivers. This is even more important for colour than for monochrome. Many monochrome sets were ac coupled and were relatively insensitive to variations in the modulation depth of black level. In colour displays the black level affects the colour, consequently in colour sets the video signal must be either dc coupled or the black level clamped. The d.c. coupled sets are particularly sensitive to variations in the modulation depth of black, a difference of some 2% between channels (radiating the same programme) being detectable by some viewers.

To set (and hold) modulation depths to this order of accuracy, new methods of measuring the modulation depth of the transmitter are necessary.

Chrominance/Luminance Inequality

In the monochrome operation of parallel transmitters a difference in the absolute delay through the two sets of video input equipment results in frequency response ripples, and a degraded pulse response, in the combined signal. The delay through a chain may change with variation of the pre-correction settings. Because of this problem some stations use a single pre-correction chain in the operating path, with the second chain as a standby, rather than using a separate pre-correcting chain for each transmitter.

With colour signals a delay difference of some 30 ns would cause a chrominance/luminance gain inequality of 10%. A chrominance/luminance delay inequality of half the delay difference can also be expected, with some broading of chrominance pulses as well as a degradation in the luminance pulse response.

For these reasons APO Specification 871 Issue 5 specified the use of main and standby paths for any video correction used and this method is to be preferred for the colour operation of existing parallel operated transmitters.

Bandlimiting

The vision bandwidth is limited at the transmitter, either at video frequencies or in the vision/sound combiner at RF (IF) or both. It is necessary to control the group delay in this region to rather closer tolerances for colour than for monochrome. This area affects both chrominance/luminance inequality and chrominance transient performance. With transmitters using high power level co-axial vision/sound combiners, or filterplexers, the effects of any instability of this cut-off region (particularly with heating) on the above parameters need to be examined where transmitters are being converted to colour operation.

These same factors are also liable to be affected by bandlimiting occurring in translator output filters and in channel combining units (where two channels combine to use a common feeder and aerial).

As all this bandlimiting is in the single sideband region, pre-correction for the group delay characteristics can be applied at video, except for translators which have no video stages. The total pre-correction needed in a transmitter can be large, especially as pre-correction for a receiver characteristic having a chrominance/luminance delay inequality of 170 ms, increasing to 300 ms at 5 MHz, must be added to that needed for the transmitting plant itself. It is possible for the total pre-correction to cause the burst to shift into the end of the synchronising pulse, and for picture chrominance to shift into clamp regions. It is preferable that the group delay correction for bandlimiting filters be associated with the filters, whether at video, IF or RF. This is however impractical in the high power RF filters and pre-correction at another frequency (IF or video) is necessary.

Excessive pre-correction has another effect, causing a ring to occur on one side of transitions — both chrominance and luminance. This then increases the peak amplitude swing to be handled in other parts of the transmitter, drives the signal into more non-linear parts of operating curves, and requires increased linearity correction.

Because of the high amplitude of 4.43 MHz involved in colour signals the attenuation of the lower sideband needs closer attention than for monochrome to ensure that out of band radiation requirements are met. This may require an additional notch filter during colour conversion, though retuning existing filters may be adequate. This aspect needs to be checked for each individual station to ensure there is no interference to other services.

Linearity

The need to handle large amplitudes at 4.43 MHz imposes power-bandwidth constraints on various parts of transmitters, mainly the output stages, and also the modulators of transmitters with high level modulation. Power-bandwidth limitations generally appear as non linearity variations with average picture level.

Differential gain and phase, chrominance amplitude and phase linearity and luminance shift all need consideration. In transmitting plant line time linearity cannot be neglected as may now be possible with other equipment.

The latter concerns double sideband frequencies which require maximum power levels, while the others are largely associated with a single sideband.

In some transmitters the uncorrected differential gain and phase can be quite high (perhaps 30% and 30°). These should be minimised as far as possible by alterations to valve operating conditions, swamping impedances, etc. before applying pre-distortion. If the basic linearity is not improved the overall linearity will depend on the cancellation of two large non-linearities and is liable to be unstable and difficult to maintain.

Excessive linearity pre-correction also increases the signal amplitudes, as with group delay pre-correction, and further increases demands on later stages. Very large pre-corrections can even extend the signal into clipping and be rather self defeating.

Large amplitude colour signals, such as red and cyan, impose peak power-bandwidth requirements on transmitting plant.

The maximum amplitude of chrominance with peaks extending into the synchronising region such as red, causes maximum power loading, particularly for any stages before the lower sideband is attenuated. Significant sideband attenuation usually takes place in the anode tuning of high level modulated equipment while power levels are generally low in the double side band stages of low level modulated transmitters. Little difficulty is anticipated in this area, though some crushing of the peak power levels of colour test signals has been observed.

Cyan or yellow signals extending beyond white cause more difficulty, especially with high level modulation. The modulated valve is nearing cut-off, is then non-linear, and so requires a large voltage swing from the modulator at a high frequency. As the load the valve presents to the modulator is largely capacitive the fact that the large swing needed is at a high frequency aggravates the situation, particularly as the second harmonic of chrominance should be handled by the modulator.

Chrominance signals beyond white level will be crushed by the non-linear characteristic (typically square law) of valve linear amplifiers and modulated stages. This crushing generates second harmonics. Stretching, in compensatory pre-distortion, also generates second harmonics, which are in antiphase to those generated in the valve amplifier.

Unless the second harmonics generated in stretching are passed to the square law stage there will be a chrominance loss, of up to 6%, and a small luminance shift.

It is consequently preferable that high level modulators be capable of handling the second harmonic of chrominance, 8.86 MHz. Similarly no band limiting, either filters or amplifying stages, should occur between the pre-correcting stages and the final amplifier in either high level or low level modulated equipment.

The problems in this region near zero carrier appear the most severe to be overcome in modifying the existing high level modulated transmitters for colour operation, however considerable progress is being made.

Even if the modulator output can be set or modified to drive the modulated stage it has been found that earlier stages may then not be adequate and grid current may be encountered. This dramatically lowers the impedance at that point and can upset the operation of clamps, leading to a loss of control of power levels.

It has been possible to reduce the modulation depth at which such effects occur to some 3%. If a hard clipper (clipping all frequencies) is set to about 5% protection is provided against such effects. This clipping causes some loss of chrominance and shift of luminance. Combined with the effect due to quadrature distortion (single sideband effect assuming envelope detection) the loss and shift are only some 4% chrominance and 4 units luminance, an increase in that due to quadrature alone of less than 1% and 1 unit. In receivers using synchronous detectors quadrature effects are eliminated. There is then slightly less chrominance loss and the luminance shift is reduced to about 1%.

The total effects of quadrature, protective clipping, and loss of second harmonics generated in pre-correction, are limited to some 8% chrominance loss and 4% luminance shift. Full brightness fully saturated yellow and cyan signals are the only ones affected. When 95% saturation is considered the total effects are significantly less.

These levels are not considered serious since they are below the limits of visibility, while such signals are statistically not common. Consequently the use of protective clipping is seen as a suitable method of avoiding the problem mentioned above, while the loss of the second harmonics (generated by pre-correction) is acceptable in existing transmitters, though it should preferably be minimised in the design of new transmitters.

Intermodulation

There are rather different requirements for the various forms of intermodulation with colour signals than with monochrome, but overall they may not be much more stringent.

Non-linearity occurring after band limiting filters can cause intermodulation products to appear at 4.43 MHz (and multiples) from vision carrier and colour subcarrier. In equipment carrying both vision and sound, particularly common amplifiers, there are three fixed frequency, high amplitude signals. Intermodulation products can then occur at multiples of the difference in frequency between these three signals; viz: at multiples of 4.43 MHz. 5.5 MHz and 1.07 MHz. Due to the levels involved the out of band "colour" spurious at 4.43 MHz below vision carrier is less of a problem than the monochrome spurii 5.5 MHz from the vision and sound carriers.

Colour does however involve a maior intermodulation product 1.07 MHz from vision carrier which appears on the viewers picture. All Post Office equipments using common amplifiers were purchased against monochrome specifications which required tests equivalent to full amplitude signals (black to white) at all video frequencies. No difficulty is anticipated from this form of intermodulation as the total RF loading when modulated with maximum chrominance (single sideband) is the same as with low video frequencies (double sideband below approximately 1 MHz).

MEASURING AND MONITORING

Instruments

It can be seen from the above that most of the effects on colour performance can be related directly to various forms of waveform distortion. Consequently for colour the waveform monitor remains the most useful general purpose tool.

The phase considerations of colour however are not examined in a waveform monitor. Some special measuring instruments then need to be considered.

The one vital need, which cannot be covered by other means, is for an instrument to measure relative phases, particularly differential phase and chrominance phase non-linearity.

The method of measurement used is to employ a product detector with the 4.43 MHz chrominance signal multiplied by 4.43 MHz from a local oscillator. If the two signals are fed to the detector at 90° to one another the detector output is zero. Any output indicates a phase shift from the 90°. This output can be calibrated in terms of phase. However, when the phase is not 90° the detector also responds to amplitude variations. The most accurate method of phase measurement is to use a calibrated phase shifter, and shift the phase to the null (90°) at every level. The change in phase with level is then read from the phase shifter.

The same type of device can also be used to measure the phase difference between burst and test signals to check on the phase accuracy of any regenerated burst. A large phase shift needs to be included for this purpose, the test signals being at 60° to the (B-Y) axis.

When the chrominance signal and the local oscillator are in phase at the product detector the output is in direct proportion to variations in the amplitude of the chrominance signal. The one device may then be used for chrominance amplitude measurement as well as phase.

As with monochrome not all degradations will be picked up from routine waveform measurement alone, an obvious example being intermittent effects. Some of these, such as a poor connection causing detection, can well affect colour more than monochrome. Consequently the final reference must be a colour monitor, and visual monitoring to find the source of some complaints remains necessary for colour.

Monitors and Receivers

There are two basic types of colour picture tube in use; the shadow mask tube and the trinitron. The shadow mask tube provides good resolution but is generally only available in larger sizes (above 43 cm). The trinitron has high brightness and is easier to adjust, but has the colour in vertical stripes which can be rather disturbing and it is generally only available in smaller sizes.

It may be noted that a vector display device has not been mentioned above. This is because it is seen to have little application to Post Office operations, though it is undoubtedly an excellent display for teaching the fundamental principles of the sub-carrier modulation used in colour television.

There is one other specifically colour measuring instrument which, while not essential, is a great aid to speed and accuracy. This is the chrominance/luminance gain and delay inequality measuring instrument. This instrument is used to introduce calibrated inequalities until the 20T (or 10T) baseline is flat. The distortion is then read directly.

These inequalities can be calculated from the baseline ripple by means of a nomogram, such as the one shown in Fig. 4. This is however rather slow and inaccurate. Error is also a significant possibility as a change from 20T to 10T requires a 2:1 change in nomogram calibration. The use of a calibrated instrument for this purpose is consequently preferred.

With increasing programme hours, time becomes a scarce commodity, especially time for routine testing. Colour aggravates this situation with the extra parameters to be kept under control. The use of vertical interval testing to permit objective measurement during programme was seen as advantageous to monochrome operations. It appears to be almost essential if adequate performance is to be maintained for colour operation.

Colour demodulation involves more stringent constraints on measuring, monitoring, and relay receivers than does monochrome. These receivers need to be accurate enough to permit measurement of some colour parameters, and monitoring and relaying of all.

The most difficult factors to control seem to be:

- The need for extremely precise control of the vision carrier position on the Nyquist (vestigial sideband) slope to maintain chrominance/luminance gain inequality.
- Control of delay near the cut-off region.
- Achieving very low differential gain and phase.

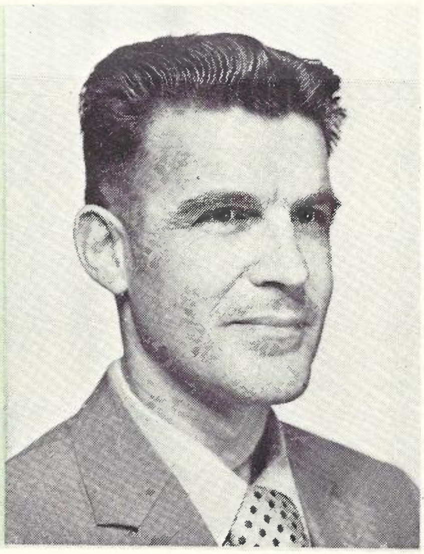
Up to date no manufacturer has been able to supply receivers which permit accurate measurement of chrominance/luminance gain inequality or differential gain. At present measurement of gain inequality using a simple wideband diode detector is preferable, while for acceptance test purposes differential gain can either be measured directly at RF, or the receiver calibrated and allowance made for its response.

CONCLUSION

Colour television brings in a range of new effects which did not influence monochrome television. Some new methods of testing to cope with these effects are being introduced.

Much of the equipment which the Post Office operates will be able to handle colour signals directly. There are however some areas where replacement or modification will be required. Other areas need further investigation before the significance of some factors is adequately known and before some modifications which may be needed can be finalised.

G. E. HATFIELD received his B.E.E. from Melbourne University in 1957 and his M.S.E.E. from the University of California, Berkeley, in 1967, for theoretical studies of TV modulation. He has been associated with all aspects of TV transmission and broadcasting almost since the introduction of television into Australia. Through 1967/68 and in 1970 he investigated colour television systems, operations, production and transmission in the USA, Canada, UK, Europe and Japan. He was closely associated with preparing the programmes for evaluating and converting the Post Office transmitting plant, arranged for new schedules and specifications covering colour requirements and represented the Post Office on the Industry Colour Steering Committee and on a number of working parties.



Introduction of Seven Digit Numbering in the Adelaide Telephone District

K. M. BARSCH, B.E. and L.A.M. VOLSKULEN, B.E.

On 30th September 1973, seven digit numbering was introduced for about 60 percent of the subscribers of the Adelaide Telephone District and its area code was changed from 082 to 08.

The article outlines the network planning and philosophies involved in the change, including the arrangements which allowed most calls to mature for a time when changed numbers were incorrectly dialled on previous six digit codes. The article also covers the methods used to minimise work in exchanges, and testing and commissioning procedures.

INTRODUCTION

A full national number is composed of an area code plus a subscriber's directory number and area codes 082, 083 and 084 were allocated for the Adelaide Telephone District, use being made initially of 082 for Subscriber Trunk Dialling (STD) to Adelaide. The recent change of many thousands of six digit subscribers' numbers to seven digits was achieved by changing the area code from 082 to 08 and using the previous third digit of the allotted area codes, i.e. 2, 3 and 4, as the first digits of the majority of subscribers' directory numbers. Digits 2 and 3 were used to prefix approximately 118,000 six digit numbers thus converting them to seven digits. Some thousands of six digit numbers, mainly in step exchanges, commencing with digit 4 were left unchanged without any need for special arrangements. However, it was also decided to leave some numbers commencing with 50, 51, 62, 71, 74, 79 and 87 unchanged. As the area code 08 plus any of these numbers appeared the same as 085, 086 087 and 088 allocated to South Australian country areas, special arrangements, to be discussed later, were necessary. In all some 86,000 six digit numbers were retained.

The timing of the change for the majority of numbers to seven digits was based on development trends with allowance made for interception of former six digit codes. The capacity of the six digit Adelaide network would have been exceeded by 1976/77, requiring seven digit introduction no later than the issue of the August 1975 telephone directory. The change, coincident with the 1973 directory, was influenced by the provision of a 10C Stored Program Controlled (SPC) trunk exchange in Adelaide in 1974/75. It was considered less disruptive to make the seven digit number change before the SPC exchange was commissioned, rather than be faced with reprogramming within the following year.

USE OF AREA CODE 08 AND 6 DIGIT NUMBERS

The new area code 08 followed by six digit subscribers' numbers commencing with 4 presented no problem as 084 was already allocated to Adelaide. However, as some six digit numbers commence with 51, 50, 62, 71, 74, 79 and 87, these, when prefixed with the area code 08, appear to have the area codes 085, 086, 087 and 088 allocated to country areas in South Australia. In these areas the equipmemnt is normally arranged to analyse the first of the dialled digits to determine the routing of the call. For example, in the Mt. Gambier exchange, first digit 2 would indicate a local call. However, as it is legitimate for local calls to be prefixed with their national area code, a Mt. Gambier caller could prefix local number 25 xxxx with the local area code 087. The equipment would normally delete 087 and route the call locally as indicated by the next digit 2. With this arrangement, the Mt. Gambier equipment would handle calls to Unley, (Adelaide) six digit numbers 08 74 xxxx by deleting 087 and analysing digit 4 which would indicate that the call should be connected to Unley. Although this method of analysis would route correctly dialled calls to the required destinations, it would unfortunately leave the possibility for Mt. Gambier subscribers to call Unley six digit (74 xxxx) numbers if wrong five digit numbers 4 xxxx were dialled. Country registers were therefore modified and analysis rearranged so that the digit after the area code was examined before a decision was made whether to delete this code or not. In Mt. Gambier code 4 was connected to NU tone. Similar arrangements were made in other country areas with area codes 085, 086 and 088 where incorrect calling could occur. Primarily for this reason and also to avoid other trunking anomalies, considerable rearrangements were necessary in many country exchanges.

CONCEPT OF DUAL TRUNKING

The total work in the project was estimated to be about 100,000 manhours. To allow the work to be scheduled efficiently and to avoid a massive cutover on one day, it was decided to develop the network so that, where possible, calls to new seven digit and previous six digit numbers would mature for a time. A foremost consideration was that of causing least disruption to subscribers, who would only be forced to use the new seven digit numbers as dual arrangements were progressively removed. This phase of the project was controlled to match subscriber acceptance of the exclusive seven digit codes and permitted interception facilities to be provided gradually as the dual facilities were removed.

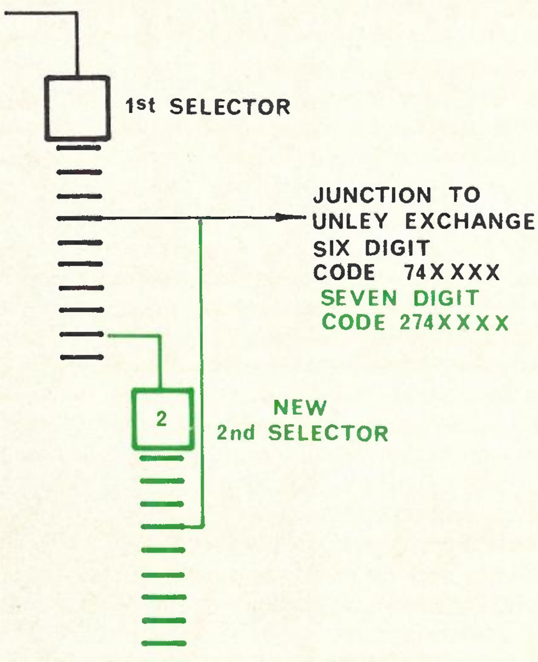


Fig. 1 — Dual Trunking in Step Exchanges

Subscribers, apart from dialling the correct area code 08, followed by the correct subscribers' directory numbers, could dial three incorrect combinations:

082 + old subscribers' numbers
082 + new subscribers' numbers
08 + old subscribers' numbers

The Adelaide ARM trunk exchange was therefore rearranged so that, wherever possible, a caller was directed to the wanted subscriber. Later, when the wrong code combinations were disallowed, the callers were connected to recorded announcements.

Dual arrangements, made in all metropolitan crossbar exchanges, consisted of changing the analysis of the registers and markers so that calls dialled to new seven digit and old six digit calls would mature.

The facility for allowing either new seven digit or old six digit codes to mature when dialled from the metropolitan step network, was provided by grading levels of newly provided second selectors to junctions served by the preceding first selectors as in Fig. 1.

However dual trunking could not be provided from the step network to four exchanges with six digit numbers commencing with either a 2 or a 3 which are the new seven digit prefixes.

CHANGES IN CROSSBAR EXCHANGES

In a crossbar telephone exchange the digits dialled by subscribers are stored in a register on a crossbar switch. A certain amount of network intelligence is wired into the register to control its operation dependent on the digits stored in it. The registers communicate with the other switching stages in a Multi Frequency signalling Code (MFC) to transfer the stored digits into analysers (markers). These analysers are programmed by hardwired logic on plug-in terminal blocks to control the route selection and the transmission of control signals.

To enable both old six digit and new seven digit subscribers' numbers to be processed, both the register logic and the analyser logic had to be rewired. Later the analyser blocks were rewired again to re-route the now incorrect six digit codes to recorded announcements Nos. 11 or 12 in a Tandem exchange (See Interception Arrangements).

Documentation

There are two types of analyser in the APO crossbar system, the large 2/160 GV metropolitan marker and the smaller 1/80 GV marker, each using different types of analysis logic.

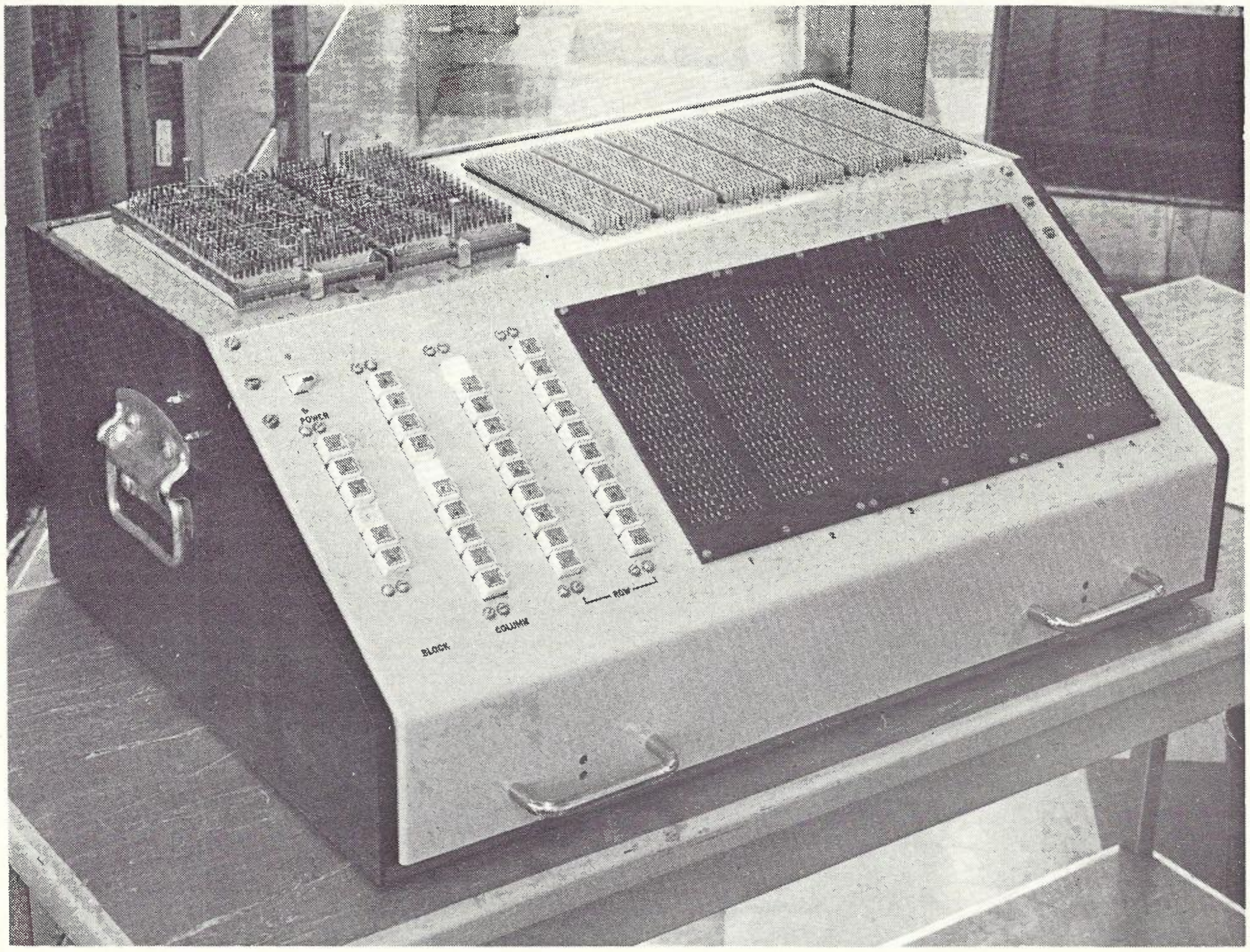


Fig. 2 — Crossbar Analyser K Block Wiring Tester

However both are programmed by wiring on plug-in terminal blocks. The design of the logic wiring for these blocks is tedious and exacting, and a computer program was used to design the wiring details for the analysis blocks of the 2/160 GV marker from basic routing and network code data. The wiring details for the 1/80 marker were still prepared manually, as they would have been far more difficult to computerise.

Two complete sets of data were prepared for each exchange; one for the dual routing phase, and the other for the final configuration.

Changes to Register Wiring

The register logic is hardwired on the back of a crossbar switch and new standard wiring forms were produced for all 900 metropolitan registers. Two forms were wired so that one could be lifted out after the old six digit codes had been phased out. The forms contained all the analysis which is common to all the metropolitan registers, and only a small amount of wiring had to be added in a third form to cater for the local exchange codes. The registers were all rewired in about 12 months, commencing July 1972.

Rewiring Analyser Blocks

Whereas most of the work was carried out on registers in their exchanges, the rewiring of the analysis blocks was done at one site using spare blocks which were then held, ready to be plugged into the equipment at various exchanges at a convenient time. To minimise faults in the wiring of the blocks, and hence reduce the testing time after insertion into the analysers, a special tester was developed. (See Fig. 2).

The tester displays, with light emitting diodes, those terminals on the blocks which are wired to any one selected terminal. Hence any omissions or extra connections are readily detected.

Implementation of Dual Routing.

Early in 1973 rewired blocks were inserted in metropolitan tandem exchanges so that they could handle seven digit traffic. Then the terminal exchanges were converted to dual working in four months ending July 1973.

The method employed to changeover blocks was:

- During quiet traffic, one set of analysis equipment was withdrawn from service and the analyser blocks were exchanged with the new ones.
- The equipment was then functionally checked, using an exchange tester, for every six digit network code that was wired on the blocks for analysis. The equipment was then placed back into service and the seven digit codes were tested.
- The other sets of analysing equipment were then converted one by one.

When all exchanges had been converted to dual analysis the complete crossbar network was ready for overall network testing.

CHANGES IN STEP EXCHANGES

Unlike the crossbar network, the step network could not be completely dual trunked before the official changeover day. Arrangements were made in each step main exchange to dual-trunk several of the exchange codes and also to prepare for the remainder to be changed from six digits only to seven digits only on 30th September, 1973.

Dual Trunking Arrangements

As the seven digit prefixes are 2 and 3, arrangements were made to introduce second selectors code 2 and second selectors code 3 into each step main exchange and dual trunk, wherever possible, the new second selector levels to the existing levels of the previous rank of first selectors. This would have been a straight-forward exercise if levels 2 and 3 of the first selectors were not in use. However code 2 was in use for a city crossbar exchange (Flinders) and code 3 was also used in three eastern subscribers' exchanges (Norwood, Paradise and Stirling), Norwood being the code 3 main exchange.

It was decided to provide dual trunking for step exchanges to possible new code 2 seven digit numbers some months before September 30th but dual trunking could only be provided for code 3 seven digit numbers on 30th September.

Code 2 Arrangements

Fig. 3 indicates the previous trunking of the six digit network, the colour showing the arrangements which were made to give dual trunking on code 2 seven digit numbers before the official changeover day.

Where originally (as indicated in black) the Flinders exchange codes 23 and 28 were obtained from the step network on one junction group code 2, before 30th September two junction groups on codes 23 and 28 were provided from the newly introduced code 2 second selectors.

As Flinders is a crossbar exchange, digits 3 and 8 lost in the step selectors were reinserted by incoming registers at Flinders.

The above arrangement provided dual trunking on codes 5 and 25, 6 and 26, 7 and 27, 9 and 29.

Code 3 Arrangements

Special second selectors code 3 were installed, and dual trunking arrangements were prepared at step main exchanges for levels 8 and 38, 5 and 35 but the code 3 second selectors were not brought into service until 30th September because of numbering difficulties involving Norwood main step exchange.

NETWORK TESTING

When the crossbar network was ready, and the dual trunking that could be done in the step network had been completed, the network was tested.

The Traffic Route Testers (TRTs) in the exchanges were set up to automatically dial 100 calls in succession into test call answering relay sets on seven digit numbers in other exchanges. The test programmes were conducted in conjunction with the normal network TRT tests to compare the seven digit performance of the network with its six digit performance.

CUTOVER OF STEP NETWORK

Rearrangements of Code 2, Second Selectors.

Prior to 30th September, Flinders was available from the step network on a six digit only basis on codes 23 and 28 and each step main exchange had two separate routes to Flinders (See Fig. 3). The cutover consisted of uniting these two routes to form the route for the new seven digit code 22 which was previously connected to recorded announcement No 13 (See Interception Arrangements).

The levels for six digit codes 23 and 28 were provided with recorded announcement No 11 which told step subscribers who called these old six digit codes to prefix the number previously dialled with a 2. As the united route was established, the special arrangements at the Flinders crossbar exchange to insert either a 3 or an 8 were withdrawn.

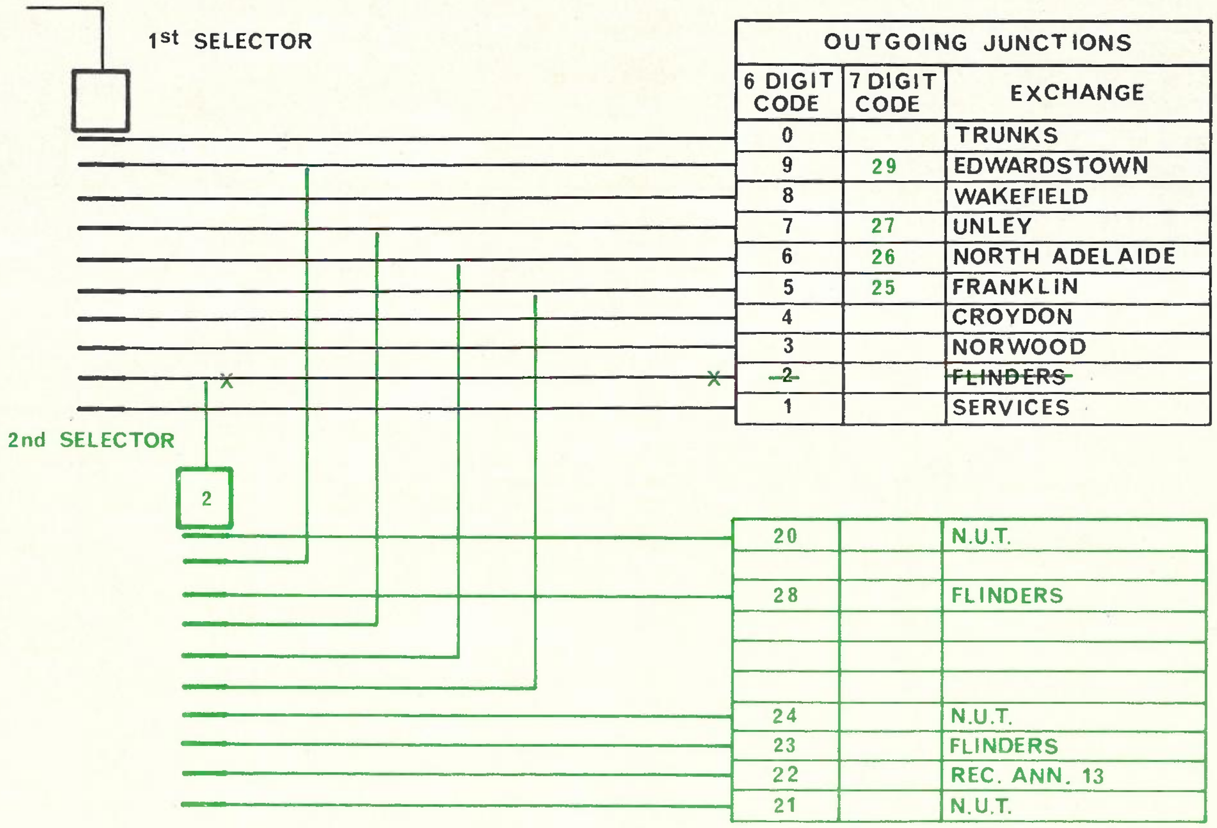


Fig. 3 — Dual Trunking in Main Exchanges before the Official Changeover Day

New Code 3 Second Selectors

Level 3 of the first selectors in the step main exchanges was graded through to the new rank of code 3 second selectors (See Fig. 4). Where previously there was one junction group from each step main exchange to Norwood on code 3, at cutover three routes were provided. These were from levels 31, 33 and 30. Exchanges on codes 31 and 30 remained six digit but those exchanges previously coded, 32, 37 and 39 were changed to 7 digit only, on codes 332, 337 and 339. Calls to these exchanges were trunked via the single 33 route to Norwood with further discrimination taking place at the Norwood step main exchange.

As levels 332, 337 and 339 became exclusively seven digit, the old six digit levels 32, 37 and 39 were provided with recorded announcement No. 12 which told subscribers to prefix the number previously dialled with a 3.

As the new code 3 selectors were commissioned, previous six digit numbers code 8 in 28 outer metro exchanges were available to the step network on a dual trunked basis as were two previous code 5 exchanges which became seven digit on code 35.

The old trunking arrangements are indicated in Fig. 4 in black, with the colour showing the rearrangements made on 30th September for code 3 exchanges.

Internal rearrangements had to be made at Norwood step main exchange on 30th September to allow Norwood step subscribers and the Summertown and Montacute exchanges to retain their six digit 31 and 30 codes. The changes are indicated on Fig. 4.

INTERCEPTION ARRANGEMENTS

Recorded Announcements

In Figs. 3 and 4 reference is made to recorded announcements by numbers. The full text of each announcement is as follows:

No. 11. "This is a Post Office Recording. The number you are calling has been changed. Dial two followed by the number you previously called. The new number appears in the 1973 Adelaide Telephone Directory."

No. 12. "This is a Post Office Recording. The num-

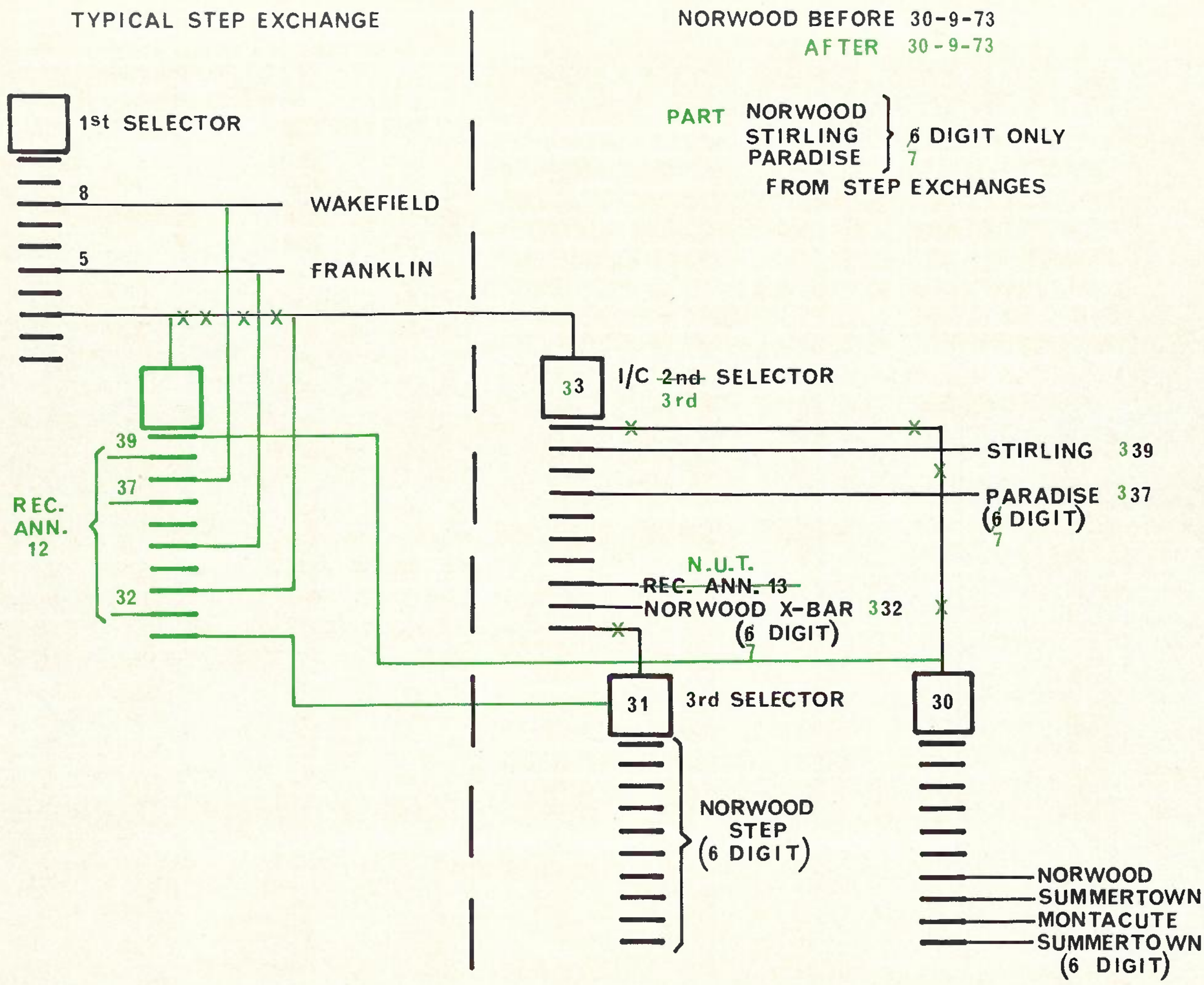


Fig. 4 — Changes in Step Main Exchanges and Norwood Code 3 Exchange on the Official Changeover Day

ber you are calling has been changed. Dial three followed by the number you previously called. The new number appears in the 1973 Adelaide Telephone Directory."

No. 13. "This is a Post Office Recording. The Adelaide Number you are calling has not yet been changed. Please use the number listed in the 1972 Adelaide Telephone Directory until Sunday 30th September".

No. 14. "This a Post Office Recording. Most Adelaide Telephone Numbers have been changed. The new numbers are listed in the 1973 Adelaide Telephone Directory".

No. 15. "This is a Post Office Recording. The new Adelaide S.T.D. area code is 08. Most Adelaide Telephone Numbers have been changed. Please refer to the 1973 Adelaide Telephone Directory or your Directory Assistance Operator".

As many Adelaide Telephone Directories were distributed before 30th September, some subscribers could dial new seven digit numbers before the due date. In fact crossbar subscribers had full seven digit dialling capability, as all crossbar dual routing arrangements were completed before the first of the directories was delivered. In the step network, where some seven digit codes were not available before the due date, call attempts to unconnected seven digit codes were directed to recorded announcement 13. Recorded announcements 11 and 12 were introduced at step exchanges on 30th September on the codes that were changed to seven digit exclusively, and introduced later to other step selector levels and crossbar tandem exchanges as dual trunking arrangements were progressively removed. Recorded announcement 15 was used in the Adelaide ARM trunk exchange. Care was taken that STD calls could not reach announcements 11 and 12 as the caller would not know whether to prefix the STD code or the subscriber's directory number by the nominated digit.

SUBSCRIBER IMPLICATIONS

Publicity, arranged by the Telecommunications Division, prepared subscribers for the number change. A survey conducted in Adelaide one week after the change indicated that 97% of subscribers were aware of the seven digit change. On the actual changeover day, when step subscribers were forced to dial new seven digit codes for calls to mature in four metropolitan exchanges, there was no noticeable increase in calls to manual service positions. The same situation prevailed during the general removal of six digit alternative codes in the following weeks. Subscribers realised that there was a change and either dialled correct seven digit numbers or dialled the extra digit when instructed to do so by recorded announcements on the old six digit numbers.

CONCLUSION

This project, which changed 118,000 subscribers numbers in 51 exchanges and involved substantial alterations to working equipment in 140 exchanges, was successfully completed as scheduled with very little inconvenience to subscribers.

The numbering capacity of the Adelaide Telephone District has now been extended to cater for subscriber growth until beyond the turn of the century without any further major change.

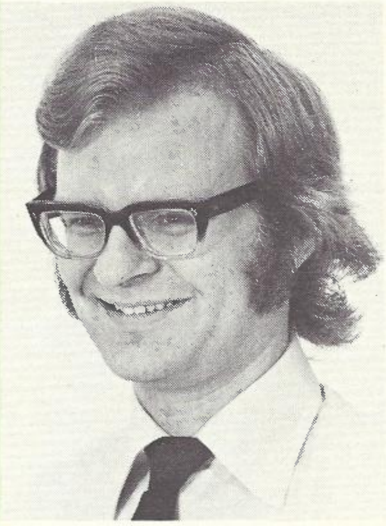
K. M. BARTSCH joined the Postmaster–General's Department as a Technician in training in 1947. He was appointed Cadet Engineer in 1953 and completed his degree of Bachelor of Engineering in 1957.

From 1957 to 1967 Mr. Bartsch was employed in Long Line and Country Installation Sub-Sections, where his projects included the provision of the first 12 Channel System from Adelaide to Darwin, which used transistorised pole-mounted repeaters, and the commissioning of the first ARK 521 telephone exchange in Australia at Gladstone in South Australia.

Following two years of experience in network dimensioning in the Traffic Engineering Sub-Section of the Planning Branch in South Australia, Mr. Bartsch was promoted in 1969 to Divisional Engineer, Metropolitan Exchange Installation Sub-Section. Since the restructuring of the Engineering Division, he has continued as Senior Engineer in the Metropolitan Installation Section, where the metropolitan portion of the conversion of the Adelaide Telephone District to seven digit numbering was under his control.

L.A.M. VOSKULEN joined the Postmaster-General's Department as a Cadet Engineer in 1969. After completing the degree of Bachelor of Engineering (Electrical) at the University of Adelaide in 1970, he was employed as an Engineer Class 1 in the Metropolitan Services and Installation Section where he assisted the Circuit Standards Engineer for some months before being transferred to the Metropolitan Exchange Installation Sub-Section.

Mr Voskulen has been closely involved in the installation of Service Assessment equipment in Adelaide, and especially in the trial of the prototype S.T.D. Serivce Assessment for Central Office. He also played a major role in the conversion of Adelaide crossbar telephone exchanges for the change to seven digit numbering and the development of the computer program which was extensively used in this conversion.



Application of Computers to the Planning of Telecommunications in the APO

M.W. SLADE, B.E. (Elec.), M.I.E. Aust., M.I.E.E. and J. N. BRIDGFORD, B.E.E.

In the early 1960's it was the practice of the Traffic Engineering Division, Victoria, to manually produce a Junction Provisioning Statement (JPS) for the network which was used for the planning of switching and external plant equipment. However, the manpower required to produce the JPS was becoming far too demanding and so delays in issue were unavoidably long. During 1964/65 work was commenced upon a suite of computer programs to allow automatic production of the JPS.

As the project developed it was realised that because of the speed of the computer, the design process could be extended into the external plant areas to incorporate junction design and statistical analysis of quantities, transmission and costs.

The flexibility built into the computer programs allows alternative telephone networks to be designed and so the MENDAP system may be used also as a forward planning tool.

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INTRODUCTION

Over the last decade the Australian Post Office (APO) has applied computers to a wide range of its activities and right from the outset these have included applications within the telecommunications network planning and dimensioning area. Throughout this period the network planning area has become recognized as one of the most important areas for computer application. In 1968 a high level group studying the potential for computer use throughout the APO highlighted the relative importance of this type of application when it reported that "the high capital intensity of telecommunications, the extreme complexity of the networks and the variety of possible network solutions make planning a prime candidate for profitable computer application".

Accordingly many individual computer programmes and systems of programmes have been developed to assist in the work of planning the telecommunications network. One such system was developed for studying the implications of introducing a new type of switching equipment into large metropolitan telephone networks. The new equipment enabled a far more flexible, multiple alternate routing of telephone traffic and the type of network configuration needed to take full advantage of these new facilities was largely unknown. The computer system developed provided the means for dimensioning a total network for each of a wide range of proposed configurations thus assisting in the formulation of network planning policies. This work was reported in a paper to the Fourth International Teletraffic Congress of 1964 (Ref. 1).

Many allied applications have been developed since then and in order to give an illustration of the current use of computers in network planning within the APO this paper will describe one of the more recent, larger types of computer systems being used. The system to be described was developed in one of the Australian state administrations (of which there are six and distinct from the central, co-ordinating, headquarters administration) to dimension and analyze large metropolitan telephone networks. Since the system was primarily developed for application to a particular state capital city (Melbourne) network, it has been called the "Melbourne network dimensioning and analysis programmes" (MENDAP) system. This approach has imposed some limitations on the wider, more generalized use of the system, but it does not mean that its usefulness is confined only to analysis of the Melbourne network. In fact the system was developed with the broader use in mind and its applications to other Australian metropolitan networks is at present being studied.

Before proceeding with a description of the MENDAP system itself, a brief description of the Melbourne telephone network will give some background to the project.

The Melbourne telephone zone, including the extended local service area (ELSA) zones, covers an area with a radius of 40 km which currently embraces a network of 153 exchange areas with more than 680 000 telephone services catering for an urban population of approximately 2 400 000. Based on a long-term demographic forecast made in 1965, it is expected that by the year 2015 it will provide approximately 2 500 000 telephone services for a population of 7 200 000.

The telephone network at present consists of a step-by-step (SxS) network developed over a period of some 45 years extended and overlayed by a crossbar (X-bar) network of which the initial installations were introduced approximately 10 years ago. At present approximately 50% of traffic is routed by X-bar equipment. This equipment is capable of testing several alternative paths when routing a telephone call. As illustrated in Fig. 3, X-bar origins may use a direct route to a destination if economically justified. If all circuits on the route are busy, then traffic will overflow to a second choice route at the end of which is a "Y" tandem stage. This "Y" stage serves an area of destination exchanges and switches terminating traffic, other than direct route traffic, to those exchanges. If the route from the origin to these "Y" stages is busy, then traffic is allowed to overflow to a final choice route at the end of which is an "X" tandem stage. This "X" stage serves an area of originating exchanges and switches last choice originating traffic from crossbar origins. The "X" stages in the network may switch directly to destinations if economically justified. If this route is busy, traffic is overflowed to the appropriate "Y" stage of the destination. Overflow traffic off "X" to "Y" routes stages is routed to a "superior" tandem exchange.

The connection between exchanges within the network is provided by junction cables installed in a combination of radial routes emanating from the central, city area (built up to meet requirements of the older fully SxS switched network) and cross country tangential routes which are being increased to meet the demands of the alternate routing facility of the X-bar equipment.

THE MENDAP SYSTEM

Basically the MENDAP suite of programmes is concerned with calculating for metropolitan telephone networks, the number and disposition of circuits and inter-exchange junction cables needed to carry specified exchange-to-exchange traffics. The system has been developed with two broad objectives in mind:

- To provide middle level management, e.g. professional engineering staff, with a network "modelling" tool giving general statistical type information and summations of detailed data to assist in planning the overall orderly and economic growth of the telephone network;
- To provide the lower levels of management e.g. sub-professional staff, with detailed short-term information for their day-to-day work requirements.

MENDAP is primarily concerned with the design of the outgoing and incoming switching equipment within exchanges and the junction cables that connect them. It is not concerned with the provision of miscellaneous circuits (e.g. private lines, data lines, etc.) that are also present in the junction cables, the design and provision of subscribers equipment within the exchange, or the cable connecting the subscribers telephone equipment to the exchange.

All the design procedures are based on average unit costs expressed as annual charges incorporating capital recovery and maintenance costs.

Fig. 1 is a block diagram of the design processes used in MENDAP. The following description of the design procedure refers to the block numbers of Fig. 1.

Manual Preparation of Data

The following types of data are required as input to the design process:

- Subscriber development figures, obtained from the results of subscriber surveys and extrapolation of past growths;
- Dispersion of traffic out of exchanges, obtained from latest traffic or call dispersion readings undertaken by engineering staff;
- The junction cable network specified as the cable links connecting the exchanges and the availability of conductor gauges on those links;
- The cost of equipment, specified as an annual charge and covering:
  - — capital recovery based on the life of the equipment,
  - — maintenance costs,
  - — allowance for building space,
  - — cost of installation;
- Types of switching equipment installed or proposed to be installed;
- Decisions on the principles governing the methods of routing between exchanges.

Automatic Check of Data

A typical MENDAP run requires approximately 2200 input cards, each containing an average of 8 numbers. Naturally the accuracy of the output (and indeed the successful operation of individual programmes) requires the data to be not only extremely accurate but also to be logically compatible, e.g. if an exchange is shown as having traffic originating from it, then naturally the exchange must be shown as having outgoing switching equipment. As many thousands of these cross checks are required, they are performed using the computer.

Preparation of the Point-to-point Traffic Matrix

The MENDAP system processes require the assembly of exchange to exchange traffics in matrix form. This matrix is constructed by reading in from cards the traffic dispersion for each outgoing equipment type from each exchange (there may be both SxS and X-bar equipment at the one exchange), the number of subscribers at the exchange and the exchange average subscribers "traffic rate". The total of the dispersed traffics is balanced against the total traffic obtained from the product of subscriber's traffic rate and the number of subscribers. This balanced matrix is then stored on magnetic tape

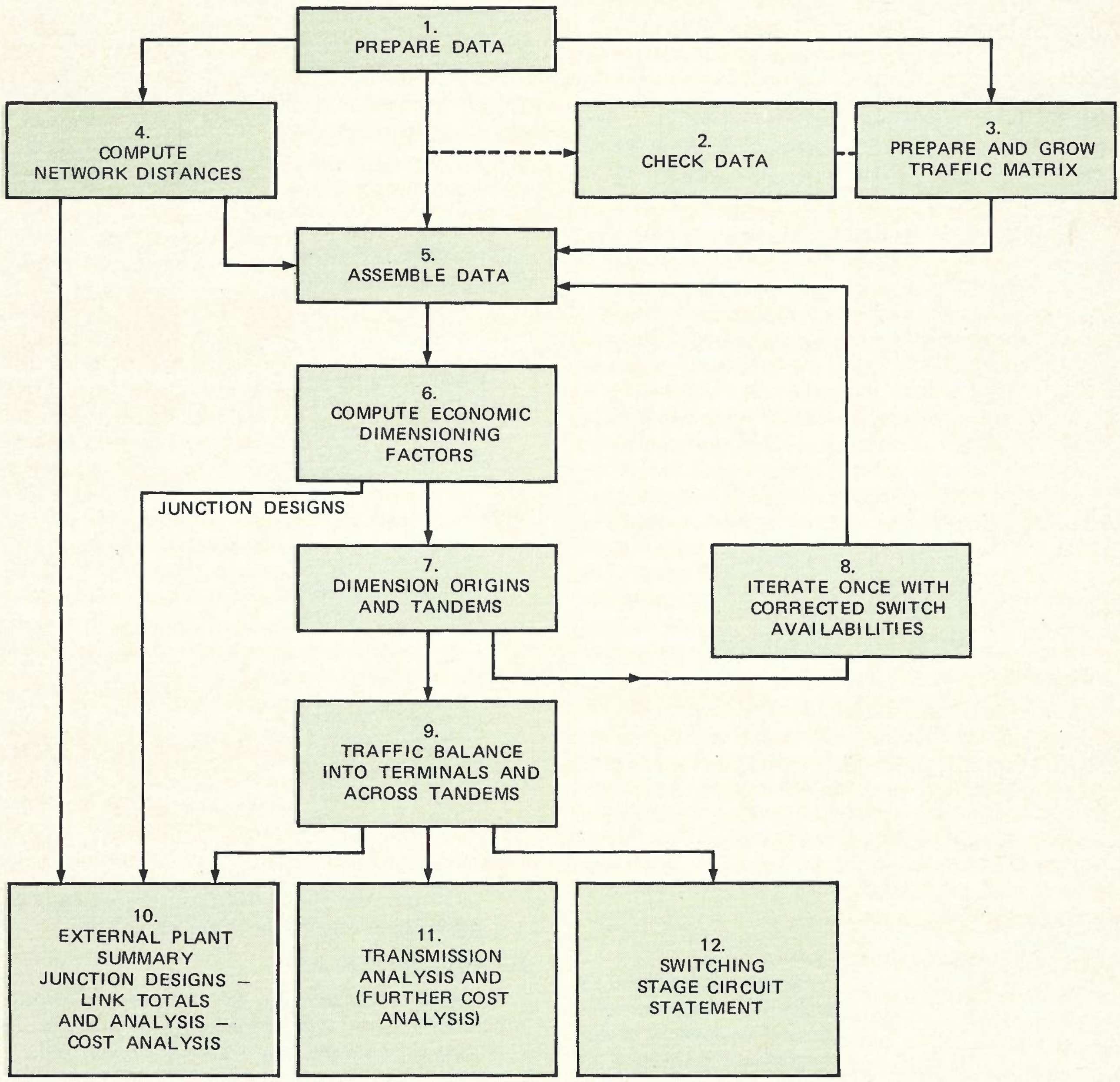


Fig. 1—MENDAP Design Procedure.

and used as a "base year" matrix. The matrix programme can be used to develop matrices for future dates by extrapolating the base year matrix, by modifying exchange subscriber areas (cutovers), growing the number of subscribers to the future date and then re-balancing the new matrix. All such matrices are stored on magnetic tape.

Computation of Network Distances

This programme calculates the minimum distances between all exchange locations using the cable links as read-in as data. Cable links are specified as either "bypass" or "non-bypass" links. Fig. 2 shows an example of a path between two exchanges A and B using bypass and non-bypass links via intermediate exchanges.

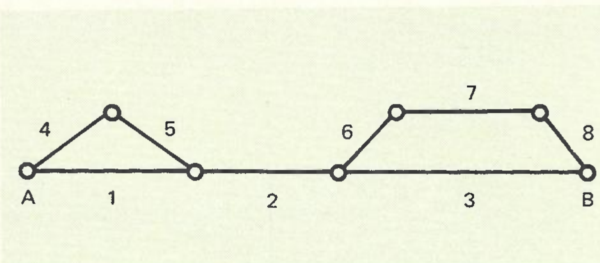


Fig. 2—Bypass and Non-bypass Link Configuration.

Links 1 and 3 are bypass links and links 2, 4, 5, 6, 7 and 8 are non-bypass links. Information on all combinations of bypass and non-bypass routing is passed direct to block 10 (Fig. 1) where detailed comparisons are made and optimum arrangements chosen. A shortest distance matrix, including only bypass links alternatives, is passed onto the data assembling programme.

Assembly of Data

This programme basically assembles all data required for later processing in origin exchange order. It combines the traffic and minimum distance routing information produced from blocks 3 and 4 with other information read direct from card input. The latter data includes details of origin and tandem exchange routing, equipment costs and switching stage availabilities (i.e. the total number of switching stage outlets available for assigning to outgoing routes). This programme also assembles the total traffic terminating at each exchange for use in checking traffic balances following the dimensioning stage (see block 7 described below).

Computation of Economic Dimensioning Factors

The X-bar switching equipment in the Melbourne network exchanges has alternative routing capabilities, i.e. it can offer traffic to a direct high usage (1st choice) route and if no circuits are available on this route the equipment will offer the traffic to 2nd and 3rd choice routes until it can be served. To calculate the optimum disposition of circuits on all these various routes is a complex task and is influenced by the relative circuit costs of the routes. Fig. 3 illustrates the general alternative routing pattern for a X-bar origin and shows the economic dimensioning equations required to be solved to determine circuit quantities. The variables $H1$, $H2$, $H3$, etc., are called the economic dimensioning factors. (The definitions of the various parameters and the theory behind the equations are given in Ref. 2). The programmes in this block process the assembled data, determine the appropriate type and pattern of routing and calculate the economic dimensioning factors for each origin—destination combination. The following details are assembled and derived for each combination:

- The traffic offered;
- Whether the route is a high usage, 1st choice route;
- Identification of the 2nd and final choice route backup for each high usage route;
- Definition of alternative routing pattern type;
- The economic dimensioning factor and circuit costs for each high usage route.

To calculate the cost components of the economic equations it is necessary to determine the junction design limits (i.e. transmission limit, short and long-distance signalling limits) and actually perform approximate junction cable designs. The design limits are passed onto the programmes of block 10 where more detailed and accurate cable designs are subsequently carried out. The effect on the accuracy of the economic equations of the differences between the approximate designs used and the later more accurate design have not been sufficient in practice to require an iteration of these calculations.

Dimensioning of all Origins and Tandems

Knowing the traffics offered and the economic dimensioning factor values enables the circuit quantities to be calculated. The programmes of block 7 determine the required numbers of circuits out of all originating exchanges and tandems. The dimensioning process used for X-bar alternative routing calculations is based on the geometric group concept described in ref. 3. Part of the process is directed at optimizing the allocation of switching stage availabilities (switching stage outlets) to the various outgoing routes. The programmes do this by initially allocating availabilities to routes according to the level of traffic and the type of route (i.e. whether or not high usage). If the total initial availability exceeds the total availability of the switching stage, the cost penalty incurred, for each route, in reducing availability is calculated. Availabilities on those routes with the least cost penalty are accordingly reduced until the total availability is less than the switching stage total availability.

Iteration of Programmes in Blocks 5, 6 and 7

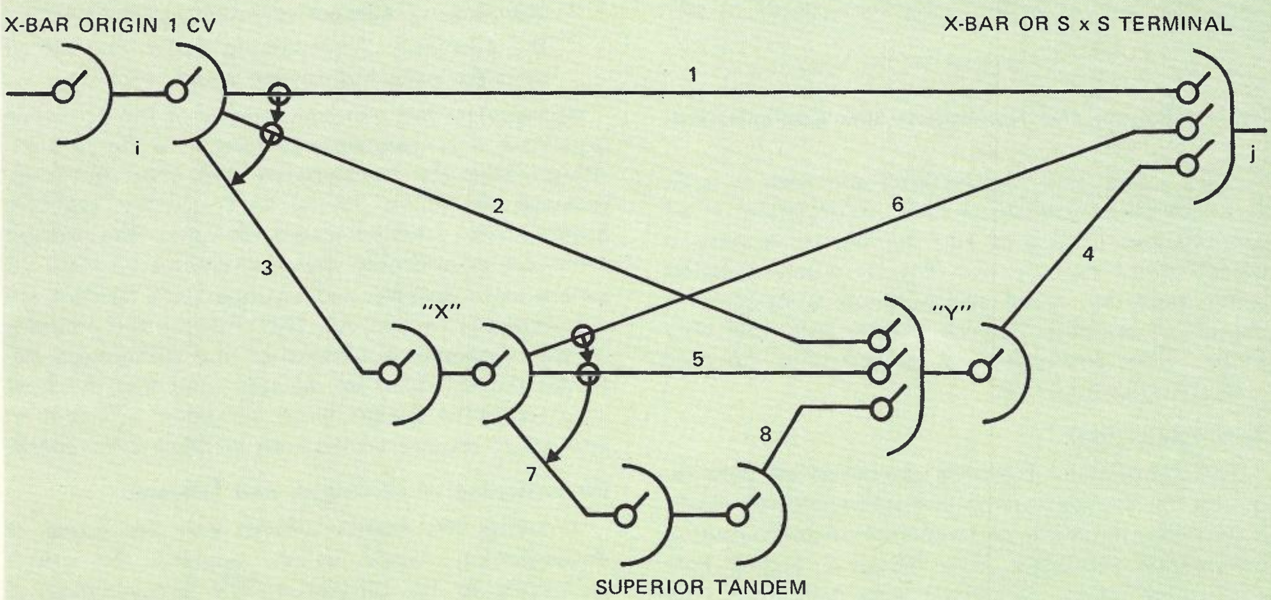
The economic dimensioning equations used in the programmes in block 6 use an approximate availability allocation made at the time of data assembly (block 5). As the availabilities more accurately allocated by the programmes in block 7 may be different from those initially assumed, an adjustment of the availabilities in the input data is required and an iteration of the programmes in blocks 5, 6 and 7 performed. It has been found that sufficient accuracy is obtained with a single iteration.

Traffic Balance Check

To check on the accuracy of manually prepared input data and programme execution, it is necessary to compare the total traffic arriving at a destination exchange after detailed dimensioning is completed with the total traffic to the exchange as produced from the programme in block 5. The traffic in and out of each tandem exchange is also compared. The need to check on programme execution is due to the size and complexity of the network being handled since decisions can be made by the person preparing the input data which invalidate elements of programme logic and may bypass the built-in error detectors.

External Plant Phase

The accumulated numbers of circuits on the various junction routes produced by the above processes are input to a programme which determines, from the shortest distances data set produced by the programme in block 4, the actual physical cable links needed to make up the junction.



"H" VALUE EQUATIONS

$$\frac{C1}{H1} = \gamma 2 \frac{C2}{H2} + \frac{C4}{\beta 4}$$

$$\frac{C2}{H2} = \frac{C3}{\beta 3} + \gamma 6 \frac{C6}{H6} - \frac{C4}{\beta 4}$$

$$\frac{C6}{H6} = \gamma 5 \frac{C5}{H5} + \frac{C4}{\beta 4}$$

$$\frac{C5}{H5} = \frac{C7}{\beta 7} + \frac{C8}{\beta 8}$$

C2 = COST TO PROVIDE ROUTE 2

H2 = MARGINAL OCCUPANCY FOR ROUTE 2

$\gamma 2$ = MARGINAL OVERFLOW FOR ROUTE 2

$\beta 3$ = MARGINAL CAPACITY FOR ROUTE 3

Fig. 3—General Overflow Routing Pattern.

A programme designs the required amount of cable conductor gauge(s) and determines whether amplification is required. The conductor gauge is allocated to cable links keeping in mind the range of conductor gauges on each link. Thus detailed junction designs are produced showing the cable conductor gauges allocated to each link, the actual loss and loop resistance, the cost of the junction (including relay sets) and the provision or not of amplification. This design process is performed for all combinations of the bypass and non-bypass links described in block 4 and the cheapest design selected.

This information is presented in several output formats:

- Lists of the junctions using each cable link;
- A cost breakdown into types of switching stage categories;
- A breakdown of traffic into types of switching stage categories;
- A summation of the quantities of cable conductors required for each cable link;
- Frequency distributions of circuit groups for switching stages, lengths of junctions and numbers of circuits categories.

Transmission Analysis

A transmission and cost analysis is performed on the designed network output from the programmes in block 10. Typical outputs are:

- A cumulative loss distribution in $\frac{1}{2}$ dB steps to 20 dB for each type of outgoing route (i.e. direct, second choice, last choice, etc.);
- Overall cumulative loss distributions for groupings of all origins, metropolitan X-bar origins, ELSA X-bar origins and metropolitan SxS origins;
- For each origin to each destination the cost and cost per unit of carried traffic;
- For each origin to each destination the direct route, 2nd choice route and final choice route traffics and the mean and standard deviation of the losses on these routes.

Statement of Circuits In and Out of Switching Stages

These programmes generate reverse order duplicates of records for each circuit between two switching stages. The circuit records and their duplicates are then sorted and printed to produce for each exchange a complete picture of all incoming and outgoing circuits.

The MENDAP system has been applied to long and short-term planning work. Full network designs have been performed for the Melbourne network up to the year 1990 to assist in formulating long-term network switching and transmission objectives and hence development policies.

A complete network design takes approximately 20 separate runs typically spread over an 8-week period to allow for cross-checking of outputs, etc., (60 man-hours of manual checking is typical). A total of some 10 hours processing time on an IBM 360/50, 170 kbyte computer is used.

In the shorter-term applications, MENDAP has been used to produce complete network "Junction Provision Statements" showing all short-term junction needs. Many of the programmes within the system are applied individually to a variety of network dimensioning projects.

FUTURE DEVELOPMENTS

The MENDAP suite of programmes has proved an invaluable aid to the effective planning of metropolitan telephone networks. Its success has been such that work has commenced on evolving the system to broaden its field of application.

It is intended to restructure the system in a more flexible, highly modularized manner so that the basic processes can be readily assembled in a variety of configurations to meet particular applications.

In this way, it is hoped to build up a generalized network dimensioning facility which can be used either for detailed day-to-day work or for assisting in broader policy-making functions and applicable not only to metropolitan networks but to trunk, regional and national telecommunications networks also.

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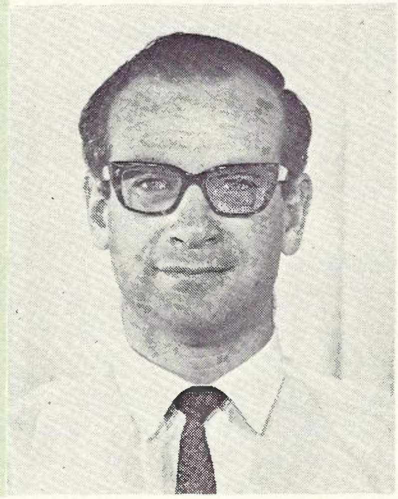
M. W. SLADE joined the APO in 1960 as a Cadet Engineer. After graduating from the University of Melbourne in 1961 he was appointed to Engineer Class 1 with the Metropolitan Internal Plant Installation Section in Victoria. From 1966 to 1971 he was an Engineer Class 2 with the Internal Planning Section, Victorian Division, working on the design of the MENDAP suite of computer programs.

In 1970 he was promoted to Engineer Class 3 in the Support Services Branch, Engineering Works Division, Headquarters. His duties were to provide advice on co-ordination on computer usage to the Engineering Works Division.

In January 1973 he was promoted to Engineer Class 4 in Telephone Switching and Facilities Branch, Planning and Research Division, Headquarters. This is the position he currently holds and is engaged upon studies of the telephone network facilities that the Department will require in the future and to co-ordinate the telecommunications industry in the provision of these facilities.

J. N. BRIDGFORD graduated with BEE honours at Melbourne University in 1955 and joined the APO Research Laboratories as a base grade engineer in 1956. Following two years on multi-channel and voice frequency equipment design he moved into telecommunications network planning areas, spending four years in the Victorian Administration and a further six years in the Headquarters Planning Administration. In 1968 he was appointed engineer in charge of a newly formed Planning Mechanisation and Techniques Section responsible for designing and co-ordinating the development of computer based engineering planning applications. He has travelled overseas on two occasions to study computer based management information systems, large data base design and network optimising techniques.



Big Changes on the Way for the Australian Post Office

A Commission of Inquiry was appointed in February, 1973 to report on what changes should be made in the organisation, administration and operation of postal and telecommunication services provided by the Australian Post Office. The Inquiry was conducted by Sir James Vernon, C.B.E. (Chairman), and Mr. B. J. Callinan, C.B.E., D.S.O., M.C. and Mr. J. J. Kennedy. The Commissioners forwarded their 600 page report to the Commonwealth Government recently.

The Government has announced its acceptance of the Commissions recommendations that:

- Separate statutory corporations should be established to administer the postal and telecommunications services.
- The new telecommunication corporation should include the Overseas Telecommunications Commission. (This was recommended by two of the Commissioners).
- The Post Office should be independent of the control of the Public Service Board.
- Each corporation should have responsibility for organisation, staff, pay and the conditions of its employees.

Future issues of the Journal will include articles outlining the details of the above changes as they are implemented.

Recent Developments in Traffic Route Testing in the Telephone Network

L. M. MITTON, M.I.E., Aust.

Although traffic route testing has long been recognised as an effective technique for supervising the quality of service offered to customers of the telephone system, many small exchanges in the APO network have not had the benefit of this technique because it has been neither economical nor physically possible to accommodate earlier designs of Traffic Route Testers in these exchanges.

The Traffic Route Tester and Remote Call Repeater described here were designed primarily to overcome these limitations. A useful incidental benefit of the Remote Call Repeater enables a section of the network previously neglected from the standpoint of automatic transmission testing to now be covered.

INTRODUCTION TO THE TECHNIQUE OF TRAFFIC ROUTE TESTING

The efficient management of the operation of a switched telephone network calls for quality control of the end product, namely the telephone calls which are established over the network. For this purpose a convenient and reliable method of measuring the capacity of the equipment in the network to establish and sustain satisfactory telephone connections is required. The technique of traffic route testing, the injection and monitoring of artificial traffic through the telephone network, has proved effective in meeting this need.

Traffic Route Testers automatically generate test calls to predetermined destinations throughout the network. These destinations are Tone Answer Responding Sets which provide automatic answering and identification facilities for the termination of these test calls. The Traffic Route Tester (TRT) together with the Tone Answer Responding Set (TARS) has the capacity to assess and record the outcome of its test calls and, by relating this to the total number of calls attempted, to provide a measure of the quality of the service offered by the equipment of the telephone network.

Test calls from the TRT are injected into the telephone system at the same point as calls from ordinary subscribers. The TRT is connected to the equivalent of subscribers' line terminals in the exchange from which the test calls originate; they are line terminals especially set aside for test purposes. Similarly the TARS are connected to the equivalent of subscribers' line terminals in exchanges throughout the network to receive these test calls. The signals used between the TRT and the originating exchange to establish the test calls and to inform the TRT of their progress, and between the TARS and the terminating exchange to receive and answer the test calls are exactly the same as would pass between ordinary subscribers and the exchange. After each test call has been established identification tone from the TARS has to pass over the established connection and be recognised by the TRT before the call is classed as successful. Thus the TRT test calls traverse the same paths through the public network, employ the same signalling facilities and encounter the same conditions as normal subscriber dialled calls. The outcome of these test calls is therefore indicative of the grade of service experienced by live telephone traffic, excluding, of course, subscribers' dialling errors.

In terms of the Australian Post Office's service targets, this grade of service is regarded as acceptable if local call failure rates of 1.5% due to plant defects and 1.0% due to plant congestion, or STD call failure rates of 3.0% due to plant defects and 2.0% due to congestion, are not exceeded.

When the TRT is being used to compile statistics on the grade of service the test call programme proceeds irrespective of the outcome of each call, the results being recorded on meters or a printer. This is known as the "Observe Service" mode of operation. "Fault Trace" is an alternative operating mode under which the TRT stops, holds the connection, applies tone to facilitate tracing and actuates an alarm on every call which fails to progress to the TARS.

Fig. 1—The Traffic Route Tester

EXTENDING THE TECHNIQUE OF TRAFFIC ROUTE TESTING

Until now, APO Traffic Route Testers have been permanently installed rack-mounted units, generally injecting traffic only into the exchanges in which they are installed, or to which they can be connected directly by physical lines (Ref. 1).

The Portable Traffic Route Tester — Functions

A recent development is a portable TRT, exploiting solid-state circuitry, designed by the Queensland Equipment Design Co-ordination Group to extend the advantages of traffic route testing to any exchange. Housed in two carrying cases, each approximately 390 x 300 x 180 mm, this TRT and accompanying Programme Unit are able to originate calls in sequence from 10 input lines to the exchange and direct them successively to up to 10 different destinations. Each of these destinations is specified by a telephone number consisting of up to 10 digits which can be programmed on a group of 10 thumbwheel rotary wafer switches on the face panel of the Programme Unit.

Fig. 1 illustrates this TRT and Fig. 2 the Programme Unit.

When used independently of the Programme Unit, the TRT is able to establish calls automatically from a single input line on any type of terminal exchange in the APO network to a single destination number of up to 10 digits.

A multi-tone-detector enables the TRT to recognise the tone sequence of a successful call (Ring Tone, then two pulses of 820 Hz tone from the TARS of at least 650 ms duration separated by a silent interval of at least 500 ms) or the service tones which mark an unsuccessful call (Busy or Congestion Tone). This Detector is of the same design as used in the Stored Program Controlled (SPC) Trunk Exchange TRT and Appointment Call Service. The Ring Tone check can be omitted when testing into exchanges which do not have Standard Ring Tone.

The Answer condition recognised by the TRT is one of the following as appropriate to the type of exchange in which it is operating:

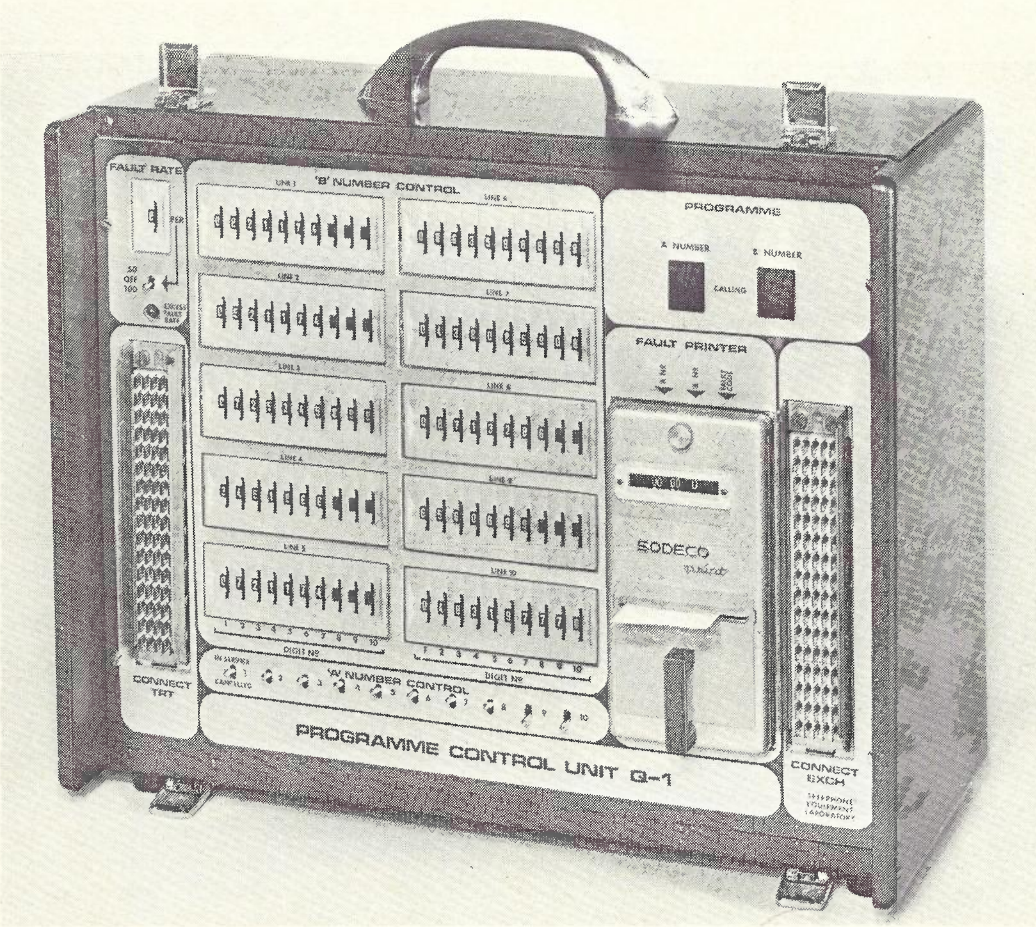


Fig. 2 — The Programme Unit.

- 1000 ohm + on r wire in ARF
- 50 volts + on p wire in Step or ARK
- 50 volts — on p wire in Step SCAX
- 50 volts + on s wire in 2VF
- Reverse polarity on a and b wires in cases where only the line pair is available.

Should the Answer condition be detected before Ring Tone, a call failure is recorded.

Resettable meters on the TRT record the number of:

- Calls attempted
- Calls failing to obtain a register or first-stage selector within 4 seconds
- Calls encountering busy tone
- Calls encountering congestion tone
- Calls not reaching the TARS for other reasons.

Terminals are provided for connection to external meters when a check of the exchange metering functions is required; these meters record the number of answered calls and the number of meter pulses received from the exchange equipment.

An external Automatic Transmission Test Unit (ATTU) (Ref. 2) may be connected to check transmission loss in both directions on calls directed to Test Call Answer Responding (TCARS), (Ref. 3).

The total number of calls to be generated in a particular test programme can be preset so that the TRT will automatically cease testing when this total is reached.

Automatic transition from the Observe Service to the Fault Trace operating mode, when the sampled grade of service is poorer than some predetermined limit, is a feature which avoids an extensive Observe Service programme having to proceed to conclusion before any serious degradation in service is brought to notice. Amplified monitoring and speaking facilities, built into the TRT, are useful aids to call tracing. The loudspeaker provided for this purpose serves also to transmit the audible alarm.

It is possible to introduce a 50 second delay between calls to minimise the competition between TRT traffic and live traffic in small exchanges where there is a risk of overtaxing common control equipment when the TRT generates successive calls with the normal interval of 2 seconds.

In general, the TRT will be used with the Programme Unit to extend both its calling and called line capacities to 10. The Programme Unit provides a printed record on every unsuccessful call of the calling line and called number involved and the abortive condition encountered.

There are some 1700 terminal exchanges in the APO network with fewer than 1000 lines connected. In these exchanges the full time usage of a TRT is not justified but, nevertheless, there remains the need to apply some automatic means of performance measurement to ensure that subscribers connected to these small exchanges are given an acceptable standard of switching performance. To a very limited extent this situation has been met by extending test lines to these exchanges from a TRT at a central point by means of physical line pairs, either cable or open wire. This solution is expensive, restricted in distance by the signalling limits imposed by the characteristics of the physical line conductors, and in many locations is impracticable simply because no physical pairs are available.

The portable Traffic Route Tester, described here, goes somewhat further toward satisfying this need but there are many cases where these small exchanges are in country areas, some hundreds of kilometres from one another and from their maintenance control centre, where transporting the portable TRT to each exchange involves considerable travelling time and distance. The Remote Call Repeater (RCR) has evolved to meet the need for an instrument which can originate artificial traffic for performance measurement purposes from any terminal exchange, without a TRT having to be actually in that exchange.

Remote Call Repeater — Functions

The RCR operates under the remote control of a Traffic Route Tester elsewhere and whilst so controlled becomes, virtually, a TRT at the exchange where the RCR is installed. The relationship of the Remote Call Repeater to the TRT is shown in Fig. 3.

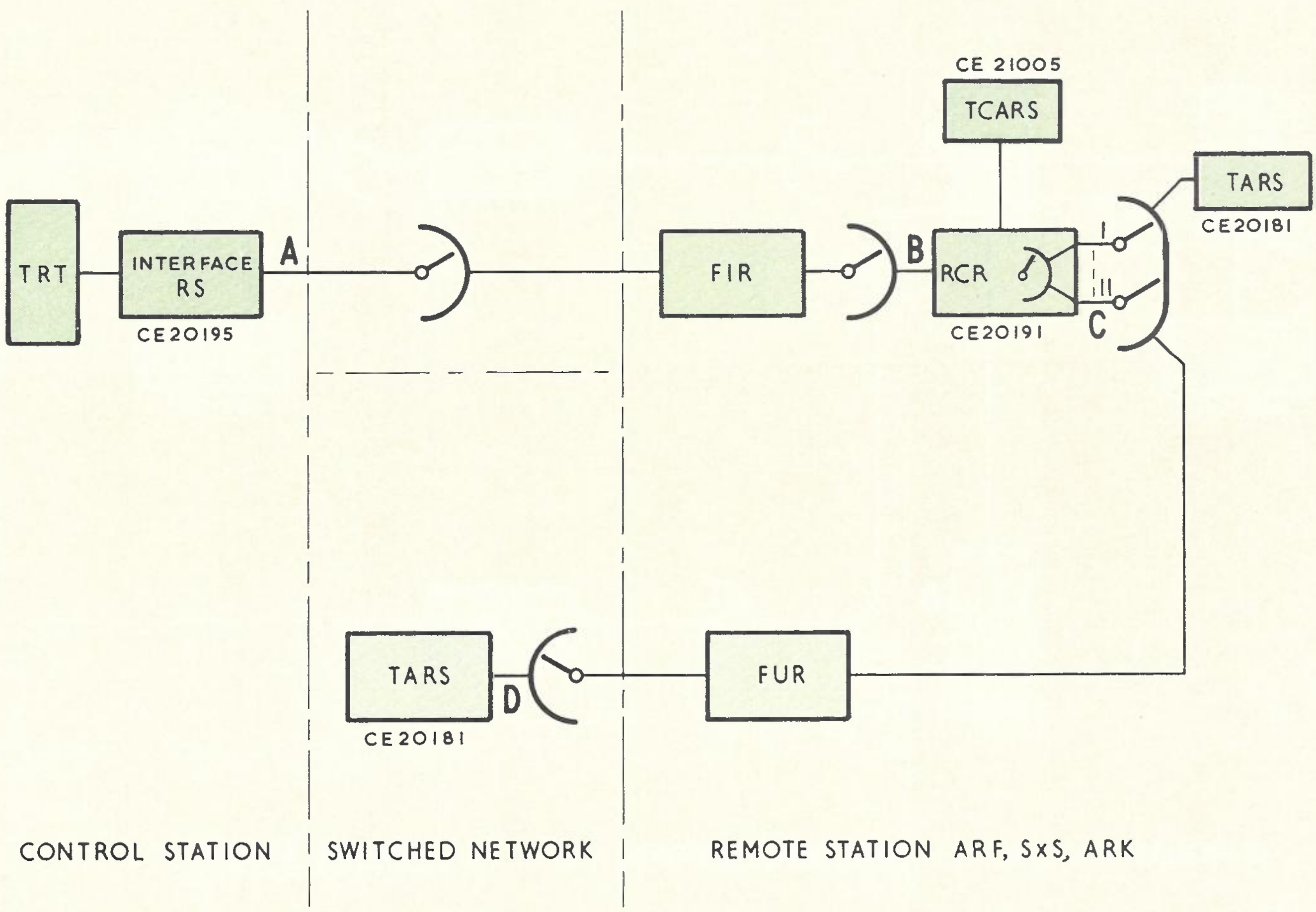


Fig. 3 — Trunking of Interface Relay Set and Remote Call Repeater

The RCR is connected, for the purpose of access from the network, to line terminals of the subscriber's stage in a terminal exchange. Thus the RCR can be addressed by a telephone number in the ordinary subscribers' number range of that exchange and is accessible from anywhere in the telephone network. The RCR has access to up to 45 lines on which it can originate outgoing calls to any destinations in the network as directed by the TRT.

To control the generation of a series of test calls from the RCR, the TRT calls its number and so establishes a voice frequency (VF) bandwidth path to the RCR over the public switched telephone network. This connection is held throughout the series of test calls and is used to convey control signals between the TRT and RCR. The TCARS associated with the RCR provides the necessary identification tone to satisfy the TRT upon the establishment of this initial connection and also enables bi-directional transmission loss tests to be conducted automatically on both the incoming and outgoing circuits of the terminal exchange. VF tone pulses comprise the signals used between the TRT and RCR. The Interface Relay Set associated with the parent TRT translates these to a form to suit the normal signalling of the TRT and the RCR translates them to subscribers' line signals in the terminal exchange.

Details of the RCR operation are given in Appendix 1.

With present day equipment, automatic transmission loss tests are confined to the circuits which call into exchanges in the APO network equipped with Test Call Answer Responding Sets (TCARS). Progressively all exchanges are being so equipped. The transmission loss check in both directions on the circuit involved is conducted by an Automatic Transmission Test Unit (ATTU) (Ref. 2) associated with an Automatic Exchange Tester (Ref. 2) a TRT or a Trunk Circuit Routiner (Ref. 4) in co-operation with the TCARS at the distant end of the connection. This testing procedure is limited to circuits on which the TCARS can be called from the ATTU. It is not possible to test circuits which carry traffic only in the other direction, that is

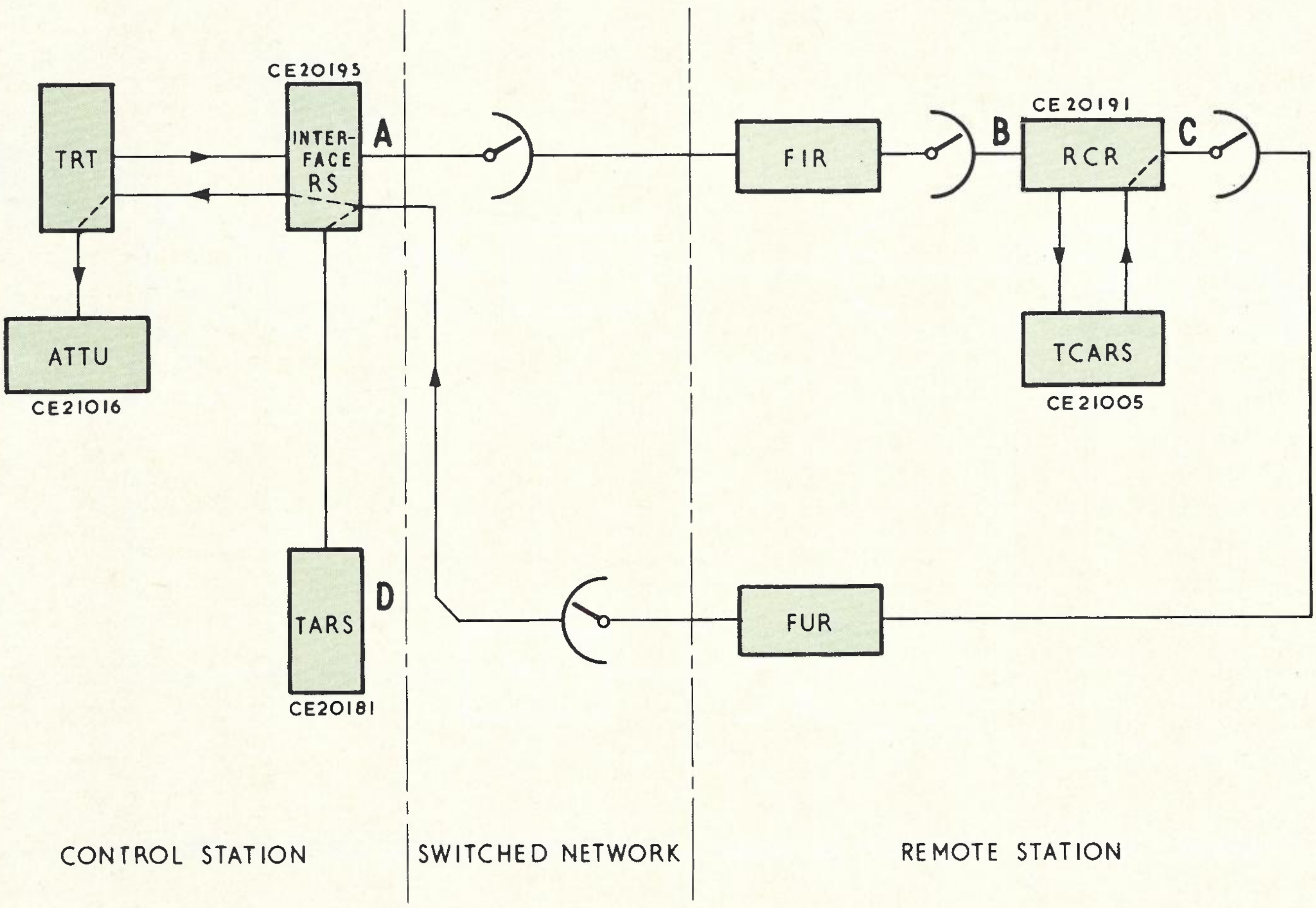


Fig. 4 — Transmission Testing with the Remote Call Repeater.

outgoing from the TCARS - equipped exchange, by this means because the exchange switching plant is not capable of coupling a TCARS to an outgoing circuit.

The Remote Call Repeater and Interface Relay Set have features which will overcome this deficiency (Fig. 4). The RCR can be directed by the TRT to call the Interface Relay Set at the TRT Control Station and then to connect a TCARS to the outgoing line from the terminal. The TRT connects the ATTU to the line on which it has been called from the distant terminal and the ATTU and TCARS then proceed with transmission loss tests in the usual manner.

CONCLUSION

By exploiting modern technology to depart from the earlier fixed rack-mounted design the portable TRT described here makes the technique of traffic route testing feasible in any automatic terminal exchange in the network. The RCR augments this by making it unnecessary to visit an exchange for the purpose of measuring plant performance by means of the "Observe Service" mode of TRT operation or for transmission loss measurements on outgoing circuits. These two devices are expected to contribute to improved monitoring of service standards and efficient usage of maintenance resources in the telephone network by bringing the advantages of automatic measurement of the switching and transmission characteristics of plant performance to parts of the APO network where previously it has not been economical nor practicable.

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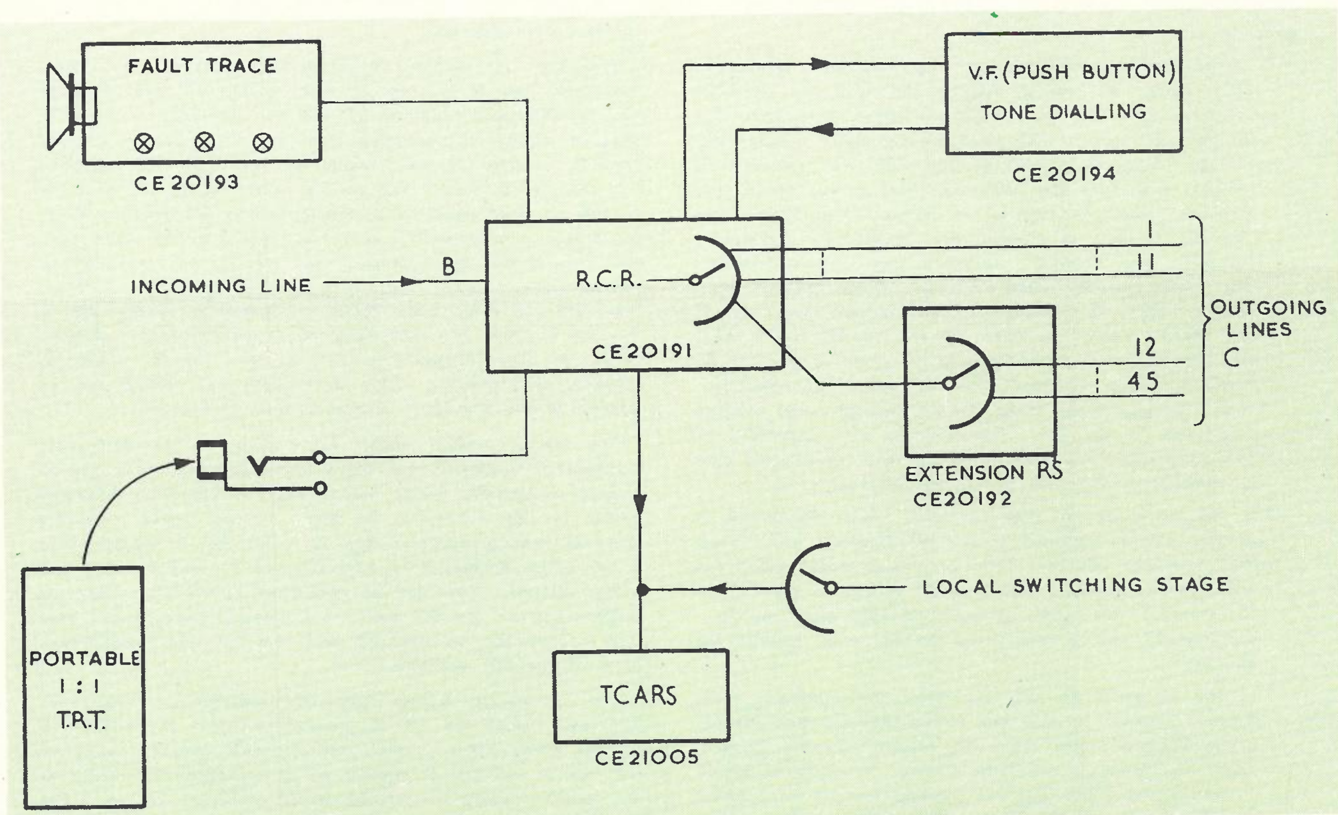

Fig. 5 — Fault Trace Facilities of the Remote Call Repeater

APPENDIX

REMOTE CALL REPEATER OPERATION

Access from the network to the RCR is obtained by calling a subscriber's number allocated for the purpose as shown in Fig. 3. When called by the TRT for establishment of the primary (A to B) connection the RCR responds to the seizure signal applied to its c or p wire and connects the TCARS through to the line terminals of the subscribers' stage, i.e., the B line. The TCARS trips the ring, simulates B party answer condition and provides tone identification as expected by the TRT.

The RCR is then switched to a condition such that it will respond to and reply with VF tone signals from and to the TRT Interface Relay Set. The signals in the forward direction, towards the RCR, consist of pulses of 2580 Hz tone constituting:

- Decadic pulse information signals which direct the secondary connection to the required destination (D number). These signals are translated either to fixed-break-corrected loop-disconnect or VF tone dialling signals as appropriate for the C line on which the secondary connection is originated. Loop-disconnect pulsing is inhibited if the C line should be on "lock-out".
- Line signals, similar to those of the APO's T pulse system, using 150 ms pulses for seizure and for connection of the TCARS to the outgoing line of the secondary connection (C line), and a 600 ms pulse for a clear-forward signal.

The signals in the backward direction, to the TRT Interface Relay Set, inform it of the progress and conditions encountered in setting up calls on the secondary (C to D) connection. These comprise:

- Service tones encountered on the secondary connection. These tones, in passing through the RCR, are amplified to compensate for the additional losses introduced due to their path to the TRT being via the RCR's terminal exchange. Since both the TRT and RCR are connected to terminal exchanges this path may add a loss up to the maximum allowable terminal to terminal transmission loss (Ref. 5), to that of a connection established directly by the TRT. The amplifier's automatic gain control characteristic compresses the level range of service tones encountered on the C to D connection and transmits them towards the TRT at a level between -15 and -4 dBm. The AGC time constant is sufficiently long to preserve the 10 dB level difference between alternate pulses of congestion tone. Service tones pass directly through the interface Relay Set to the TRT. To eliminate any possibility of fraudulent use of the RCR its service tone transmission path is interrupted when the D number answers.
- A 150 ms pulse of 1980 Hz tone, which signals the D number answer condition to the TRT Interface. The Interface translates this to a form of answer signal which the TRT normally expects, that is either a polarity reversal on the a and b line wires, or earth via 1000 ohms on the r lead, or 50 volt positive pulse on the c or p wire for 200 ms.
- A 150 ms pulse of 1860 Hz tone, which indicates satisfactory reception by the RCR of the 820 Hz tone identification sequence from the TARS accessed by the D number. The Interface translates this to the form of identification signal which the TRT expects from a local TARS, namely, pulses of 820 Hz tone of 1.5 seconds duration separated by 1.5 seconds duration separated by 1.5 second intervals.
- A 600 ms or longer pulse of 1980 Hz tone, which conveys a manually actuated command from the Fault Trace Panel to restart the TRT test cycle. The Interface translates this to a reset signal to the TRT.

The basic RCR can have access to up to 12 different line circuits (C lines) from which to originate the secondary connections for checking on the grade of service offered by the remote exchange. It seizes these lines in sequence using a different one for each successive test call. The number of C lines can be increased to 45 by the addition of the RCR Extension Relay set.

The Interface Relay Set enables the total number of secondary (C to D) test calls generated over each primary (A to B) connection to be pre-selected, in increments of 10, up to a total of 50. When this pre-selected total is reached the TRT is caused to release the primary and secondary connections and to establish a new primary connection having as its B termination a Remote Call Repeater in some other exchange. Then follows a new series of C to D test calls from this other exchange while the primary connection is held.

When the Observe-Service mode of operation reveals a call failure rate exceeding the acceptable grade of service targets, the "Fault Trace" mode of TRT operation is employed to locate the cause.

The RCR offers two possible methods of using a TRT for fault tracing. Both methods assume, though most exchanges with RCRs will normally be unattended, that during fault tracing operations human attention will be available at the RCR site, since the final diagnosis and clearance of the fault requires this in any case.

With the first method, the Fault Trace Panel in the remote exchange, Fig. 5, is used to control the TRT and the RCR and to observe the process of test call generation. The TRT's program cannot be controlled from this Panel, but a test call held for tracing can be released and the test cycle restarted by means of a "Reset" key on the Panel, Fig. 6, which causes a 1980 Hz tone signal to be transmitted to the Interface Relay Set where it is translated to a reset signal to the TRT. Control keys enable the secondary test calls to be originated on any particular C line. For observation of the progress of the test calls the Fault Trace Panel has lamps to indicate the C line in use and the occurrence of a call failure, an audible alarm to draw attention to call failures, and a monitoring amplifier and speaker. Tone to facilitate call tracing can be applied to the secondary connection from this panel.

The second method allows full control of the destination numbers (D numbers) from the remote exchange. This method requires a portable Traffic Route Tester, of the type described earlier in this article, to be taken to the remote exchange for fault tracing purposes (Fig. 5). This TRT is plugged into a jack which enables it to originate calls via the RCR's' C line access selector. Calls can be established to any D number as programmed on the TRT from all C lines in sequence or from one in particular, as required, with the full fault tracing facilities of the TRT available.

For transmission testing from an exchange equipped with RCR and TCARS the TRT is programmed first to call the B number which addresses that particular RCR and then to direct the RCR to call the D number of an incoming access line to the Interface Relay Set at the home exchange (Fig. 4). The Interface Relay Set, on receiving a call on this line, first connects a TARS to send to the RCR over the D to C connection standard 820 Hz identification tone pulses. This identification is relayed back to the Interface over the B to A connection as a 150 ms pulse of 1860 Hz tone, which is translated by the Interface back to 820 Hz tone pulses to indicate to the TRT that the D number has been identified. The TRT then signals to the Interface that a transmission test is required. The Interface Relay Set transmits A to B a 150 ms pulse of 2580 Hz tone as a command to the RCR to couple the TCARS to the C line. After a delay of 16 seconds, to prevent the TCARS answer and tone identification process from interfering with the transmission test, the Interface couples the ATTU to the D line. The ATTU then co-operates with the TCARS in transmission loss tests on the outgoing circuit from the terminal exchange. Upon completion of the test the ATTU signals the TRT to release the C to D connection and to establish a new one.

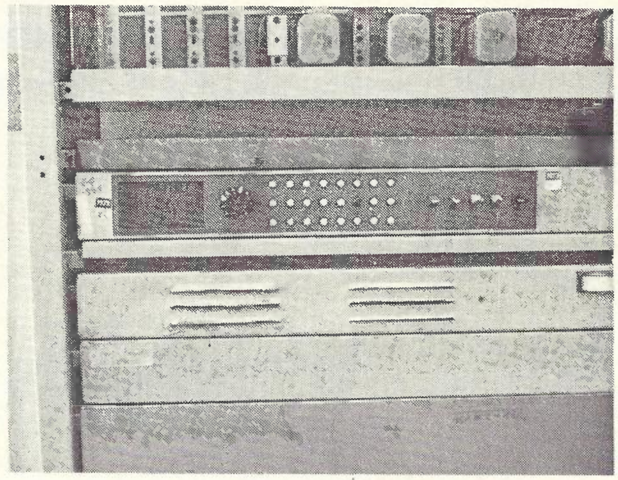

Fig. 6 — The Fault Trace Panel

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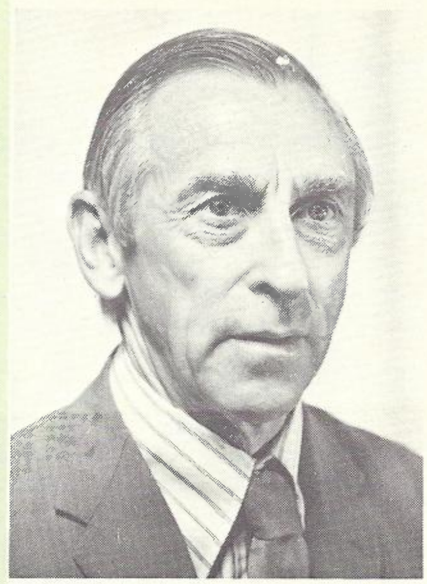
After some seven years as a Senior Technician on trunk switching equipment maintenance, he qualified as Engineer in 1957 and was appointed to the Planning Section where he was engaged in the development of plans for regional networks and local and trunk switching centres. In 1962 he returned to Trunk Service as Engineer responsible for maintenance of South Australia's trunk switching network, sound and television programme channels, and their switching centres. After a brief period on acceptance and commissioning of the Telex ARM and ARB exchanges in 1966, Mr. Mitton became project engineer for the installation of the ARM telephone trunk exchange in Adelaide and for various carrier and crossbar exchange equipment installations throughout South Australia and the Northern Territory.

Mr. Mitton came to the position of Senior Engineer Testing Techniques in the Headquarters Telephone Switching Equipment Operations Section in 1970, with responsibility for development of techniques and specification of facility requirements for exchange test equipment and service aids. He is a Member of the Institution of Engineers, Australia, and was, for five years, Secretary of the Telecommunication Society's S.A. Division.



Design Criteria for Corrosion Protection of Telecommunication Structures

M. T. FORDHAM, Dip. C.E.

The premature failure of corrosion protection systems on telecommunications structures is often due to insufficient attention being paid to constructional details, and to the designer not appreciating that the peculiar local environment at or within a detail is very different from the structure's general environment.

The paper shows the need to appraise and design for the peculiar environment, and describes with illustrations good and poor constructional practice.

The principles and the corrosion protection of high tensile friction grip bolting, as used with extremely rigid radio structures, are dealt with.

INTRODUCTION

"Criteria" are "those standards by which a thing is judged". The common base by which all structures from Opera Houses to Breweries, Armament Factories to War Memorials are judged is the true annual cost of maintaining, operating and preserving the structure. In a forward looking community, the preservation of the natural environment and our planet's resources are other criteria.

This paper will concern itself with those design considerations, practices and arrangements, which tend to achieve this true minimum cost objective. Here "true annual cost" embraces the principles of discounted cash flow, which realistically reduce future expenditure and savings to their true present worth after making due (compound interest) allowance for the depreciating value of money, the loss of earning power (i.e. the profit that the capital outlay would otherwise have made), the risk factor and allowances for depreciation and taxation relief (Ref. 1).

Costs may also be minimised if at the design stage "Value Analysis" techniques are used (Ref. 2).

ENVIRONMENT

From a corrosion aspect, the general and the particular environment must first be studied. Despite detailed assessments of the general environment and the careful selection of protective finishes, many corrosion failures occur in telecommunication structures at points of structural change, such as welds, overlaps or fasteners where the particular environment is quite different. Figs. 2 - 18, which will be referred to later, illustrate some good and poor design practices at such places.

These "Achilles Heels" warrant far more consideration than is usually accorded them. Invariably more difficult and costly to maintain, they are where advanced corrosion develops despite the otherwise good condition of most of the structure.

Even the general environment may vary considerably within short distances. Recent exposure tests in and around Sydney, of grit-blasted steel, galvanised steel and aluminium, showed large differences in corrosion rates between close locations. At one site, number 5 (Fig. 1), a difference in height of 20 metres increased the corrosion rate four times. Stratification from industrial discharge, salt-spray carry-over, aircraft exhaust and wind patterns were causative factors. The marked differences in the corrosion rates of the grit-blasted mild steel and the galvanised steel specimens are shown in Fig. 1, in particular at the two close sites, numbered 5 and 10. (Operational needs curtailed the testing period on the radar tower to 3 months but linear extrapolation is applicable).

Whilst the selection of materials, finishes, the overall design of the structure in relation to economics, the total corrosive environment and the structure's functions are basic, the detailed design of the "Achilles Heels" is often more important from a corrosion aspect.

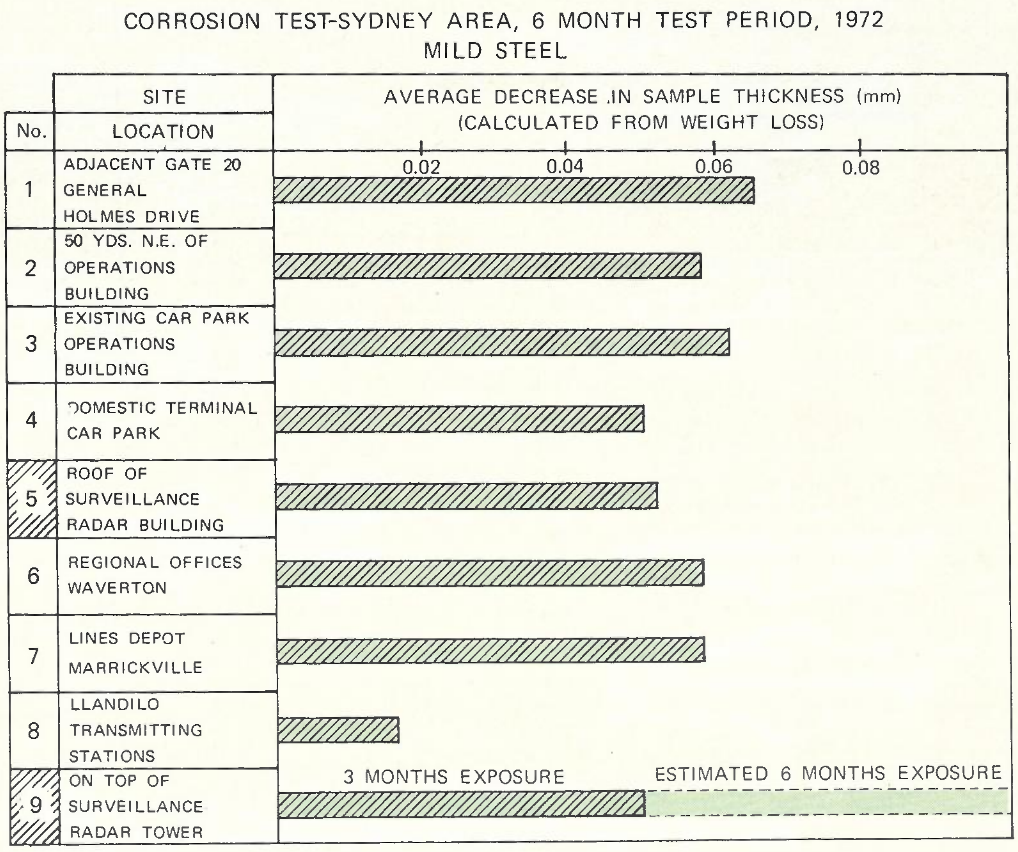


Fig. 1—Environment and Corrosion Rate.

DISSIMILAR METALS

Figures 2 - 4 illustrate some alternative means of dealing with crevice and interface corrosion in bolted and/or riveted lapped joints of dissimilar metals. In general one would try to avoid using dissimilar metals in contact outdoors unless their galvanic difference was less than 0.25V (as measured against a saturated calomel electrode in sea-water at 25° C).

The many other factors influencing the compatibility of dissimilar metals in contact is dealt with in Australian Defence Standard DEF (AUST)-143 (Ref. 3), and should be studied with other texts on the subject.

Even similar metals in contact may corrode under certain conditions. Within 2½ years, serious corrosion developed between galvanized components in large pre-fabricated insulated metal equipment shelters, where it was believed "desert" conditions would apply.

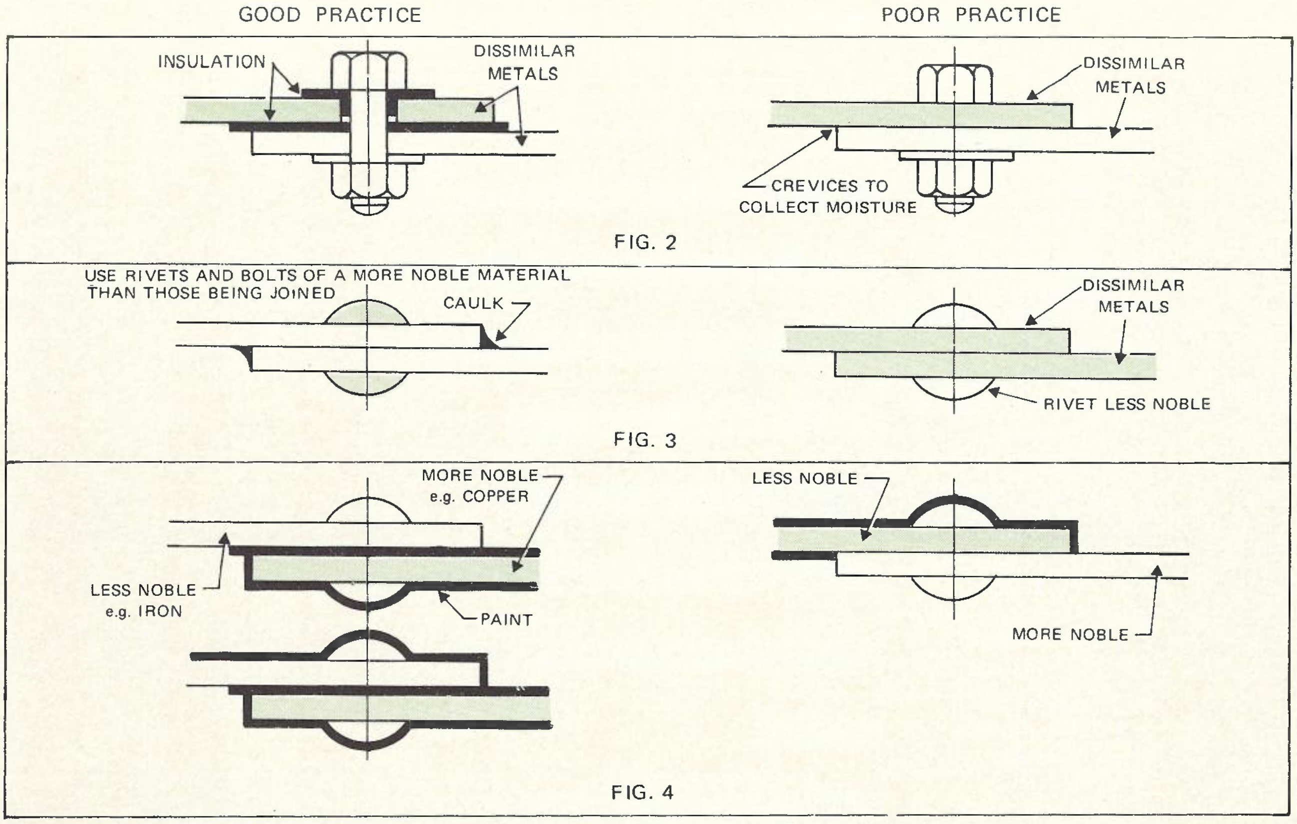
In these desert conditions, low night temperatures caused condensation in the insulated cavities which, combined with the local ubiquitous reactive dust and the hygroscopic zinc corrosion products, formed an aggressive electrolyte. "White Rusting" is no new phenomenon, but one that is often overlooked.

Better practice would be to manufacture from pre-painted galvanized sheet (e.g. "Colour Bond"), or to coat all interfaces before both shop pre-fabrication and field assembly, see Fig. 17.

Similar interface problems caused the failures of VHF aerial clamps for which the designers had deliberately selected type 316 stainless steel, cast aluminium alloy LM8 and hot-dip galvanised components. In their appropriate context, all are very suitable materials but, between the stainless and the LM8, and the LM8 and the galvanised steel, hygroscopic corrosion products developed to such an extent that the clamps burst.

The use of an inhibitive jointing paste on all mating faces virtually cured the trouble. The comparative results of 300 hours salt-spray testing are shown in the photographs "A" and "B".

Other dissimilar metal problems and suggested means of dealing with them are shown in Figs. 2 - 5 and Ref. 4.



Figs. 2 to 4—Joint Design, Rivetted and Bolted.

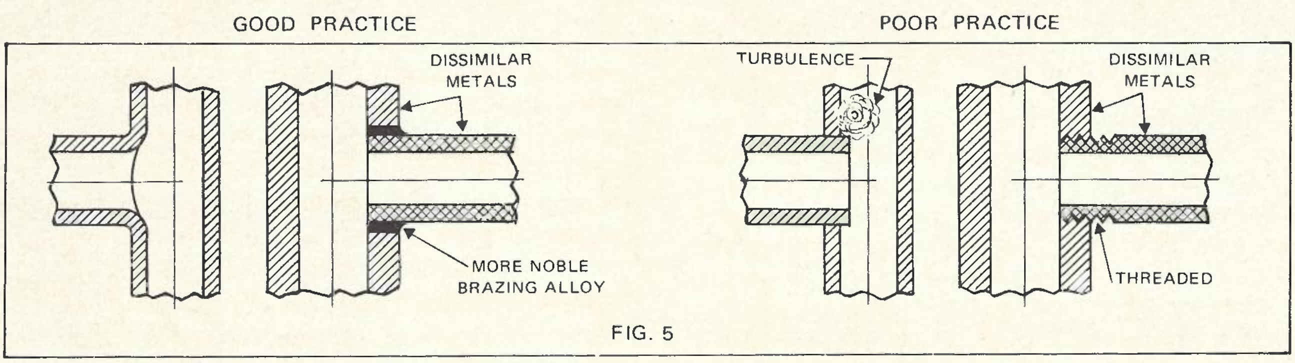


Fig. 5—Pipe Joints.

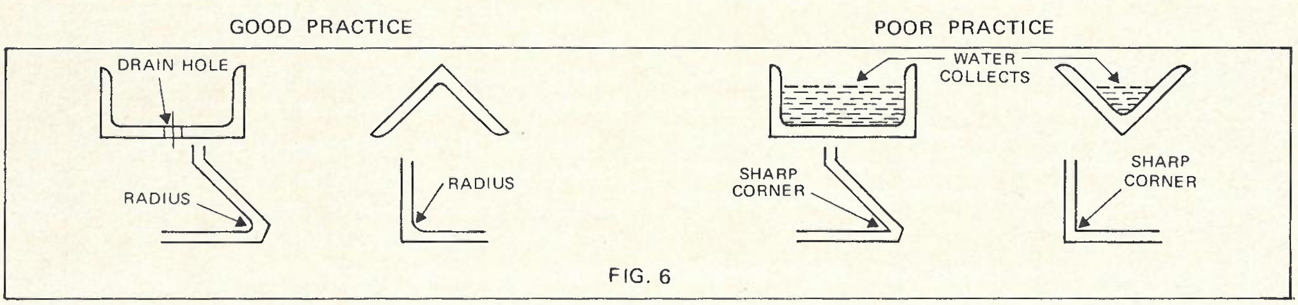


Fig. 6—Design Features.

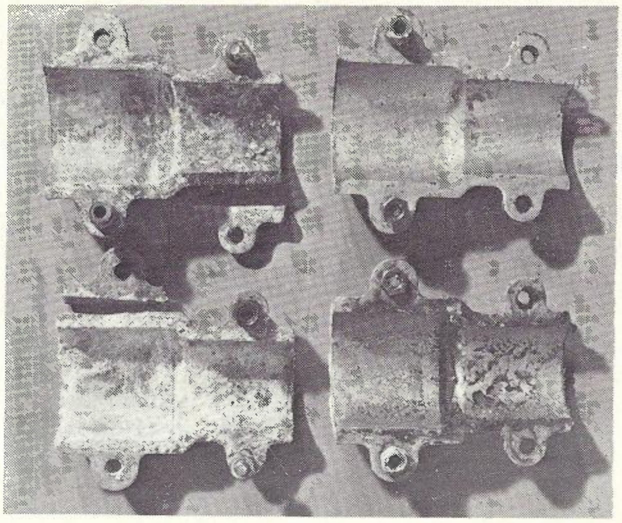


Fig. A.

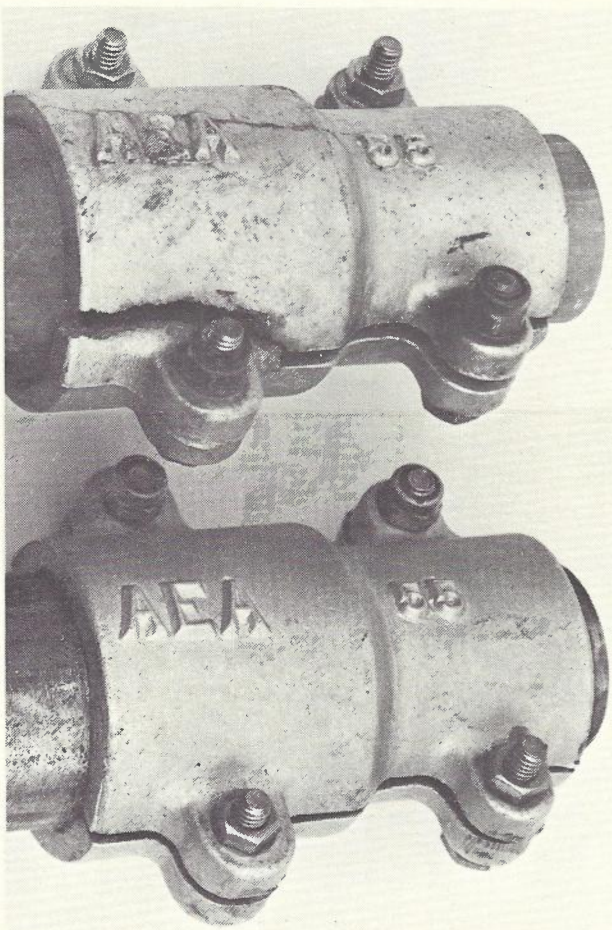


Fig. B.

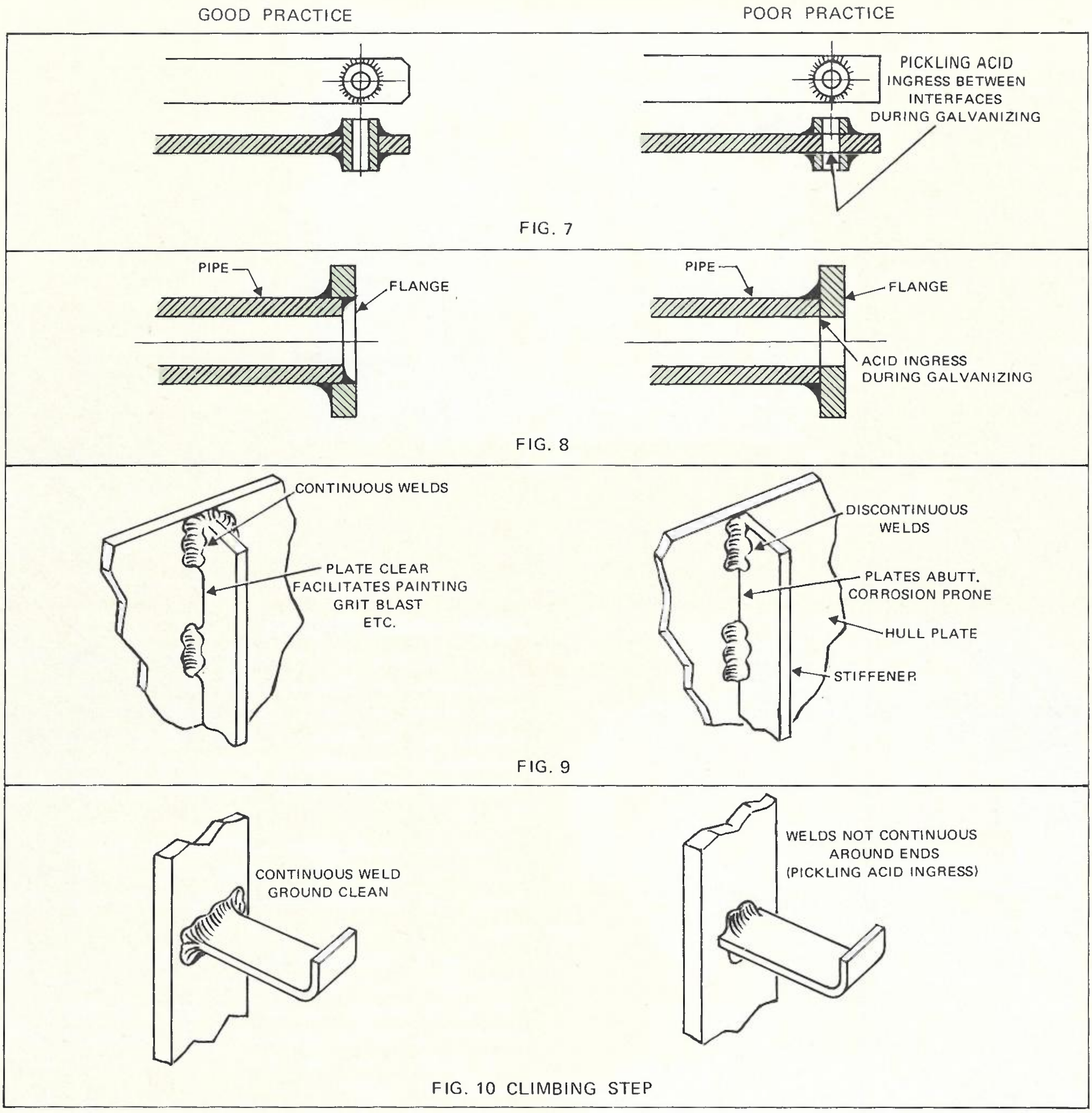
DESIGN CONSIDERATIONS

It is obvious that if we prevent or reduce the formation of an electrolyte, corrosion will be inhibited. Simple principles, such as effective drainage, ventilation, avoidance of sharp edges or corners, maintaining temperature above dew point, etc., if observed, will do much to control corrosion (see Fig. 6).

Figs. 7 - 18 illustrate methods adopted by the author to cope with a wide range of "Achilles Heels" in telecommunication structural engineering.

In some instances (Figs. 7 - 10) it will be noted that crevices are avoided because they retain pickling acids used in various corrosion protection processes, e.g. hot-dip galvanising, phosphate conversion coatings, etc., and this can contribute to later failures in service.

The absence of drip edges or grooves frequently contributes to corrosion and avoidable maintenance expense (see Figs. 12 and 13). An adequate concrete "cover" over steel reinforcement is essential, the thickness of cover depending upon the nature of the exposure (underground, marine, industrial, etc.). When minimum cover is sought, such as for the cladding roof panels of the Sydney Opera House and for many pre-cast concrete facade panels, galvanised steel reinforcement should be considered, due concern being paid to the strain-ageing induced by the temperature of the molten spelter bath and the characteristics of the steel if cold formed.



Figs. 7 to 10—Constructional Details.

Galvanised steel, when emerging from concrete, should also have some barrier protection for a distance of approximately 70 mm above and below the point of emergence, i.e. the concrete surface. This avoids a damp zinc-concrete interface, see Figs. 14, 15. Care must be taken **not** to coat that portion of the galvanised steel stirrup or anchor rod used in the design for developing the required bond between the concrete and the steel for anchorage.

Fig. 16 indicates an acceptable method for grouting anchor rods into suitable rock whereby the rod is positively located in the centre of the drilled hole.

For such anchors, effective corrosion protection against possible ground waters, entering through

GOOD PRACTICE POOR PRACTICE

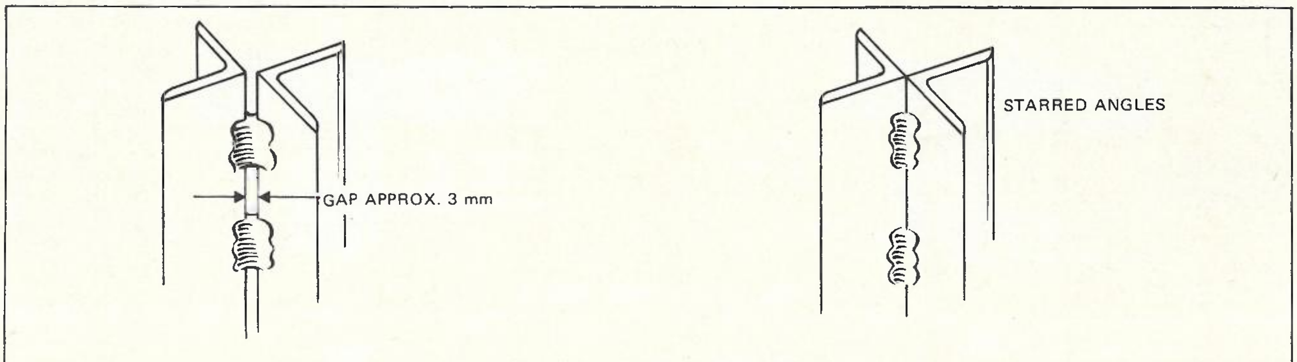


FIG. 11 STARRED ANGLES

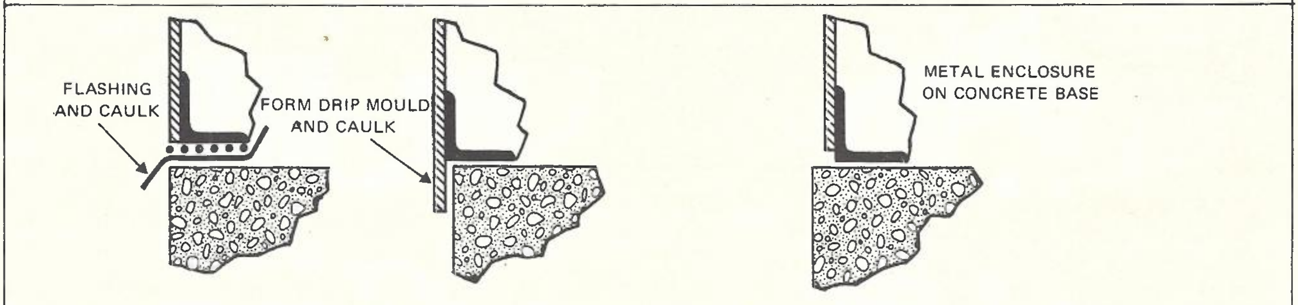


FIG. 12 METAL ENCLOSURE ON CONCRETE BASE

Figs. 11 and 12—Constructional Details.

GOOD PRACTICE POOR PRACTICE

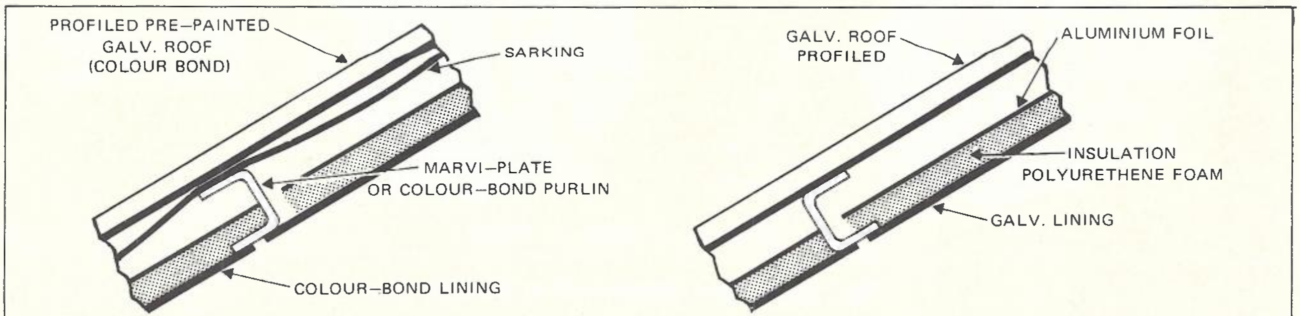


FIG. 17 INSULATED PRE-FAB METAL ROOF CONSTRUCTION

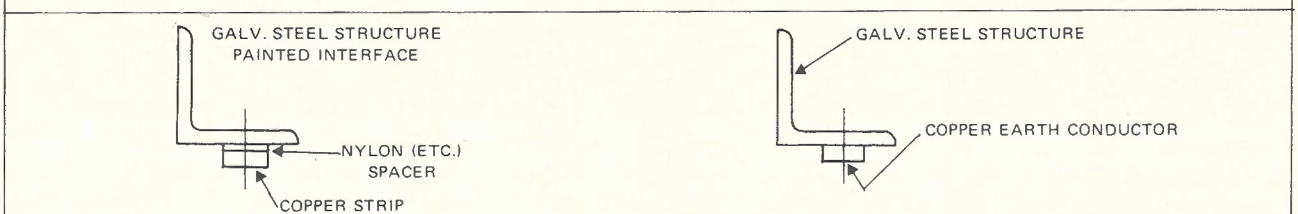
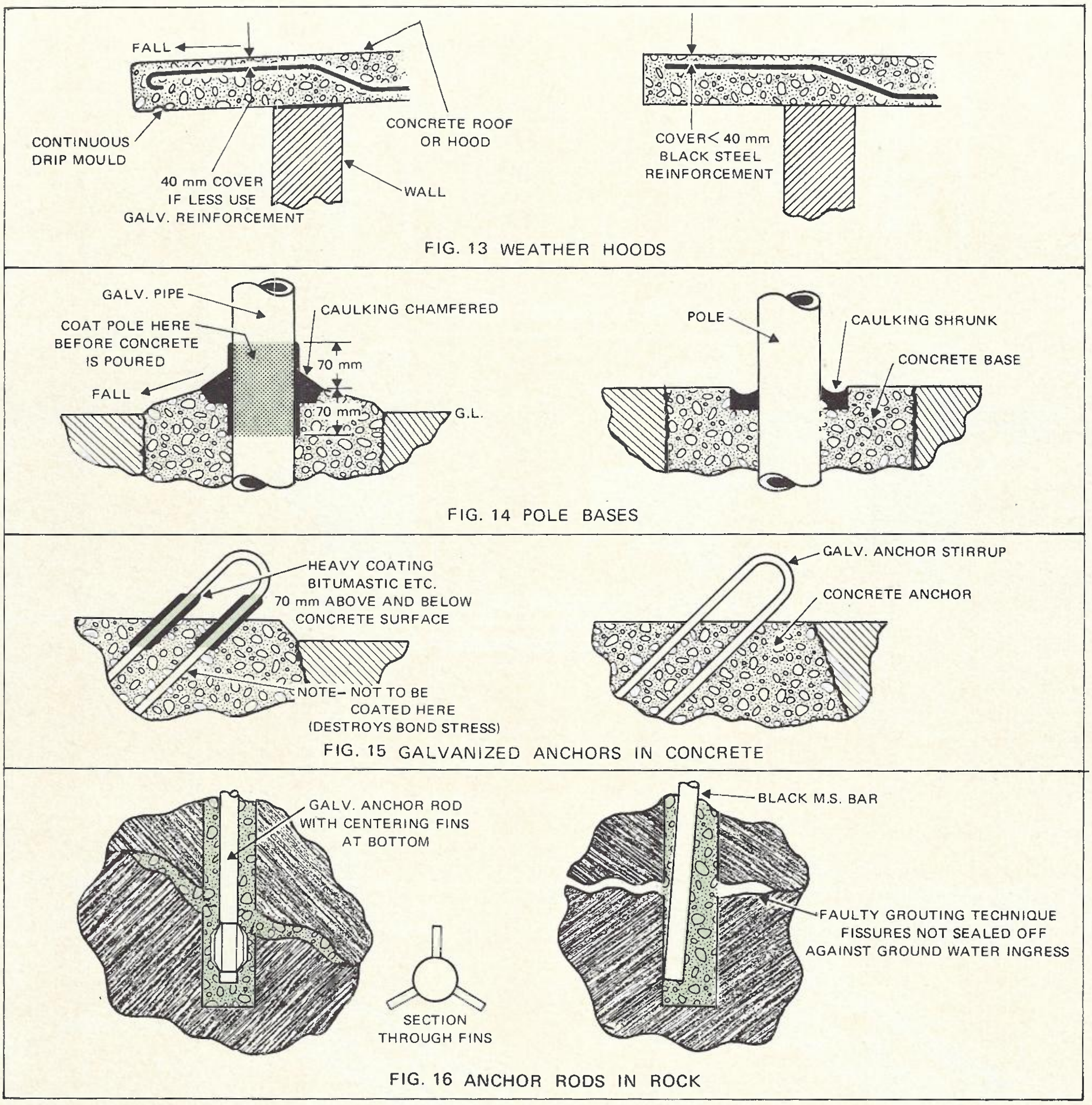


FIG. 18 MOUNTING LIGHTNING CONDUCTOR

Figs. 17 and 18—Constructional Details.



Figs. 13 to 16—Constructional Details.

fissures or porous rock, may be achieved by either drilling large diameter holes, so as to provide adequate grout cover for the steel, or by using a galvanised anchor rod with appreciably less cover. The latter is favoured for economic reasons and because the impermeability of the cover, however thick, is suspect in these situations. Special grouting techniques ensure a satisfactory anchorage, but certain proprietary grouts should be avoided in rock anchorages because of the possibility of continued dampness maintaining corrosive attack and continued expansion of the grout.

BOLTING SYSTEMS

The selection of protective finishes for large open steelwork structures is sometimes governed by the type of fastening (bolting) system used.

Where rigidity is of paramount importance, it is common to use a high tensile friction-grip bolting system, e.g. radar and some microwave towers.

With constantly alternating loads, such as are imposed by rotating aerial systems, the high tensile friction grip bolt shown in Fig. 19 is used, whereas for stationary aerial systems, such as micro-wave or tropospheric scatter links, a HT friction-grip interference body bolt is used.

Principle of friction type joint using a high strength bolt.

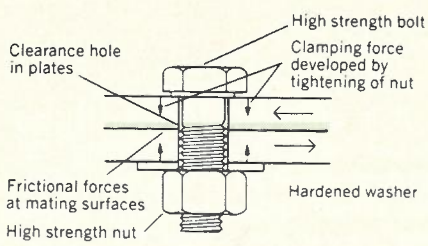
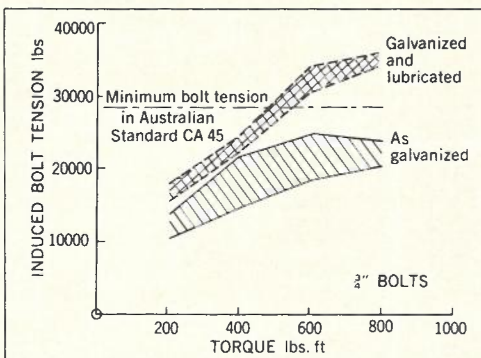


Fig. 19—High Tension Friction Grip Bolt.

Early F/G systems were confined to black steel structures and black HT F/G bolts. Any paint or coating between the friction faces of the structural members was not permitted because this reduced the required coefficient of friction. Maintenance of such exposed structures was a problem.

Development has resulted in the current practice of using hot-dip galvanised wax-lubricated high tensile friction grip bolts with inorganic zinc silicate protective coatings on the structural steelwork (Ref. 5).



Torque-induced tension relation for ¾" UNC high strength structural bolts, as-galvanized and galvanized and lubricant coated.

Fig. 20—Friction Grip Galvanised Bolting; Torsion and Tension.

TABLE 1—SUMMARY OF SLIP COEFFICIENTS FOR VARIOUS SURFACE TREATMENTS (†)

	Surface Treatment	No. of Tests	Slip Coefficient Mean	Min.	Max.
I.	Plain Steel				
(a)	Mill scale	352	0.32	0.17	0.60
(b)	Rusted	15	0.43	0.41	0.55
(c)	Flame cleaned	88	0.48	0.31	0.75
(d)	Blast cleaned	183	0.57	0.32	0.81
II.	Steel with Corrosion Protection				
(a)	Red Lead Paint	6	0.07	0.05	
(b)	Rust Preventative Paint	3	0.11	0.07	
(c)	Hot-dip galvanized	95	0.19	0.08	0.36
(d)	Lacquer - varnish	17	0.24	0.10	0.30
(e)	Blast cleaned - vinyl wash	24	0.28	0.22	0.34
(f)	Galvanized & grit blasted	12	0.49	0.42	0.55
(g)	Grit blasted & zinc rich paint	48	0.51	0.38	0.65
(h)	Grit blasted & metallized	42	0.65	0.42	0.99

† Data from various sources in list of references on AZDA and AISC publications "HIGH STRENGTH BOLTING OF GALVANIZED CONNECTIONS."

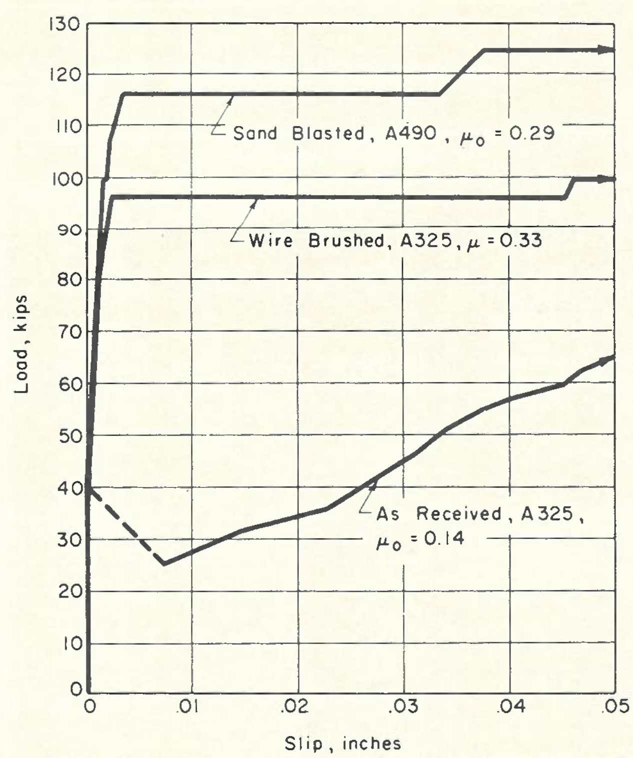


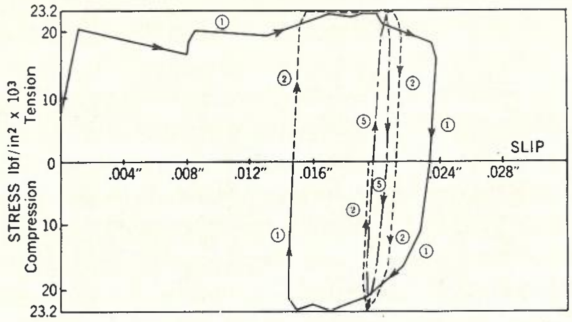
Fig. 21—Load-Slip Curves from Four-Bolt Joints.

The lack of correlation between applied torque and bolt clamping force for galvanised fasteners was overcome by the use of special wax on the galvanised threads, the use of the "turn-of-nut" tightening method (or the use of galvanised load indicating washers under the head of the bolt) and the use of higher strength steel for the nut because of the greater thread clearance for galvanised fasteners. See Fig. 20 and Ref. 6.

Table 1 lists "Slip Coefficients" for a variety of surface treatments, from which it will be seen that the inorganic zinc silicate coating has a high slip factor. This coating affords good corrosion protection and does not suffer from "white rusting".

A more recent development in the use of hot dip galvanised structurals with galvanised HT F/G bolts, is the brush-off grit blasting of the galvanised faying surfaces of the structural members in order to obtain the required coefficient of friction. (Shown as "γ_0" on Fig. 21.)

Not that in Fig. 21 the higher loads sustained before slip by the "A490" bolts is because of their higher strength and consequent greater clamping force than the "A325" HT bolts.



Stress versus slip for fatigue specimen subjected to alternating stress of 23200 lbf/in². Galvanized members and bolts. First, second and fifth stress cycles.

Fig. 22—Galling or Lock-up of Galvanised Bolted Joint.

It is of interest that galvanised surfaces tend to lock-up under cyclic loading. Fig. 22 shows the gradual reduction in slip until at 5 cycles the joint has almost locked up. This "galling" of the zinc interfaces is one reason for the lack of correlation between torque and clamping force with galvanised fasteners.

TABLE 2.

HOT DIPPED GALVANIZED COATINGS

*NOTES— 1. WT. OF COATING TO BE AGREED UPON BY GALVANIZER AND PURCHASER.
2. AS AT NOV. 1972, AUSTRALIAN STANDARD "AS 1214" IS BEING PRINTED, THIS COVERS HOT DIP GALVANIZED COATINGS ON FASTENERS.

METRIC SYSTEM (NEW PRACTICE)				IMPERIAL SYSTEM (PREVIOUS PRACTICE)			
ITEM	SPECIFICATION	WT. OF COATING g/m² PER FACE	THICKNESS OF COATING µm	THICKNESS OF COATING INCHES	WT. OF COATING OZ/FT² (1 OZ = .0017)	SPECIFICATION	ITEM
CASTINGS		610	86	0.0034	2.0	B.S. 729	CASTINGS
IRON AND STEEL	I.S.O. R/1461	500	71				IRON AND STEEL
FABRICATED STEEL ARTICLES							FABRICATED STEEL ARTICLES
			86	0.0034	2.0	B.S. 729	STEEL ⩾ 0.2" THICK
STEEL > 5.0mm THICK	I.S.O. R/1461	610	86			B.S. 729	STEEL ⩾ .5 mm THICK
STEEL 1 mm TO 5 mm	I.S.O. R/1461	*500	71				
			65	0.0025	1.5	B.S. 729	STEEL 0.08" TO < 0.2"
		460	65			B.S. 729	STEEL 2 mm TO < 5 mm
STEEL < 1 mm	I.S.O. R/1461	350	49	0.0020			
			47	0.0019	1.1	B.S. 729	STEEL 0.048" TO < 0.08"
		340	48			B.S. 729	STEEL 1.2 mm TO < 2 mm
SCREWED FASTENERS							SCREWED FASTENERS
NUTS AND BOLTS WITH SCREW THREADS OVER 9 mm DIAMETER	I.S.O. R/1461	375	53				THREADED WORK OTHER THAN TUBES OR FITTINGS
			53	0.0021	1.25	A.S. B193	> 3/8" DIAMETER
			43	0.0017	1.00	A.S. B193	⩽ 3/8" DIAMETER
			43	0.0017	1.00	B.S. 729	⩾ 3/8" DIAMETER ⩾ 10 mm DIAMETER
		300	42				
			38	0.0015	0.90	B.S. 729	< 3/8" DIAMETER < 10 mm DIAMETER
		270	36				

This brief comment on friction grip bolting and its corrosion protection is made because bolts and the inaccessible mating faces of structures are among the "Achilles Heels" referred to earlier in the paper.

GALVANISING (METRIC UNITS)

The paper concludes by reference to Table 2 which, at this time of Metric Conversion, should be of assistance in comparing 'Metric' and 'Imperial' specifications, weights and thicknesses of hot-dip galvanised coatings.

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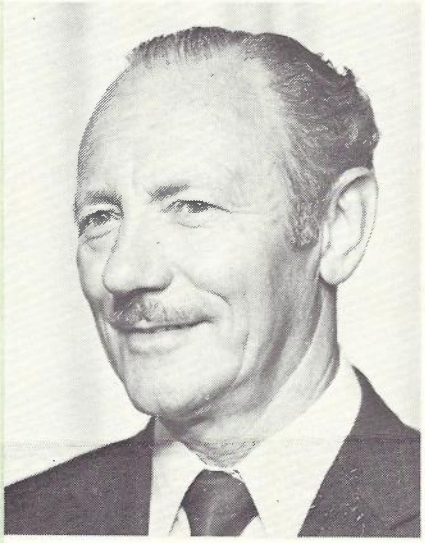
6, "Bolting Zinc Coated Structural Steel": Australian Zinc Development Association/AJAX Fastener Co. Handbook.

M. R. FORDHAM obtained his tertiary qualifications and an Exhibition in Civil Engineering at the Melbourne Technical School (now R.M.I.T.), after which he served articles in architecture with the late Walter Burleigh Griffin. Later, as manager of the joint Melbourne Office of W. B. Griffin and The Reverberatory Incinerator and Engineering Company, he obtained wide experience in structural and mechanical design and construction.

Joining the P.M.G.'s Department in 1938, he was appointed to the Research Laboratories as Design Draftsman where he was responsible for the structural and mechanical design apsects of the radar projects being developed by the Laboratories during World War II.

Promoted to D.C.A. in 1946, he became Chief Airways Draftsman then, after appointment as an engineer in 1948, Senior Engineer in charge of Airways Structural and Mechanical Design, Workships, Lines Engineering and Corrosion, and acted as Chief Mechanical Engineer for extended periods. He rejoined the P.M.G.'s Department in 1973 as Supervising Engineer, Radio Branch, Central Office, in charge of the Design (Structures) Section.

A Past Australasian President and a Life Member of the Australasian Corrosion Association, Mr. Fordham has been the author of several papers published on corrosion and structures, and has presented them at Interstate Conferences and to the Structural Branch of the Institution of Engineers.



Computer Sorting of ADR Non-Action Information

I. R. COTTERELL and R. DOHERTY

The large volume of messages generated by Automatic Disturbance Recording (ADR) equipment requires machine sorting to assist field staff to locate faults and fault trends. This article discusses problems encountered with manual sorting and early computer programs for sorting ADR messages and describes a field trial of the standard method of message sorting using an on-line mini-computer.

INTRODUCTION

This article describes the methods used for computer sorting of "non-action" messages generated by Automatic Disturbance Recording Equipment (ADR) — see Ref. 1. Non-action messages are a written record, in telegraph code, of the condition of selected key relays in a common control marker when it force releases because of failure to satisfactorily switch a call.

ADR is installed in approximately 200 ARF telephone exchanges which range in size from 2,000 line, low calling rate exchanges in rural or residential areas to 20,000 (plus) line, high calling rate exchanges in business or industrial areas. The number of messages generated will vary according to the type of exchange concerned. Exchanges which are performing well will generate fewer than sixty "non-action" messages per thousand lines, per week. While many exchanges have attained this level, other exchanges with a high calling rate, high fault incidence or congestion problems will generate many times this number of messages.

Whilst it is possible to manually sort and analyse small quantities of "non-action messages, it becomes extremely difficult to handle the large quantities generated and to obtain the depth of analysis necessary to quickly isolate faults.

MANUAL SORTING

Manual sorting of ADR non-action messages is basically a two level operation. Firstly, a skilled technical officer scans the printed output from the teleprinter and determines which messages warrant further attention; some are marked for plotting by non technical staff, whilst others, either because of their nature or quantity, indicate the need for prompt remedial action. At regular intervals (e.g., weekly) the summary sheets, on which message totals and the "deferred action" messages are plotted, are examined by the technical officer to ascertain the existence of faults or fault trends.

This process is time consuming and has the disadvantage that faults may remain undetected, particularly when a large number of messages is handled. These disadvantages can be overcome by computer sorting.

INTERIM METHODS OF COMPUTER SORTING

Two different methods of computer sorting of ADR "non-action" information have been used in the field, the first was introduced in 1970 and provided a simple message sort of markers within exchanges. No statistics were provided and only limited numbers of messages could be processed in each batch. The second method, developed in 1972, sorted messages from each marker into groups that readily assisted fault location (e.g., into fault types or inlets). Statistics were compiled for selected groupings for each processing period. The latter method was developed in conjunction with IBM and could be used wherever their facilities were available.

Data collection was similar for both methods; namely "non-action" messages from the individual exchanges were routed through a switching stage (ADX) and collected on punched paper tape using telegraph perforating machines. The paper tape was removed periodically (usually weekly) and taken to a processing centre from which the sorted information would be collected and distributed to the various exchanges. This process is shown in Fig. 1.

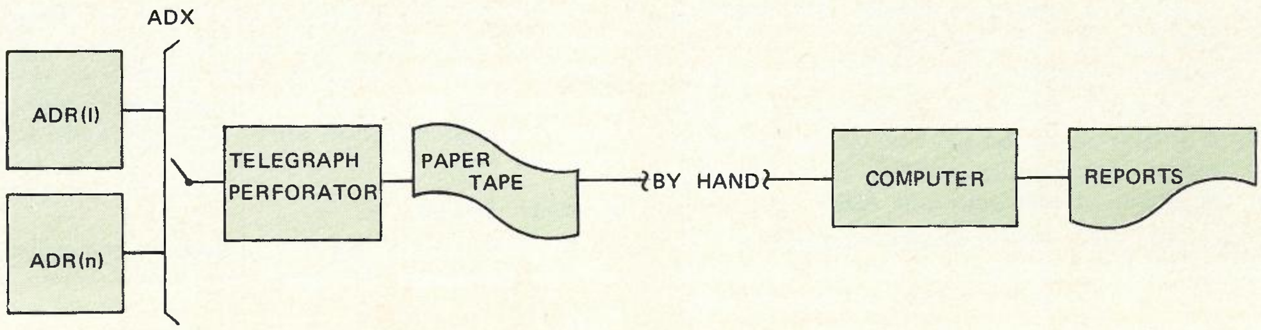


Fig. 1 — Interim Method of Computer Sorting of "Non-Action" ADR Information.

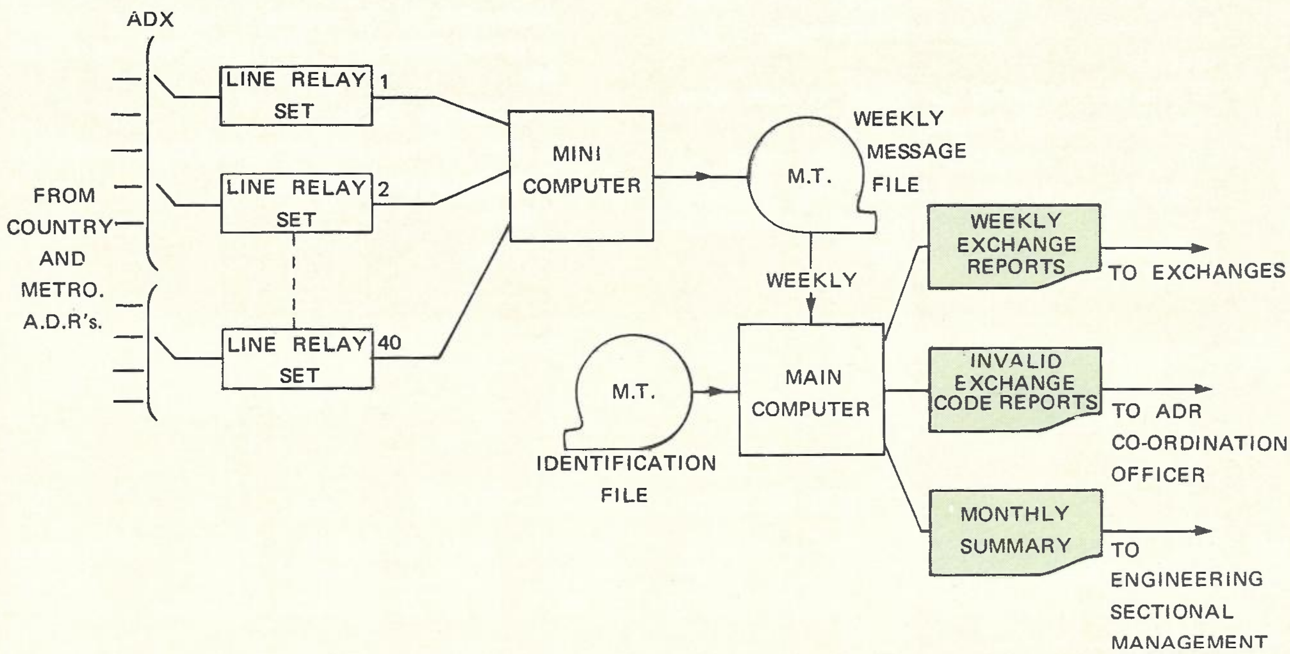


Fig. 2 — Mini-Computer System for Sorting "Non-Action" ADR Information.

Both methods provided satisfactory service but suffered from the following disadvantages:

- High running costs.
- Housekeeping problems, i.e., storage and care of paper tapes.
- The paper tape had to be physically removed from teleprinters and despatched to the processing centre.

STANDARD APO COMPUTER SORTING SYSTEM

The system adopted by the APO as a standard utilises an "on line" mini-computer to collect messages direct from selected ADR's via their respective ADX's. Introduced in New South Wales as a trial, in 1974, it will then be progressively extended to exchanges in other States where justified.

The main advantages of this system over previous methods are:

- Less manual effort — no handling of tapes.
- Lower operating cost (estimated 0.1 to 0.3 cents per message).
- More detailed sorted information including statistical summaries.

Fig 2 is a block diagram of the mini-computer system for sorting non-action messages.

Messages can be received on a maximum of 40 incoming ADX lines simultaneously. Each ADX line terminates on a *line relay set* which:

- Provides an interface between the incoming line and the mini-computer.
- Repeats telegraph signals to the mini-computer.
- Provides telegraph line supervision facilities. If a fault occurs on the receive leg, the send leg is automatically opened, thus providing an alarm at that particular ADX.

The "on line" *mini-computer* receives the repeated telegraph signals, from the line relay sets, in standard telegraph code No. 2 (5 element code) and performs the following functions:

- Edits the received messages; deleting all unwanted control characters, e.g., letter shift, figure shift characters, etc.
- Converts the required characters into AS-X1, 7 bit code. This code facilitates ease of processing.
- Counts the characters contained in each message for a validity check.
- Records the messages, in AS-X1 Code, on magnetic tape and includes the character count and ADX identification information pertaining to each message.

Each week the magnetic tape will be removed from the mini-computer for processing on a large general purpose computer. The processing will be completed that same evening and the resultant reports mailed direct to each exchange with an expected arrival in 24 to 48 hours.

Message Sorting

Computer processing of "non-action" messages will be developed through three stages.

Stage 1:

To be used during the New South Wales trial to prove the operation of the mini-computer system, i.e., the interworking of the mini-computer with the selected ADX's and the processing of the magnetic tape by a general purpose computer. Messages will be sorted by:

- Exchange prefix.
- Item of equipment identification number.
- Alphabetical sequence.
- Date.
- Time.

EXCHANGE: 999 LETHBRIDGE
3 ACKLANDS ROAD
LETHBRIDGE

NO. OF MESSAGES (* = GREATER THAN LIMIT)

EQUIPMENT	WEEK ENDED 19 JUL 73	WEEK ENDED 26 JUL 73	WEEK ENDED 2 AUG 73	WEEK ENDED 9 AUG 73	WEEK ENDED 16 AUG 73	WEEK ENDED 23 AUG 73	WEEK ENDED 30 AUG 73	WEEK ENDED 6 SEP 73	CURRENT WEEK'S LIMIT
SLM/S O/G									
111	6	2	2	12	3	10	5	10	20
112	18	10	18	18*	15	8	6	5	17
113	9	3	6	10	10	6	9	0	20
114	12	15	37*	5	8	9	18	12	22
115	3	5	12	13	3	15	3	5	20
117	7	6	15	6	5	0	10	0	15
AVERAGE	9	7	15	11	7	8	9	5	
SLM/S I/C									
131	17	18	29*	18	1	5	12	95*	25
132	5	15	10	20*	60*	7	18	10	20
AVERAGE	11	16	19	19	30	6	15	53	

Fig. 3 — Weekly Exchange Summary Report.

Stage 2:

To be introduced immediately after the trial period in New South Wales. This becomes the initial system in all other States that acquire mini-computer facilities. This stage will provide a statistical summary with each exchange report and a more detailed sorting of messages than Stage 1. Messages will be sorted by:

- Exchange prefix or identity number
- Item of equipment identification number
- Defined groups according to the type of equipment marker, e.g., (i) SL and 1GV marker messages are sorted into the first two letter combinations relating to the more common time-out occurrences. SLM/S outgoing groups are "VH, CP, CG and others" whilst 1GV groups are "AE, CE, EE, IN, PA, VZ and others". (ii) GIV messages are sorted according to inlets.
- Date.
- Time.

Stage 3:

This would cater for future needs including additional analysis of data or to limit unnecessary output.

WEEK ENDED: 6 SEP 73

EXCHANGE: 999 LETHBRIDGE
EQUIPMENT TYPE: SLM/S O/G

		1AN1	1AN2	1AN3	1AN4	1AN5	REST	TOTAL
111								
	CG	2	1		1			4
	CP	1		1				2
	VH		1			1		2
	OTHERS		1				1	2
	TOTAL	3	3	1	1	1	1	10
112								
	CG							0
	CP	3	1					4
	VH					1		1
	OTHERS							0
	TOTAL	3	1	0	0	1	0	5
114								
	CG		3					3
	CP	1	2					3
	VH		4		2			6
	OTHERS							0
	TOTAL	1	9	0	2	0	0	12

Fig. 4 — Equipment Summary Report.

Computer Outputs

The standard system in all States (Stage 2) will supply the following reports:

- Weekly Exchange Reports — in four separate parts, namely:
  - (i) Exchange Summary Report — indicates the number of messages received per individual marker and includes the previous seven weeks history (See Fig. 3).
  - (ii) Equipment Summary Report — provides the number of messages received per sorting group for each marker (See Fig. 4).
  - (iii) Message Data Report — contains actual messages received for each device listed according to sorting priority (See Fig. 5).
  - (iv) Invalid Message Report — lists all messages containing errors in format, length or device code.
- Invalid Exchange Code Report — lists messages received that contain exchange code errors. This report is forwarded to the ADR Co-ordination officer so that system faults, causing this type of error, can be corrected.
- Monthly Summary Report — produced every four weeks and is a duplicate of the Exchange Summary Report for distribution to Sectional and Regional Offices.

The Exchange Summary Report is examined to ascertain those markers that are not performing within expected limits. As an aid to the ready identification of these markers a "limit flag" is used to mark those entries that exceed a limit calculated by the computer for each marker after reference to its past sixteen weeks history.

The Message Data Reports for these selected markers can then be examined to ascertain the reason for the high failure rate and to determine what action, if any, is required to rectify the condition.

The Monthly Summary Report provides engineering sectional management with a quick reference to the progressive performance level of the equipment within each exchange under its control.

This valuable indicator, however, does not provide a means of comparing relative performance

WEEK ENDED 6 SEP 73

EXCHANGE : 999 LETHBRIDGE
EQUIPMENT TYPE : SLM/S O/G

DEVICE 111

1AN1	CGAZ.	O....	.D...	....Z	73	09	02	1240
	CGAN.	..S..	...Z.	....Z	73	09	03	1310
1AN2	CGS.R	S.Z..	..Z..	....A	73	09	02	0931
1AN4	CGZ.R	Z.D..	...S.	....D	73	08	31	1316
1AN1	CPAZ.	ZZ..Z	...Z.	....Z	73	08	31	2320
1AN3	CPD.V	LOV..	...Z.	....S	73	08	31	0051
1AN2	VHS.Z	..A.S	.....	....A	73	09	02	1034
1AN5	VH.AZ	A...Z	.....	....Z	73	09	01	1173
REST	AL.N.	S..A.	..S..	.....	73	09	02	0925
1AN2	CDS..	.D.Z.	...Z.	....A	73	09	02	1530

Fig. 5 — Message Data Report.

of exchanges as the ADR/ADX system is not dimensioned to provide a 100% collection of disturbances. The percentage of marker timeouts that will be received at the mini-computer will vary from exchange to exchange depending on such factors as the number of simultaneous time-outs occurring and the dimensioning of the ADX equipment.

FUTURE DEVELOPMENT

In time, the weekly ADR computer report may consist only of the Exchange Summary report, unless items of equipment exceed the limit. In these cases, additional information in the form of Message Data Reports will be produced. Another variation is to associate the exchange permanent meter statistics with the computer calculation of the limits so that the permanent meter readings influence the generation of the "Message Data Reports".

CONCLUSION

Computer sorting of "non-action" messages will assist field staff to attain the full potential of the ADR as a maintenance aid.

Where large numbers of messages are generated much valuable time and effort is consumed if manual sorting is employed.

A high proportion of these expended manhours can be saved by an efficient computer sorting system such as the APO standard mini-computer system, which also increases the efficiency of maintenance staffs by:

- Providing uniform information at each exchange.
- Highlighting those areas in need of attention.
- Providing an easy means for the officer-in-charge to oversight results and to assist in determining maintenance policy.

REFERENCE

1. A. D. Peterson: 'Automatic Disturbance Recording (ADR) equipment for Crossbar Exchanges'; Telecomm. Journal of Aust., Vol. 17, No. 1, Feb. 1967, pages 53-54.

I. R. COTTERELL joined the APO in Western Australia in 1959 as a Technician-in-Training. He was involved in the development of ADX equipment and assisted with the establishment of the Perth ADR/ADX Network and the Western Australian, IBM based, computer sorting programme. He is now Senior Technical Officer, Grade 1, in Network Performance and Operations Branch, Headquarters.

R. DOHERTY entered the APO as a Technician-in Training in 1950. He served with Country Installation and Metropolitan maintenance staffs before joining the Network Performance and Operations Branch, Headquarters, in 1972. His present position is Senior Technical Officer, Grade 1, and among his current projects is that of the development of the Automatic Disturbance Recording equipment.

Solvents and Safety

F. M. PETCHELL, A.S.M.B.

This article sets out some of the general and physiological properties of solvents commonly used in the telecommunication industry.

A brief outline of the chemical structure and behaviour of several groups of substances is given.

INTRODUCTION

With the increased use of solvents for a wide variety of purposes, it is essential that the user be aware of the nature of these solvents, the hazards involved in their use, and the precautions that must be taken to minimize these hazards. Although users are often aware that the two hazards associated with the use of organic solvents are toxicity and fire, it is often only against the latter that any definite precautions are taken. While the effect of a solvent fire is dramatic, the toxic effect of a solvent is often insidious and not noticed until some organic damage is done and health is impaired.

The purpose of this article is to describe some more frequently used solvents and to list those properties which may help in the choice of the most suitable solvent for a particular purpose, having in mind the potential hazard involved in its use. This article seeks to highlight the potential hazard of each solvent listed.

In discussing physiological properties, the term threshold limit value is used, and it is desirable that this should be clearly defined.

Threshold limit values are those prescribed by the American Conference of Government Hygienists, and are the maximum concentrations to which it is believed that nearly all workers may be repeatedly exposed day after day, without adverse effect. The exposures are assumed to take place over an eight-hour shift, followed by a 16-hour exposure free period. At the same time, it is recognised that wide variations exist in individual susceptibility and that a small number of hypersensitive individuals may react at or even below the values listed.

The contaminant concentration in the air inhaled seldom remains constant during the working day, and a typical day's exposure consists of concentration peaks, superimposed on a lower level background. The peaks of fast acting compounds, such as irritants and narcotics, may cause ill effects in less than 15 minutes, so values of these are prefixed with the letter C to indicate that they are ceiling values, which may be only momentarily exceeded.

SOLVENT CLASSIFICATION

Solvents generally fall into one or another of several chemical groups, each group comprising of a closely related homologous series. Although the chemical and the physical properties of solvents within a particular series change only gradually with increasing molecular weight, solvents from a different series can differ markedly. Each family of solvents possesses certain radicals which give its members characteristic properties, but as the molecular weight increases in the series, the effect of these radicals lessen, as the ratio of the group radicals to the rest of the molecule decreases.

While the user of a particular solvent, knowing the group to which the solvent belongs, can obtain a general idea of its properties, he must bear in mind that individual members sometimes have much more severe physiological properties than other members of the group. Examples of this are benzene in the aromatic hydrocarbon group and carbon tetrachloride in the chlorinated hydrocarbon group.

Listed below are the main chemical groups of solvents, together with typical examples.

Hydrocarbons.

This class of compounds is mainly obtained from petroleum oils which occur in pockets in the upper strata of the earth, where they are probably formed by the decomposition of organic matter.

They are all flammable and immiscible with water and the lower alcohols and esters. They are solvents for oil, fats, waxes, bitumen and, with the exception of the simpler aromatic solvents, particularly benzene, are relatively non-toxic.

They can be further sub-divided as follows:

- Aliphatic hydrocarbons, paraffins or alkanes;
- Cycloparaffins or cyclo-alkanes;
- Aromatic Hydrocarbons.

Aliphatic Hydrocarbons: Methane, Ethane, Propane, Hexane, Octane, Paraffin Wax, etc.

Members of this series range from gases through liquids to hard wax-like substances as their molecular weight increases. They are characterised by their chemical inertness, showing little tendency to combine with many reagents. They consist of straight or branched chains of carbon and hydrogen atoms, hence, the name hydrocarbons. The lower molecular weight liquids comprise the major constituents of engine fuels, lighter fluids, kerosene, etc.

Cycloparaffins: Cyclobutane, Cyclopropane, Cyclohexane.

These bear a close resemblance to alkanes but, instead of an open chain, have a ring structure.

Aromatic Hydrocarbons: Benzene, Toluene, Xylene, Naphthalene, etc.

These are also ring structured molecules and, in general, the aromatic hydrocarbons are more powerful solvents than the aliphatics; the cycloparaffins being intermediate in their solvent properties.

Halogenated Hydrocarbons:

- *Chlorinated Hydrocarbons;*
- *Fluorinated Hydrocarbons.*

Chlorinated Hydrocarbons: Carbon Tetrachloride, Trichloroethylene, Trichloroethane, etc.

These are characterised by the presence of one or more chlorine atoms replacing hydrogen atoms in the molecule. On coming in contact with a flame or hot surface their vapours are decomposed into toxic, irritating and corrosive gases, – phosgene, chlorine and hydrochloric acid gas. Phosgene is particularly toxic, having a threshold limit value of 0.1 ppm (parts per million). An atmosphere containing 5 ppm is stated as probably being fatal after an exposure of about 30 minutes, and the least detectable odour of phosgene in air is said to be approximately 0.5 ppm.

This highlights the danger in smoking when using halogenated solvents, because their vapours readily decompose into these harmful gases, on being drawn through burning tobacco.

Fluorinated Hydrocarbons: 1,1,2, Trichloro, 1,2,2 Trifluoro-ethane.

In this class of compound, fluorine replaces some or all of the hydrogen atoms in the molecule, although in the compound we will discuss, both fluorine and chlorine replace hydrogen atoms.

These compounds also decompose into phosgene and other irritating and corrosive gases when brought in contact with a flame or hot surface.

Alcohols:

- *Monohydric* — Methanol, Ethanol, Butanol, etc.
- *Polyhydric* — Glycerol (glycerine), etc.

The presence of the hydroxyl group (–OH) in alcohols makes them polar in nature, the properties of the particular alcohol being determined by the proportion of hydroxyl to hydrocarbon residue in the molecule. In general polar substances are miscible with other polar substances and immiscible with non-polar substances. The simple alcohols, methanol, ethanol and propanol are strongly polar, completely miscible with water, and only partially so in hydrocarbons. The higher members become increasingly soluble in hydrocarbons and progressively less so in water.

Ketones

- *Simple Aliphatic:* e.g. Acetone, Methyl ethyl ketone;
- *Cyclic:* e.g. Cyclohexanone.

The ketones are characterised by a typical carbonyl radical (CO) in the molecule. The lower members are strong solvents for nitrocellulose and vinyl resin lacquers, and as their molecular weight increases the ketones become better solvents for oils and fats, yet still remain good solvents for nitrocellulose and vinyl resin lacquers.

PROPERTIES OF COMMONLY USED SOLVENTS

A brief outline of the physical and physiological properties of some commonly used solvents is given. The information is considerably abridged and for further information on this subject the reader is referred to the bibliography at the end of this text.

Acetone (dimethyl ketone, CH_3COCH_3).

Acetone is a simple aliphatic ketone and is a colourless, very volatile, highly flammable liquid, with a sweet odour. It has a very low flash point and its vapour forms explosive mixtures with air. It is completely miscible with water and many other solvents. It is miscible with vegetable oils and is a solvent for nitrocellulose, polyvinyl acetate, polystyrene and silicone oils.

Because acetone dissolves 300 volumes of acetylene at a pressure of 12 atmospheres, one of its important uses is as a solvent for acetylene in acetylene cylinders, making them considerably safer to handle.

There are no recorded cases of fatal poisoning from acetone. In view of the widespread use of acetone in industrial processes there have been few cases of even mild intoxication by acetone, and such cases have often proved to have been associated with exposure to other solvents in addition to acetone. It has a threshold limit value of 1,000 ppm and the principal effect of inhaling high concentrations is narcosis, in that it depresses the central nervous system, tending to produce unconsciousness.

Alcohol (ethanol, ethyl alcohol, absolute alcohol, C_2H_5OH).

A monohydric alcohol, it is a clear, hygroscopic, colourless, flammable liquid with a fragrant odour. It burns with an almost non-luminous flame. It is completely miscible with water, ether and most organic solvents.

To conform with Australian excise regulations, ethanol is usually sold in the form of methylated spirits. This can be in two grades:

Special Alcohol

Contains only 2% methanol as an adulterant and is completely miscible with water. A Customs permit is required to purchase this grade.

Ordinary Methylated Spirits

This is denatured alcohol and to comply with Australian excise regulations must contain the following (expressed as proportion by volume):

- 1% hydrocarbon (petroleum fraction).
- 0.125% pyridine.
- 0.25% methanol.

Ordinary methylated spirits form a turbid solution when mixed with water.

The effects of excessive ingestion of ethanol are well-known. In acute poisoning, death usually follows complete coma and the amount of alcohol in the blood causing death varies from 180 to 600mg per 100ml of blood. Ethanol has a threshold limit value of 1000-ppm.

Benzene (benzol, C_6H_6).

Benzene is an aromatic hydrocarbon and is a highly flammable volatile liquid with a low flash point. It is practically insoluble in water, but is miscible with most organic solvents. It is a solvent for rubber, fats and resins. It is used in blended motor fuels, but should not be confused with "benzine," a term sometimes used for petrol, although most petrols contain some benzene.

Benzene is extremely toxic and is readily absorbed through the lungs. As an acute poison its chief effect is narcosis, but, it is as a chronic poison that it is most dangerous. Repeated exposure to low concentrations of benzene vapour can cause damage to bone marrow and affect the structure of the blood. Serious illnesses and death have resulted from chronic exposure to benzene. Benzene has a threshold limit value of C25 ppm, but even prolonged exposure at this level may cause benzene poisoning in susceptible individuals.

It is important to replace benzene whenever possible with other solvents which, although perhaps not innocuous, lack the serious chronic effects of benzene.

Carbon Tetrachloride (CCl_4).

A heavy colourless liquid, with a sweetish odour. it is non-flammable, but the vapour, in contact with a flame or hot surfaces, decomposes to form toxic and corrosive gases—chlorine, hydrogen chloride gas and phosgene. Phosgene, as stated earlier, is extremely toxic.

Carbon tetrachloride is a solvent for polystyrene and rubber, and forms azeotropic mixtures with such solvents as ethanol, methanol, iso-propanol and methyl ethyl ketone. In the past carbon tetrachloride was widely used as a fire extinguisher, but now has been largely replaced by much safer halogenated solvents, such as bromo-chloro-difluoromethane.

Carbon tetrachloride vapour is strongly narcotic, even at moderate concentrations, and rapidly induces unconsciousness. Injury to liver, kidneys and other organs may result either from a single long exposure at high concentration, or from prolonged or frequent inhalation of low concentration vapours. Carbon tetrachloride is readily absorbed through the skin and is highly toxic, whether it be absorbed by skin, inhalation or ingestion. It is an insidious poison and the odour is not usually objectionable even at highly dangerous levels. It has a threshold limit value of 10 ppm.

Methanol, (methylalcohol, wood alcohol, CH_3OH).

A colourless, mobile liquid with an odour rather more pungent than ethanol. It is highly flammable and its vapour forms explosive mixtures in air. It is miscible with water, ether and most organic solvents. It is only a mild solvent for fats and oils.

The manifestations of acute intoxication following ingestion of methanol are similar to the well-known effects of over-indulgence of any alcoholic beverage with one outstanding feature of methanol poisoning—a permanent blindness. Poisoning can also occur from inhaling the vapour, resulting in blindness also. This is a potential hazard rather than an actual hazard when reasonable care is taken to keep the vapour concentration at a safe level. The threshold limit value is 200 ppm. Methanol is readily absorbed through the skin resulting in methanol poisoning.

Methyl Ethyl Ketone (M.E.K., $CH_3COC_2H_5$).

A colourless, mobile, highly flammable liquid with an acetone-like odour. It is soluble in water to some extent and miscible with acetone, ether and many other solvents. It is widely used as a solvent in lacquers and adhesives. The vapour of methyl ethyl ketone has a narcotic effect and at relatively low concentrations is an irritant to the eyes and mucous membranes. It has a threshold limit value of 200 ppm and despite its widespread industrial use, no serious chronic effects have been recorded. It is a severe poison when ingested and both the liquid and vapour are said to cause dermatitis.

Mineral Turpentine.

A well known petroleum solvent, consisting essentially of aliphatic, cyclic and aromatic hydrocarbons. It is a colourless liquid, whose main use is as a solvent in paint. The toxicity of mineral turpentine depends to some degree on the aromatic content (40 - 50% by volume), but it is not considered to present any industrial hazard under the usual conditions of use, due to its low vapour pressure. In view of its extremely wide use without any apparent ill-effects, it may be regarded as a relatively safe solvent, but it will defat the skin and could give rise to dermatitis.

"Shellite" ("X55" Solvent).

Shellite is a highly volatile, highly flammable petroleum solvent, composed of aliphatic hydrocarbons with small amounts of aromatic hydrocarbons, and is approximately that fraction of the petroleum distillate from which petrol is obtained. The aliphatic constituents consist chiefly of isomers of hexane, heptane, pentane and octane with about 4% by volume of the aromatic hydrocarbons toluene and xylene. It is stated to contain less than 1% by volume of benzene.

"Shellite" is not a single chemical entity, but a mixture of hydrocarbons. It has a narcotic effect and the degree of this effect would vary with its constitution. The aromatic content would give it some toxicity, but not of a high order. "Shellite" has a high vapour pressure, so its vapour concentration in the air would tend to become high when adequate ventilation was not available.

Tetrachloroethylene (perchloroethylene, CCl_2: CCl_2).

A heavy, colourless, mobile, non-flammable liquid with a chloroform-like odour. It is a good solvent for oils, fats and resins. It is freely miscible with alcohol and ether and is widely used in the dry cleaning of textiles.

Tetrachloroethylene is a narcotic. There have been cases reported of chronic and acute poisoning and it appears that this compound may not be as harmless as it was first thought to be, but as yet no definite conclusions have been reached. It has a threshold limit value of 100 ppm.

Toluene (toluol, $CH_3C_6H_5$).

Toluene is an aromatic hydrocarbon and is a colourless mobile highly flammable liquid with a sweetish odour. It is extensively used as a solvent in paints and adhesives. Toluene is a solvent for ethyl cellulose, ester gums, epoxy resins, alkyd resins, raw rubber, chlorinated rubber, polystyrene, polyvinyl-acetate and acrylic resins. It is not a solvent for shellac, polyethylene and teflon. It is miscible with hydrocarbons, oils, ethanol and other solvents.

Although toluene is primarily a narcotic of greater potency than benzene it is believed to be much less toxic in regard to chronic effects, because it does not have the serious effect on the blood as does benzene. It should be remembered, however, that commercial toluene is not pure and can contain benzene. Toluene is not absorbed readily by the skin, but the vapour is very readily absorbed by inhalation and has a threshold limit value of 200 ppm. Toluene is also an irritant for the skin and mucous membranes.

Trichloroethane.

A colourless, mobile non-flammable liquid with a characteristic sweetish odour of chlorinated hydrocarbons. It is miscible with chlorinated solvents and is soluble in the other common organic solvents. It is a solvent for fats, greases, waxes, and a wide range of organic materials.

Trichloroethane exists as two isomers; that is, with the same molecular formula, but having different properties owing to a different arrangement of atoms in the molecule. The two isomers are 1,1,1, trichloroethane (CCl_3CH_3) and 1,1,2 trichloroethane ($CHCl_2CH_2Cl$). Until recently the 1,1,1 isomer was regarded as being much more toxic than the 1,1,2 isomer, but it has now been definitely established that the 1,1,1 isomer is considerably less toxic.

1,1,1 Trichloroethane ("Genklene," "Chlorothene N.U.") has wide application as a cold cleaning solvent for electrical and electronic apparatus, because it has little solvent action on insulating varnish. It is not used as a metal degreaser at elevated temperatures, because it tends to oxidise in the atmosphere and one of the decomposition products is the dangerous phosgene.

In contact with moist air, especially under the influence of light, hydrolysis may result in liberation of hydrochloric acid. Small amounts of stabilisers are added to inhibit the formation of hydrochloric acid. "Genklene" and "Chlorothene N.U." are stabilised 1,1,1 trichloroethane.

The main toxic effect of 1,1,1 trichloroethane is exerted on the central nervous system in a manner similar to any anaesthetic agent. There is no evidence of it causing systemic injury and is regarded as one of the least toxic of the chlorinated hydrocarbons. It has a threshold limit value of 350 ppm.

The 1,1,2 isomer is, as stated earlier, considerably more toxic than 1,1,1 and as a chronic poison would be comparable to carbon tetrachloride. It has a marked capacity for causing injury to the liver and the kidneys and is a severe irritant of the gastrointestinal tract. It also acts as an anaesthetic and narcotic and has a threshold limit value of 10 ppm.

1,1,2 Trichloro, 1,2,2 Trifluoro Ethane (CCl_2FCClF_2, "Freon T.F.," "Arklone P").

A fluorinated hydrocarbon, which is a colourless, non-flammable very volatile liquid. It is stable to light, moisture and heat up to 300°C. It is miscible with most organic solvents. It dissolves oils and greases, but not rubbers, plastics and varnishes and its main application is as a cleaning solvent for electronic equipment. Being a pure solvent, containing no stabilisers or other additives, it may be used where high standards of cleanliness are essential.

Although relatively non-toxic, having a threshold limit value of 1,000 ppm, its vapour in contact with a flame or hot material decomposes into the corrosive and toxic gases chlorine, fluorine, hydrogen chloride, hydrogen fluoride and phosgene.

Trichloroethylene ($CCl_2 : CH\ Cl$).

A heavy colourless, non-flammable liquid with an odour rather like that of chloroform. It is readily miscible with other solvents, and finds wide use in dry cleaning and vapour degreasing of metals. It is a solvent for rubber, chlorinated rubber, grease, many vegetable oils, silicones, polyvinyl acetate and acrylic resins. Although it is non-flammable, its vapour in contact with flame or hot surfaces decomposes to form toxic gases—chlorine, hydrogen chloride and phosgene.

Trichloroethylene is a narcotic, and inhalation of high concentrations causes unconsciousness, and it was once used as a surgical anaesthetic. Acute poisoning by ingestion is sometimes fatal, but cases of great severity have recovered with suitable treatment. It has a threshold limit value of 100 ppm.

White Spirit.

A name applied to a petroleum solvent which consists largely of aliphatic hydrocarbons, with a variable content of aromatic hydrocarbons and cyclic paraffins. The aromatic hydrocarbon content ranges from 16 to 22 per cent by volume. It is a colourless, mobile, flammable liquid with an odour characteristic of petrol. It is used as a dry cleaning solvent and as a paint solvent as a substitute for mineral turpentine.

The toxicity of white spirit depends to some degree on its aromatic content. It is not considered to present any industrial hazard under the usual conditions of use, due to its relatively low vapour pressure. At high concentrations the vapour may cause giddiness.

CONCLUSION

Although the few solvents dealt with in this article vary considerably in their toxicity and flammability, no solvent should be regarded as being completely safe.

The hazard associated with some solvents is increased because of their high vapour pressure and their high rate of evaporation; and where adequate ventilation is not provided, the concentration of solvent vapour in the air can readily reach hazardous levels. In some instances this can be quite localized, the source being an open container, or a cloth impregnated with solvent. The most effective means of protection is adequate ventilation, by means of exhaust hoods and fans, or even open windows.

Do not overlook the possibility of skin absorption, so avoid skin contact with solvents. In choosing a solvent for a particular purpose, do not use a highly volatile solvent when a less volatile solvent will serve equally well. Do not use a highly toxic solvent when a solvent of lower toxicity may be used.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the permission of Macmillan, London and Basingstoke to quote from the book 'Solvents and Allied Substances Manual' by C. Marsden.

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APPENDIX

Listed below are trade names used in this article and the companies with which they are associated:

Freon TF	E. I. du Pont de Nemours & Co.
Arklone P Genklene	Imperial Chemical Industries Ltd.
X55 Solvent Shellite	Shell International Chemical Company.
Chlorothene N.U.	The Dow Chemical Company.

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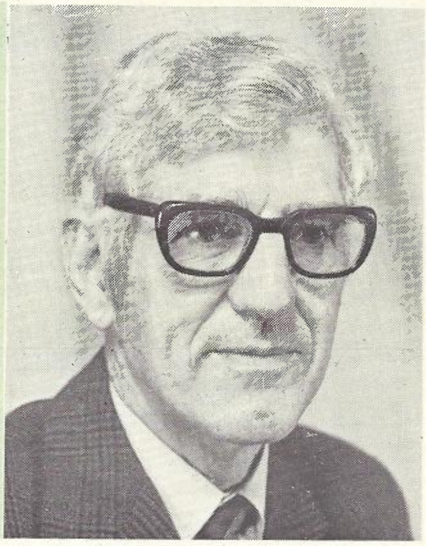

The APO Design Guide for Long Line Equipment

J. C. WILSON

A unified style of construction, together with standardised electrical interfaces, is being introduced for locally manufactured line transmission equipment. This article out lines the problems in achieving the objectives and describes the basic concepts of the solution.

INTRODUCTION

The aim of the Design Guide is to incorporate sufficient standardisation in Long Line Equipment to achieve uniformity in our practices and reduce significantly the overall costs.

This article describes the dynamic problem which faces an Administration when trying to achieve uniformity in design of transmission equipment, the basic concepts on which a solution can be based, the method of implementing the solution and finally some details of standards being introduced from 1972 onwards.

THE GENERAL PROBLEM

Basically the problem may be divided into three important constituents, namely:

- The rapid progress in component design leading to evolution of new component forms and the withdrawal from the market of existing forms.
- The demand for and achievement of bigger and/or better system designs.
- Competition within the industry on a world-wide scale to exploit both improved component forms and advances in system design.

Evolution in component design is a continuing process during which the size of components is being reduced at a remarkable rate, the quality is being improved gradually and the cost reduced significantly. However these improvements are being made and can only be sustained by increasing the scale of production. Indeed this increase in scale of production appears to be greater than the increase in scale of demand, which means that many components are available from fewer sources as time goes on. Moreover many components used in transmission equipment are highly specialised, which means that they are not available "off the shelf", but are obtained only by direct order on the manufacturer. Thus equipment suppliers with world-wide applications are constrained to order in bulk for their total requirements over the longest economic period in order to achieve optimum deliveries and prices, even if they are "in-house" components. Meanwhile, of course, earlier types of components, if available at all, are the subject of higher prices and longer delivery delays.

During the last generation it is the common experience in developed Western world countries for trunk circuit requirements to increase from between 12% and 18% every year and Australia is no exception to this trend. Moreover the employment of electronic transmission equipment over shorter distances to extend the use of, or reduce the cost of, copper in the ground is common everywhere although the extent depends on the circumstances which vary greatly in different countries. The immense improvements in the component situation has enabled system development to keep pace with demands. The two main fronts of progress are increased system capacity and increased feasibility of equipment concepts to exploit less sophisticated bearers and equipment accommodation. Current examples are the emerging 60 MHz coaxial systems with 10,800 voice circuit capacity and the low sending level 12 channel cable carrier systems which can exploit existing voice frequency cables, with minimal demands for equipment accommodation. Although the demand for these improvements is ever present, in our Western social structure the stimuli to undertake the development are commercial gain and competitive advantage. Thus Administrations are faced with the situation where their suppliers are continually striving to market improved designs, incorporating features that, hopefully, their competitors cannot match in the immediate future and which are advantageous so far as operating costs are concerned.

The fact is that any particular style of equipment has a currency nowadays of about six years after which the components become obsolescent, or in other words difficult and costly to obtain. Another feature of the problem is that the major developers do not work in a synchronous fashion; that is they seldom produce designs with similar features simultaneously.

Thus the dilemma for an Administration in this rapidly changing situation is described by the facts that if any particular design is chosen as a standard, in practice its currency will be only about six years, and in the meantime competitors will offer many attractive new features.

The Australian Situation

Although it is the common practice to centralise basic design activities and component production because of the huge investments in scientific skills required, especially to gain competitive advantage, it is common for large commercial organisations to decentralise assembly of equipment because of advantages in obtaining labour and the costs of marketing and servicing. About 40 years ago manufacture of some of the more basic items of equipment for the APO market was commenced in Australia by overseas interests with large funds of specialist skills and this was encouraged by the Government. The Second World War stimulated this encouragement and since then several companies have established production facilities with a willingness to undertake the production of all the items of transmission equipment for which the demand is reasonably regular.

It is now slightly more than ten years since Australian production commenced on a broad front and today more than 80% of transmission equipment used in the APO is locally produced.

It is a tribute to the effectiveness of industry in Australia that today the APO buys about twice as much equipment for a considerably inflated dollar than it did ten years ago. In this period also the suppliers have built up design resources which have worked in harmony with APO designers to design several systems and adapt others to meet special conditions of the Australian environment whilst simultaneously developing design techniques to improve reliability. However it must be emphasised that effective local design effort is constrained ultimately by the availability and cost of components.

In mid-1968, when it was clear that the transmission equipment manufacturing business in Australia was a viable operation the Headquarters Long Line Equipment Design Group decided to take stock of the situation so far as design aspects were concerned. Very briefly the following undesirable features were evident:

- Because in earlier years equipment had been procured on a system basis from different suppliers whose main customers overseas had different interfacing standards (and sometimes performance standards also), we were now requiring optional electrical standards at the interfaces. For example optional impedance and levels were required at the points where channel modems were connected to group modems (GDF). As well as being costly this introduced performance hazards, very frequently so in the cases where optional earthing arrangements were provided.
- Whilst the main performance features were standardised on a back-to-back testing basis there were no guarantees that different makes of multiplex at the ends of circuits would interwork satisfactorily.
- There was no inter-compatability between modems on the one hand and power supplies and carrier supplies on the other in multiplex equipment. Thus any rank of modems at a station could be extended only with the same manufacturers type unless additional carrier supplies and power supplies were installed.
- There were 16 distinct types of rack in use. As some of these types were prewired racks the variations possible were great indeed. The complexities in ordering, stocking and installing were already too great.
- Too many primary power supply options were being provided at unnecessary expense.
- There was insufficient standardisation of physical features of the equipment alone to permit any systematic attempt to set down uniform installation techniques or develop standard times for estimating purposes.
- Considering the large number of small stations in the APO network the diversity of physical features could lead to ridiculous installation requirements. For example a station which required a 12 channel cable system terminal and a 12 channel VF Telegraph terminal to meet a six year requirement could require installation of three racks, one with a capacity for eight cable system terminals, one with a capacity of nine groups of twelve channels and another with a capacity for four telegraph terminals; in all about eight times the needed capacity of the station in a six year period and with the certainty that when extensions are needed spare space on two of the three racks, and all of the common equipment, i.e., carrier supplies and power supplies, could not be utilised.
- Great variety existed in the conditions at test points in equipments performing the same functions from different suppliers.

These were features which could barely fail to arise in the situation which existed up to that time, namely one of expansion of unpredicted high magnitude and insufficient resources available to the supplier and the customer to plan a sophisticated approach yielding adequate supplies.

Method of Implementation

Nevertheless at this time a plan of attack known as Design Guide Issue 1 was prepared and presented for consideration to companies with established production facilities in Australia who were tendering for supply of major items.

After 18 months of dialogue, substantial agreement was reached on the points set out and in February 1970 Design Guide for Long Line Equipment, Issue 2, was promulgated as a guide to the requirements which the APO would be seeking in our Specifications. It is the custom to seek quotations for supply over a three year period to give suppliers a chance to offer prices which allow for recovering development costs over that period; further, in order to even out the work load, the three year period for different types of equipment are staggered. In this situation it was decided to apply the Design Guide principles in the first instance to channel modems which represent about 40% of locally produced equipment and to apply them to other types as opportunity offered, in the meantime encouraging suppliers who may be undertaking redesign for their own reasons, e.g., cost reduction or use of more advanced components, to apply the principles.

At the time of writing, production of the 66 Style Channel Modems is being phased out; several hundred banks of the new style have been delivered already and various items from voice frequency equipment to supergroup modems following the new style have been supplied by various manufacturers.

BASIC CONCEPTS OF DESIGN GUIDE SOLUTION

Many equipment physical construction styles are available, most of which the designers would be only too happy for Administrations to adopt as their standard for prestige reasons alone. It is usual for these styles to incorporate hardware features which are highly specialised, often subject to patent protection, and generally depending on very specialised tooling. In any case competition in this area as already described is a demanding master and evolution of commercial designs is continuous, thus lacking in permanency. For this reason it was decided to create our own design, inviting the major tenderers to contribute and criticise, which they did, while establishing these main features:

- Equipment would be built in panels of standard width and depth and modular heights, which

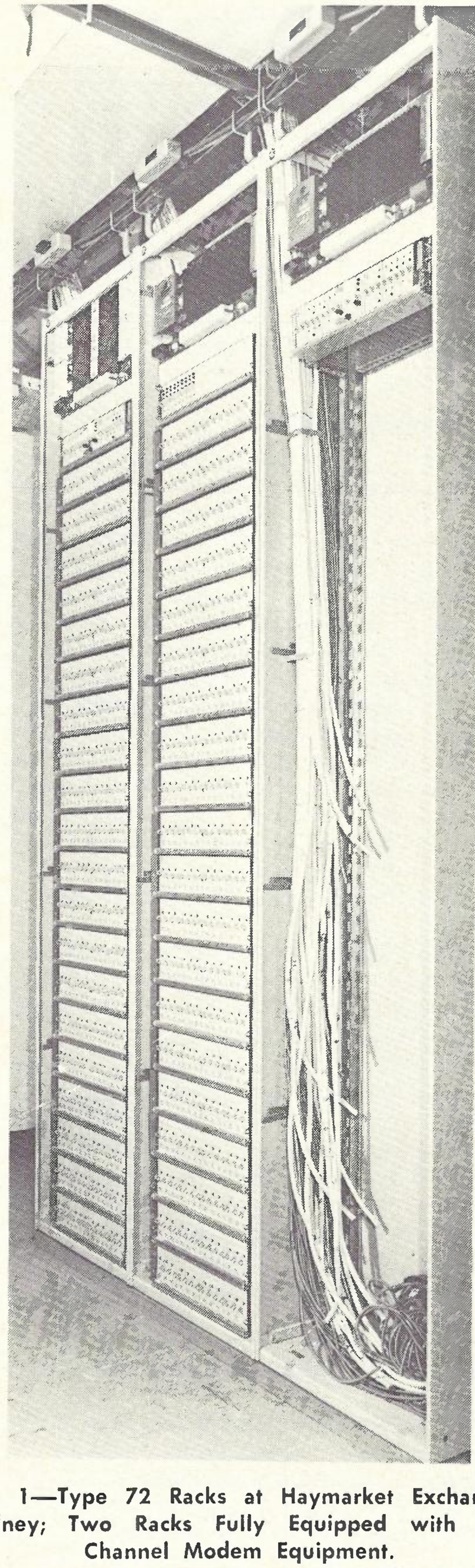

Fig. 1—Type 72 Racks at Haymarket Exchange, Sydney; Two Racks Fully Equipped with STC Channel Modem Equipment.

would have standard mechanical and electrical interfaces for various functions.

- Within the panel the supplier can use any components and hardware techniques so long as APO standards of functional performance and reliability are met.
- All external physical connections on the panels, whether for electrical or mechanical purposes, will be standardised. Panels for all purposes will mount in one only style of rack developed under APO control in which all cabling would be terminated directly on panels. Cables, methods of terminating, choice of connectors, power supply distribution methods, etc., are determined by the APO.

The important internal APO guidelines in this part of the operation are that the rack style be suitable for accommodating all the commonly and widely used equipment for the next ten years or so and that cables, connectors and terminating blocks be good quality and readily available locally. Whilst current space layout standards, floor loadings, etc., were not regarded as sacred, every effort was made to continue on the traditional paths unless there was some severe disadvantage or cost penalty in so doing.

In actual fact it turns out that most future installations (though not necessarily most of the equipment) could, and should, share space with switching equipment and this has been catered for.

Fortunately there is very much less decision making required in the matter of electrical standardisation. The CCITT Series G, H, J and M Recommendations are acknowledged universally. With some exceptions however, they deal mainly with "in service" performance of circuits for various purposes, e.g., speech, telegraphy, programme, data, etc. There is still a good deal of work transcribing these overall circuit performance requirements to detailed requirements for equipment as appropriate to the geographical and environmental conditions of the territory where it is to be used.

As mentioned earlier most of our suppliers of locally manufactured equipment are associated with organisations with relationships in several other countries and centralised facilities for basic design and component development or selection. Naturally these organisations make some effort to find a common solution to meet the requirements of all their customers and arrange a regular interchange and review of their customers' requirements. Although there are no strictly formal procedures for the purpose there is a free interchange of information between Administrations including our own and between our Administration and the suppliers central design organisations, mainly by means of personal visits, on the status of detailed design requirements. These interchanges lead to a selection of reasonably common approaches to specification details in the very many cases where theoretically a wide variety of consistent choices could be made.

Details of Implementation

As mentioned earlier the Design Guide for Long Line Equipment, Issue 2, of February 1970 sets out the principles which will be employed in Specifications for transmission equipment. Specifically the detailed requirements are set out in two groups of APO Specifications. Those known as the 1000 Series, viz. Specifications 1000 to 1020 set out all common requirements such as details of racks, power supplies, components, alarm facilities, test access facilities, etc. Then there are individual specifications for the various items of equipment which, in the main, describe exactly the standards of electrical performance expected from the various items.

It is not the purpose of this paper to deal with the aforementioned specifications but, having described the general nature of the prevailing problems, to indicate the broad nature of the solutions.

These are:

- Continuation of existing standards for space layout and floor loading.
- Rack design with dimensions which will be accommodated by present standards of overhead ironwork including cable runways employed in carrier stations and switching stations. This is a rack height of 2750 mm, width 600 mm and depth 240 mm, which allows the use of back-to-back layout in bays. A short version of the rack with overall height 2318 mm will be available for use in prefabricated buildings for ARK exchanges.
- Accommodation for equipment panels on the rack of dimensions which so far as width is concerned accord with that used on the most commonly used overall rack width of 525 mm or $20\frac{1}{2}$ inches and in height equal to a multiple of one half the most commonly used module. This is 22.225 mm or $\frac{7}{8}$ in. which is one half of the commonly used $1\frac{3}{4}$ in. module.
- Inter-rack cabling will be accommodated in a duct formed within the rack on the left hand side of the equipment. Such cabling will terminate directly on the appropriate equipment panels. All cables with balanced pairs, including screens, e.g., primary groups or balanced pair line connections down to dc leads, e.g., E & M leads, will be terminated by wrapped wire connections.
- Intra rack cabling will be accommodated on the right hand side of the rack. A narrow duct

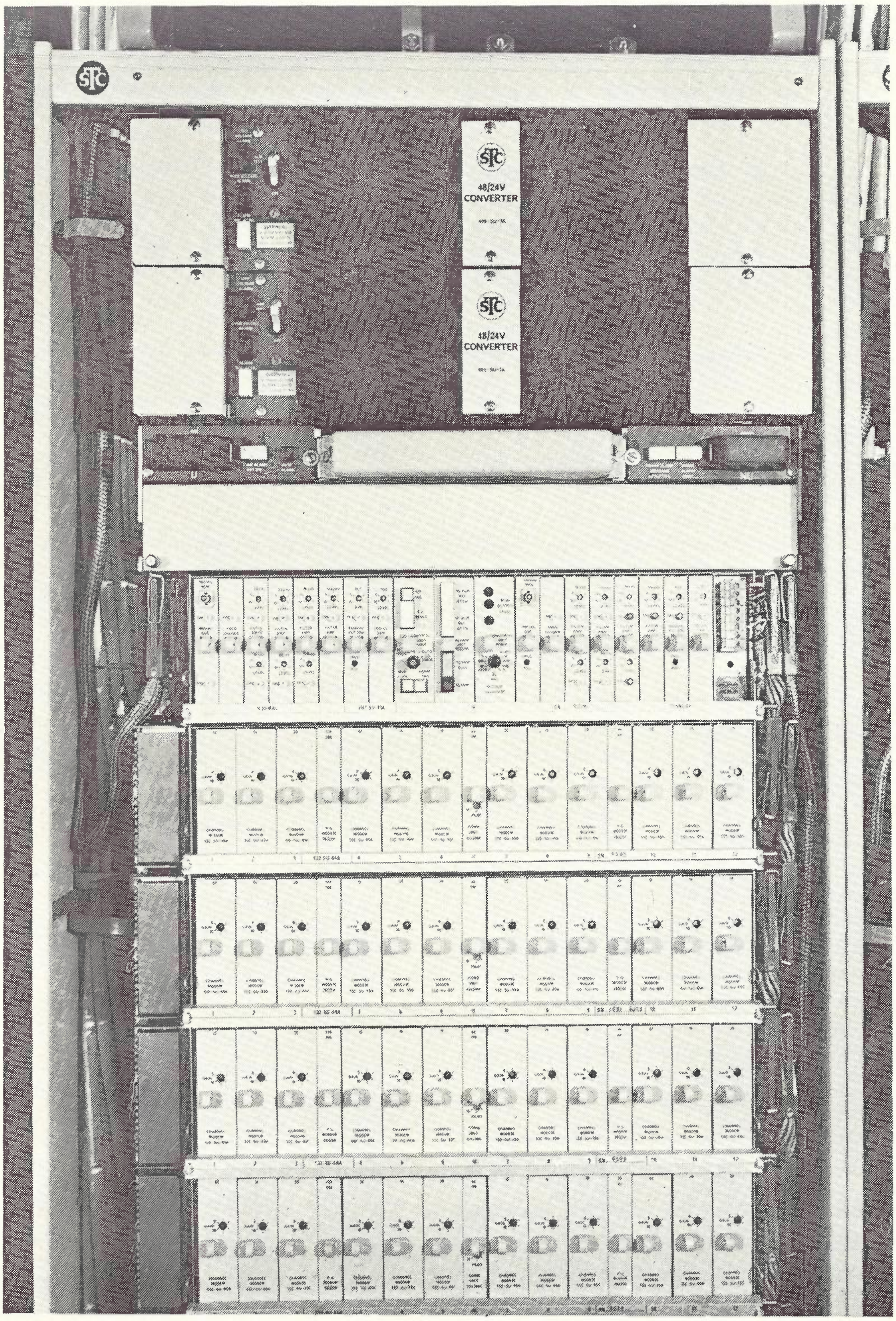

Fig. 2—Close-up View of Upper Part of First-in Rack, Showing (From Top):

- Two 48V/24V power supply converter panels (for connection in parallel)
- Alarm and power distribution panel
- Duplicated carrier supply panel
- Four channel modem panels
- Inter-rack cabling at left and intra-rack cabling on right.

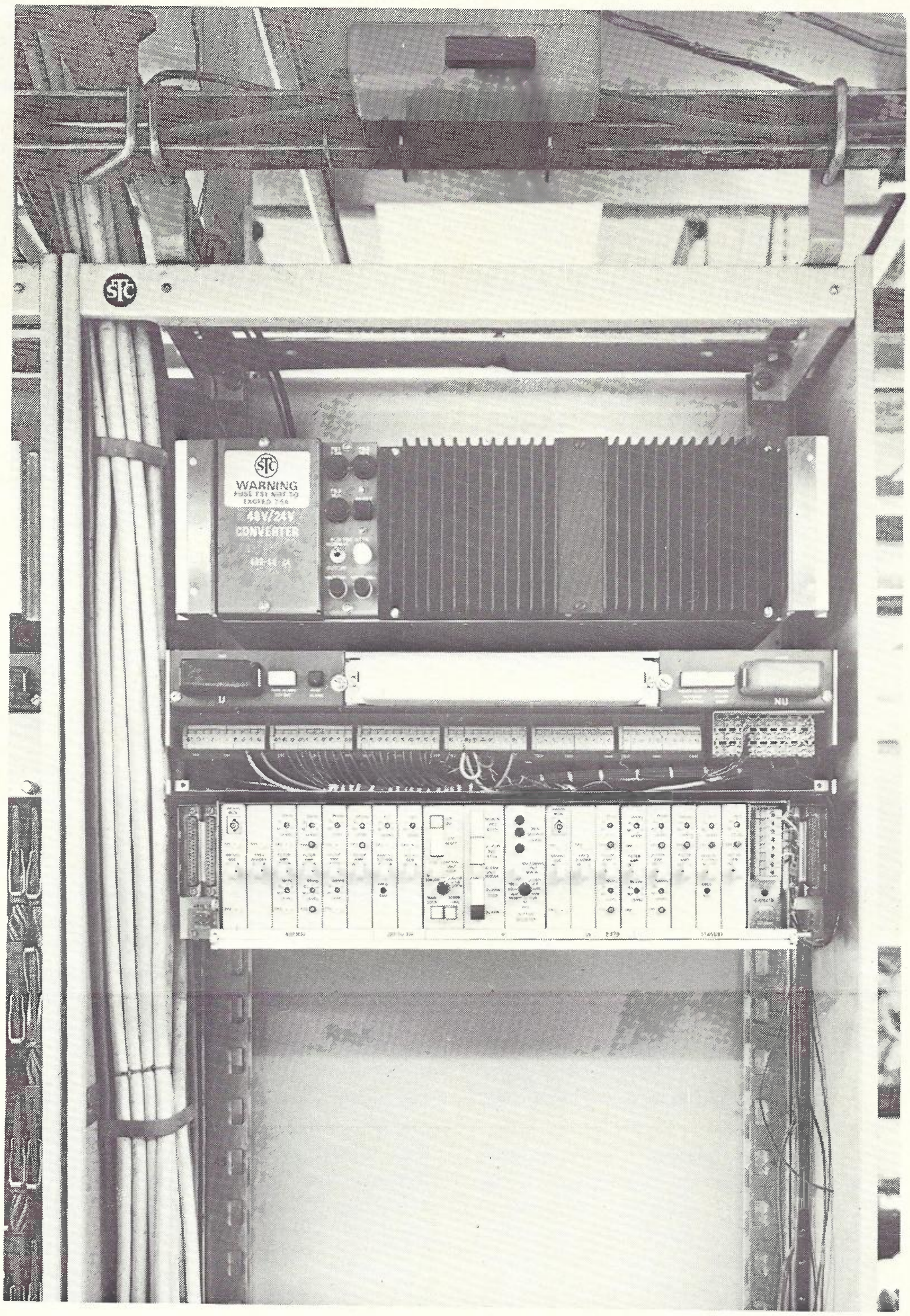

Fig. 3—Close-up View of Upper Part of Third Rack in Fig. 1, Showing Detail of Rack Construction, Power Distribution and Rack Earth Leads for Connection to Panels.

is provided for this purpose and will always accommodate power distribution. Carrier supply connections for multiplex equipment are also accommodated on this side. Carrier supplies are distributed on a ring main basis and the connections are made by a pair of multiway connectors on a recessed end of the panel at the right hand side of the rack.

- The rack construction is such that adequate earth-mesh and screening features are incorporated for the range of frequencies and levels used in any equipment.
- The primary source of power for all equipment will be -48V dc. Thus the same primary source is used for switching and transmission equipment in most cases, so avoiding compounding possible sources of failure in a station. In most cases transmission equipment will operate from -24V dc obtained by using voltage converters. In large installations existing 24V dc installations may be used but their extension is not favoured. In general the higher voltage remote power feeding supplies will be obtained by conversion from -48V dc. Power packs to supply -48V dc from commercial ac supplies will be available for situations where a -48V dc supply does not exist.
- Power supply protection will be rationalised. The primary source will be protected by fuses in the supply leads as is standard with switching equipment. The operating supply to the equipment will be protected by fuses in a distribution panel on the basis of one fuse in one lead for each panel.
- Total power dissipation in a rack will be limited in most cases to 150 watts with further limitation of temperature rise at any point on the surface of a panel to 10 °C. Special ventilation or heat exchange arrangements are required where power consumption in a panel is such that the temperature rise limits may be exceeded otherwise.
- Interconnecting levels between ranks of multiplex equipment and to line systems are standardised. This is accomplished with a standard level at each type of interconnecting frame, allowing a fixed value of loss between equipment and frame which may be built out and equalised if necessary by pads and equalisers at the equipment inputs and outputs. Thus jumpering rearrangements may be made on frames without readjustment of levels.
- A standardised alarm system is employed which gives options by strapping to assign any alarmed feature urgent or non-urgent attention as required by the circumstances in the station where the equipment is installed.
- As far as possible test and adjustment access is minimised and standardised. In general operating conditions will be checked by level monitoring only with provision for injection of test signals at the point nearest to the origination of the traffic signal.
- Wherever possible carrier supplies are centralised. This does not mean that there will be one only point where a carrier is generated but it is intended to avoid the distribution of control frequencies, e.g., 4, 12 and 124 kHz between racks thereby exposing such frequencies to additive interference from fluorescent lamps and the like which is converted to phase modulation or jitter in carrier generators.
- To the extent that it is economically advantageous, modulation patterns and carrier, signalling and pilot sources will be standardised, so that with standard operating voltages, equipment from different suppliers will be interchangeable.
- With standardisation of interconnecting levels, equipment for automatic gain regulation and level supervision can be standardised and freed from constraints on its application.

CONCLUSIONS

Experience has shown that specification of the electrical performance of components of a transmission system alone is not sufficient to achieve economic programmes of installation and maintenance operations. A sufficient degree of physical standardisation must be enforced to avoid difficulties and delays in these operations. Despite the variety of basic design concepts and component sources which are employed in our transmission equipment supplier organisations, the total enterprise in Australia has shown itself capable of coming to agreement on a plan which will permit a rational and less costly approach to provisioning, installing, commissioning and maintaining transmission equipment.

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J. C. WILSON is Staff Engineer, Design, with the Long Line Equipment Branch at Headquarters. For about 10 years, he has been in charge of the Section in the Long Line Equipment Branch dealing with design matters. Before this, he was in charge of the Line Communications Sub-section in the Research Branch for a similar period.

An MFC Display Instrument

J. E. LOFTUS

This article describes a test instrument which will store and display in decimal form the Multifrequency Code (MFC) Signals used for signalling between cross-bar exchanges and overcomes some of the difficulties encountered with current testing techniques. The instrument was designed by the Author and developed in the APO Research Laboratories.

INTRODUCTION

The APO Research Laboratories have recently been conducting field trials of electronic exchange switching and signalling systems (Refs. 1, 2). During these field trials, a need arose for a test instrument which could conveniently monitor and display the multifrequency code (MFC) information signals used to communicate with crossbar exchanges in the network.

Information signalling equipment in crossbar exchanges transmits and receives forward and revertive multifrequency code signals during call set-up. The information signals consist of 2 out of 5 or 2 out of 6 VF tones, thus giving ten or fifteen combinations respectively.

PRINCIPLE OF OPERATION

Until now there has been no device which will conveniently monitor and record the MFC signals under dynamic conditions. The usual technique is to watch the relay armatures in the signalling senders and receivers, or to connect lamps which flash while each relay is operated. These methods are inconvenient because of the number of relays involved, and the short duration of operation.

The test instrument developed to overcome this problem has six inputs which monitor the MFC receive relays or their "slaves" in the receiving part of the MFC code sender (KSR) or code receiver (KMR) equipment. The signals received are decoded, stored and displayed in decimal form on Light Emitting Diode (LED) numerical indicators, the display being from left to right in the same sequence as the signals are received. A block diagram of the instrument is given in Fig. 1.

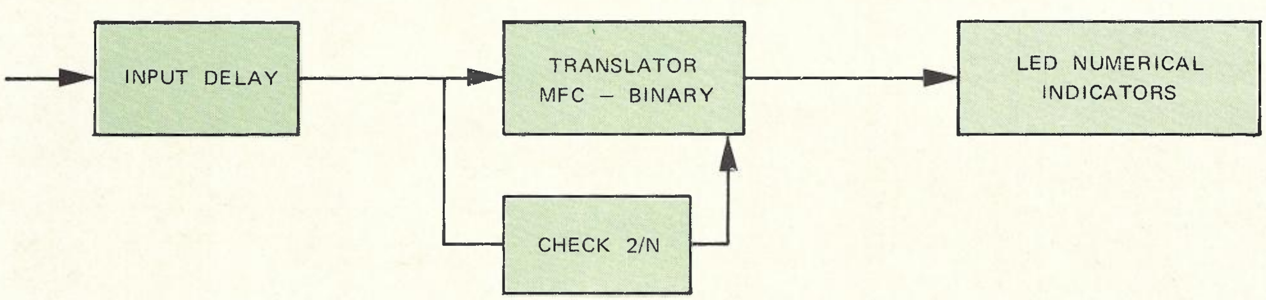

Fig. 1 — Block Diagram.

INPUT CIRCUIT

This instrument was designed to connect to both TTL integrated circuits (0 to +5 V) and relay circuits (0 to —50 V). A special feature incorporated in the input circuit eliminates the need for a changeover switch when going from equipment using low voltage TTL levels, to equipment employing high voltage relay circuitry. Because of this feature, the input circuit is thought to have considerable potential for more general use, and a circuit diagram is given in Fig. 2. The circuit uses a combination of diode steering (SC1) and potential divider networks . The remaining diodes form part of the voltage protection circuit. The LM311 is a voltage comparator. The circuit is of high input impedance, and provides protection from the high voltage transients caused by relay operations in the crossbar exchange.

REALIZATION

The prototype recorder (Fig. 3) built for use by the Laboratories has provision for displaying up to eleven digits. Each numerical indicator circuit has a dot matrix array which will display the numerals 1 to 0, corresponding to Multifrequency Codes 1 to 10, and will remain blank for codes 11 to 15. In applications where an indication is required for codes 11 to 15 a hexadecimal indicator could be used giving 16 states, 0 — 9 and A — F.

The circuitry employed in the recorder is all solid state and uses TTL integrated circuits resulting in a small lightweight test instrument.

Before displaying the digits, two main functions are performed to ensure the validity of the displayed signals. These functions are a two out of N test and contact bounce protection.

Two Out of N Test

A proper MFC signal consists of two tones only. If this condition is not satisfied, a decimal point will be displayed and stored in the position where the next digit would have been, thereby indicating a two out of N failure.

Due to differences in MFC receiver response times, the relays associated with the two tones may not operate simultaneously. Observations have shown this difference to be generally less than ten milliseconds. The recorder will accept a difference of up to 15 milliseconds before indicating a two out of N failure.

Contact Bounce Protection

The recorder is not affected by contact bounce having a break less than 15 milliseconds. Where a break exceeds 15 milliseconds the recorder prepares itself to receive the next digit.

The recorder information may be erased at any stage by operating a manual reset key located on the front panel. The recorder will then be prepared to receive the next eleven digits.

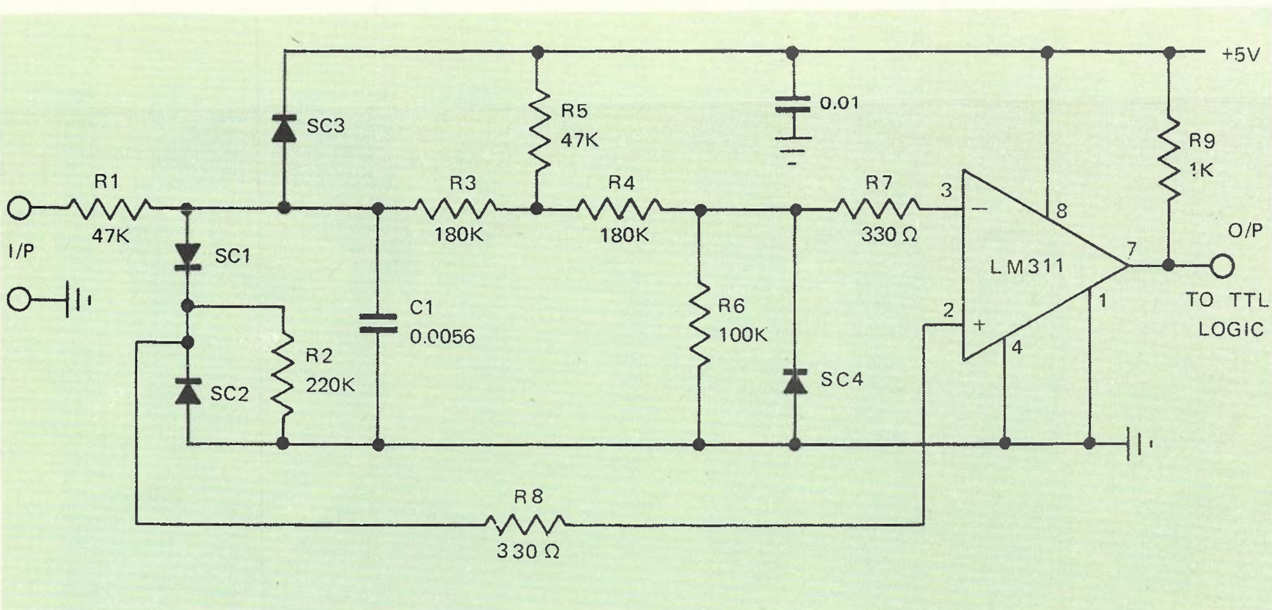

Fig. 2 — Input Circuit.

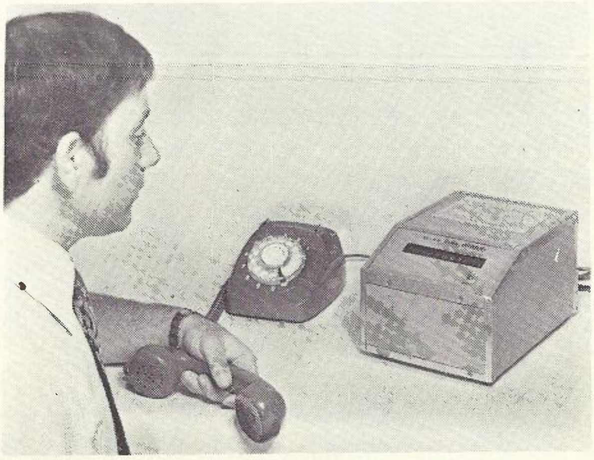

Fig. 3 — The Instrument, Connected to the Exchange Equipment, Undergoing Tests.

An additional feature which could be provided would be an automatic reset function. This would be particularly useful for displaying a faulty call on a KSR time-out. By using the time-out to stop the automatic reset function, the digits of the unsuccessful call would be left on display.

FURTHER DEVELOPMENT

The recorder has been used as a maintenance aid during the field trial of the No. 6 CCITT signalling system and is being used in conjunction with Hardware/Software testing on the Integrated Switching and Transmission (IST) Project.

It has been demonstrated to and used by Staff of the Victorian State Administration, and Central Office, and has given rise to considerable interest.

It is recognised that modifications and additions could be made to suit the user's application. Some of the suggestions already received are listed below:

- Increased digit capacity.
- A second display so that forward and revertive signals can be displayed simultaneously.
- Automatic reset facility.
- Provide a BCD digit output from the recorder to be taken to data logging equipment.

All of these suggestions can be easily implemented.

ACKNOWLEDGMENT

Advice received from Mr. P. J. Bowtell, S.T.O. 1, Research Laboratories, during the development and testing of this instrument, is acknowledged.

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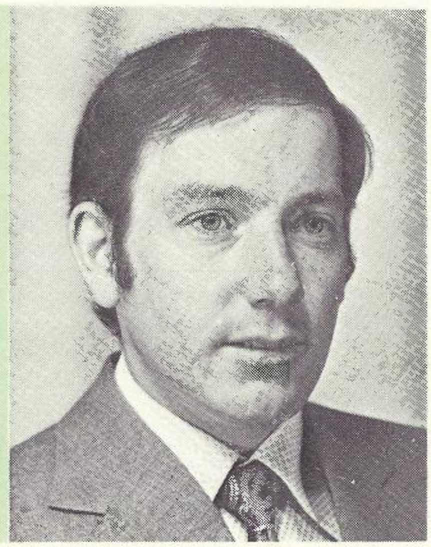
J. LOFTUS joined the Australian Post Office as a Technician-in-Training in 1966 and completed his Technician course with the APO Research Laboratories. He has been associated with the field of the CCITT Signalling System No. 6 and development of the Integrated Switching and Transmission (IST) Project. He is currently acting Technical Officer, Grade 1, with the Switching and Signalling Branch of the Laboratories.



Centenary of Telecommunication Societies in Australia

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The first known Australian society to specifically cater for telecommunications interests was called the Telegraph Electrical Society. It was formed in Melbourne, in August 1874, by an enthusiastic group of officers of the Victorian Post and Telegraph Department, and flourished well for a number of years. Unfortunately after 1881 interest in Society activities apparently declined and no records beyond that year can be located.

In 1908 a new society called the Postal Electrical Society was formed which had as its first president Mr H. W. Jenvey, one of the foundation members of the original Telegraph Electrical Society. After some difficult years, including a re-formation of the society in 1932, the Postal Electrical Society survived until it became the Telecommunication Society of Australia in 1959.

In this centenary year of 1974 a selection of some of the very interesting original papers and records of these early societies has been reprinted here (in the original typescript wherever possible) for the enjoyment of modern readers.

INTRODUCTION

One hundred years ago in August, 1874, a group of officers of the Post and Telegraph Department, Melbourne, founded a society called "THE TELEGRAPH ELECTRICAL SOCIETY". The purpose of the Society was stated to be . . . *"The promotion of the knowledge of electricity, especially as connected with telegraphs"*.

The Society was energetic in its early days and regularly published a little booklet called 'Transactions' to record its activities. The name of this booklet was later changed to 'Journal' of the Society, and, as can be seen from the extracts shown in the accompanying figures, it was similar in many ways to the present Telecommunication Journal of Austraia. In Figs. 1 to 9 are photocopies of the cover and the first group of pages of the very first issue of the 'Transactions' of the original Society. Figs. 2 and 3 describe the society's rules and give a list of the society's officers and members in those eary days.

It is very interesting to compare these rules and other aspects of this original Society with the present-day Telecommunications Society of Australia. In spite of the differences in size and state of technological development, the basic objectives and the functioning of the Telegraph Electrical Society of 100 years ago were remarkably similar to Telecommunication Society activities in 1974.

BRIEF HISTORY

The original Telegraph Electrical Society after its very good beginning apparently flourished from 1874 to about 1881 when Volume 19 of the Society's Journal was published covering the period January — December, 1881. Unfortunately no further papers relating to the Society can be located. (See Refs. 1 and 2.)

On 11 November, 1908 a new society called the Postal Electrical Society of Victoria was formed, and a paragraph from the first part of the inaugural address of the chairman of the new Society, Mr. H. W. Jenvey (who was a surviving member of the original Telegraph Electrical Society) is given below.

. . . . "We have to consider what is really the object of forming a P & T Society. In the first place there must be solid co-operation in order to keep it alive. Members should prepare papers and present them for discussion at the meetings regularly and give encouragement to those who contribute papers. The motive of the Society should be to improve the knowledge of the Officers — there is ample scope for study in our business without going outside the Telegraph and Telephone service. The field of study is not only Electrical. It is too often thought that knowledge of Electricity and Electrical laws is sufficient to fit an officer of this Branch for his duties — but that is not the case — that fact is becoming more widely recognised in all Electrical Engineering concerns, whether Private or Governmental. Before a person can deal satisfactorily with and solve Electrical Engineering problems, whether Telegraph or Telephone, he must be fortified with sound general knowledge. Knowledge of Electrical laws itself is not sufficient, he must have a knowledge of things which are taught in schools and universities — without that knowledge he will always find himself deficient. Then again outside the field of Electrical Engineering comes Mechanical Engineering which is so closely allied to it. In this service technical men should have a sound and solid knowledge . . . . "

The next part of this interesting address, which is still very relevant to the conditions of today, is unfortunately lost. In Fig. 10 a photograph of Mr. H. W. Jenvey is reproduced from Ref. 1. The photograph also shows the other original committee members of the Postal Electrical Society in 1908.

At a later stage apparently the society once more ran into difficult times and it was again reformed in 1932. Part of the inaugural address given by Mr. H. P. Brown, MIEE, Director-General of Postal Services on 12.12.1932 at that re-formation is given below:

. . . . "I assume that the activities of the Society will be related almost exclusively to the subject of communications, embracing of course, all the ramifications of technique, traffic organisation, finance, and economics, and it may be appropriate therefore, if I submit some observations on this interesting branch of commercial enterprise.

The advancement of all forms of communication in the last twenty or thirty years has been phenomenally rapid, and there are few civilised people in the world today who are really isolated — cut off from contact with the outer world. The world has become to this generation comparatively small. Distances as measured by the time to traverse them have contracted out of an earlier recognition. The knowledge of things and current happenings beyond our immediate environment is comparatively extensive and comprehensive and contrasted with 30 years ago the change is almost staggering.

The reason for this vast transformation is to be found in technical development, which has revolutionised the art of communication and led to the establishment of intercommunication with almost every part of the earth.

It is an astounding fact that there is not a square yard of the earth's surface over which are not passing messages, news, music and information of all kinds in such a form that it would be simple to detect and make intelligible to any or all with the desire and interest to provide one or other of the well-known means of radio reception. These radiations are all-pervading; they are to be found in every locality, whether during day or night; their existence is more continuous even than the sunlight, which is restricted in its incidence over every part of the earth's surface to only a proportion of the hours of the day."

Mr. H. Brown (later Sir H. Brown) retired from the Post Office in 1939.

On October 19, 1959, the Postal Electrical Society of Victoria was re-constituted as the Telecommunication Society of Australia, and there has been little change except general growth since that date.

In Figs. 11 to 17 are published photocopies of some further extracts of the original Telegraph Electrical Society Journal which it is felt may be of interest to readers of today.

MILESTONES

The following list of milestones has been assembled to show the relationship of the Telecommunication Societies in Australia to interesting dates in the development of telecommunications technologies.

?B.C. : First optical telegraphy (arm-waving, signal fires and smoke signals).

1753 : Multi-wire electro-static telegraph system suggested by unknown "G. M." in Scots Magazine.

1786 : Continuous electric current discovered by Luigi GALVANI

1794 : Multi-wire spark telegraphy developed by Reisser (or Reusser)

1805 : Multi-wire electrolytic telegraphy proposed by Salva

1820 : Multi-wire telegraphy using suspended magnets by Andre AMPERE

1825 : Electromagnet developed by William STURGEON

1831 : Electromagnetic telegraphy using coded signals by Joseph HENRY

1832 : Single-wire telegraphy proposed by Samuel MORSE

1838 : Morse code invented by Samuel MORSE

1843 : U.S. Congress voted funds for Baltimore-Washington telegraph line

1844 : Baltimore-Washington telegraph line demonstrated successfully

1850 : Morse code systems in widespread use

1853 : Duplex telegraph system proposed by Wilhelm GINTL

1858 : Machine telegraph system using perforated tape proposed by WHEATSTONE

1872 : First overland telegraph line in Australia opened between Darwin and Adelaide. See Refs. 4, 5, 6 and 7.

1872 : Telegraph communication established between Australia and England

1873 : Radio wave theory developed by James Clark MAXWELL

1874 : TELEGRAPH ELECTRICAL SOCIETY formed in Melbourne

1876 : Telephone invented by Alexander Graham BELL (See Fig. 12)

1878 : First Australian telephone exchange opened in Collins St., Melbourne (See Ref. 3).

1879 : First London telephone exchange opened

1880 : First official telephone exchanges opened in Australia at Brisbane, Sydney and Melbourne.

1887 : Radio waves produced in laboratory by Heinrich HERTZ

1896 : First patent on radio by Guglielmo MARCONI

1908 : POSTAL ELECTRICAL SOCIETY formed in Victoria

1914 : First automatic telephone exchange in Australia at Geelong

1923 : First radio broadcasting licence in Australia to station 2BL Sydney

1923 : Television systems demonstrated by BAIRD (U.K.) and JENKINS (USA)

1932 : POSTAL ELECTRICAL SOCIETY re-formed in Victoria

1936 : First Television broadcasting service in world inaugurated by BBC London.

1956 : Television broadcasting service inaugurated in Australia

1959 : TELECOMMUNICATION SOCIETY OF AUSTRALIA formed from Postal Electrical Society of Victoria

PREVIOUS HISTORICAL ARTICLES IN TJA

Two articles describing some of the early history of telecommunications societies in Australia were published in 1938 and 1939; see Refs. 1. and 2.

An excellent description of early telephony in Victoria was published in 1962 in Ref. 3.

Good descriptions of the overland telegraph line between Darwin and Adelaide were published in Refs. 4, 5, 6 and 7.

ACKNOWLEDGEMENTS

The co-operation of the Library of the Royal Society of Victoria; Mr. Ron Anderson A/g Deputy Principal Librarian of the State Library of Victoria; The Mitchell Library of New South Wales Mr. J. Olsen, Historical Officer, Public Relations Office, P.M.G. Department N.S.W.; and Mr. N. Ross, Secretary of the Telecommunications Society of Australia, in making available their valuable copies of the early publications referred to in the above article is most appreciated.

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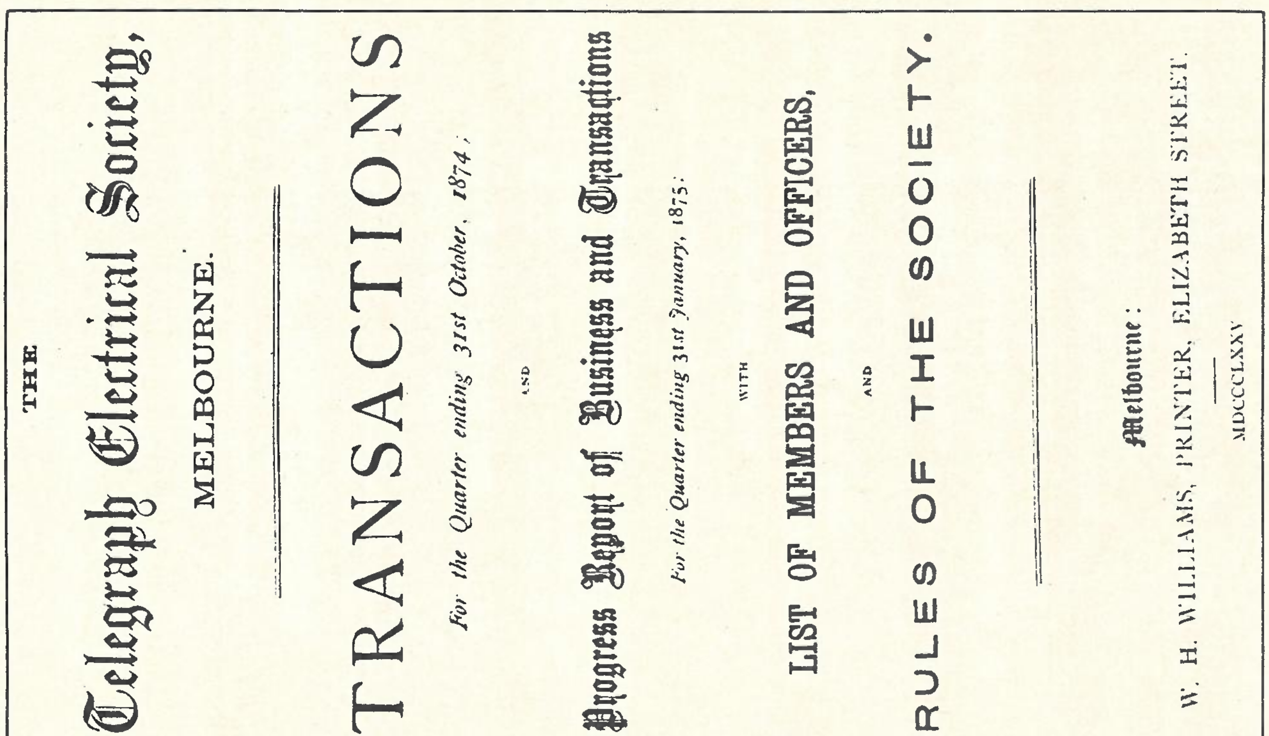

THE

Telegraph Electrical Society,

MELBOURNE.

TRANSACTIONS

For the Quarter ending 31st October, 1874;

AND

Progress Report of Business and Transactions

For the Quarter ending 31st January, 1875;

WITH

LIST OF MEMBERS AND OFFICERS,

AND

RULES OF THE SOCIETY.

Melbourne:

W. H. WILLIAMS, PRINTER, ELIZABETH STREET.

MDCCCLXXV.

Fig. 1 – Front Cover of First Publication by Telegraph Electrical Society, 1875

The Telegraph Electrical Society.

ESTABLISED IN AUGUST, 1874.

For the Promotion of the Knowledge of Electricity, especially as connected with Telegraphy.

Meets for the Transaction of Business at the **Melbourne Athenæum, on the Second and Fourth Wednesdays of each Month, at 8 p.m.**

Committee of Management:

Mr. G. SMIBERT	Mr. D. J. McGAURAN
Mr. D. MICKLE	Mr. H. W. JENVEY.

Hon. Secretary and Treasurer:

Mr. L. S. DANIEL.

SUBSCRIPTION, £1 PER ANNUM.

Corresponding (or Country) Members, 10s. per annum.

Payable Quarterly, in Advance.

Membership restricted, for the present, to Officers of the Post and Telegraph Department.

List of Members of the Telegraph Electrical Society:

Atkinson, J. P.
Betheras, R.
Barry, J. J.
Cawley, M. J.
Challen, P. R.
Clay, P.
Collier, W.
Costelloe, M.
Cregan, P.
Cross, W.
Cumming, A.
Curtis, J.
Daniel, L. S.
Doyle, J. D.
Edgar, H. S.
Edwards, J. E.
Fitzgerald, M. H.
Gay, T.
Gillan, J. D.
Green, F.
Greening, B.
Harper, W. J.
Hannah, A.
Howard, M. H.
Hayes, J. F.
James, T. R.
Jenvey, H. W.
Jonas, I.
Macaw, J. C.
McGauran, D. J.
Mackenzie, E.
Mackenzie, J. J.
Martin, A. P.
Matthews, J. B.
Mickle, D.
Miller, C. W.
Montefiore, S.
Morgan, R.
O'Shea, M.
Payter, J. W.
Quarry, H.
Quarry, G. F.
Scott, A.
Smibert, Geo.
Stevenson, A. H.
Turner, W. (D.P.M.G.)
Williams, W. W.
Wright, T.

Corresponding Members:

Allison, E.
Aubin, H. J.
Bechervaise, W. P.
Belling, A. H.
Blandford, W.
Born, A.
Bossence, A.
Bristow, H. B.
Cheyne, A. B. S.
Cheshire, H. E.
Colles, J.
Collier, J. L.
Comyns, J.
Constable, J.
Coverdale, J.
Dawkins, A.
Deverell, S. R.
Dobson, F. A.
Dore, F.
Duigan, J.
Ferris, J.
Green, T.
Groves, G. E.
Hall, E. B.
Haley, W. W.
Hayes, J.
Hayes, M.
Houson, H. J.
Kelsall, J. E.
Kelly, I.
Kinahan, S. E.
Landells, I. J.
Larritt, M.
Lewis, T.
Maplestone, C.
Maguire, W. H.
McDonagh, M. A.
Macourt, W.
McKay, G.
McLaine, H.
Merchant, F. L.
Murray, K. L.
Newland, G. W.
Nicol, J.
Orr, P.
Outtrim, F. L.
Rackham, F. W.
Roberts, J.
Stanton, A. W.
Saxe, W. H.
Segrave, W.
St. Leger, F.
Sennett, J.
Smith, C. O.
Smith, J. A. B.
Swann, W. T.
Thwaites, J.
Tucker, P. K.
Tymms, H.
Williams, W.
Yule, A.

Fig. 2 – Pages from First Publication by Telegraph Electrical Society, 1875

RULES AND REGULATIONS

OF THE

Telegraph Electrical Society.

1. The Society to consist for the present of Members of the Post and Telegraph Department.

2. The Society to be managed by a Committee consisting of five (5) Members, including the Secretary, to be elected annually by ballot.

3. A Subscription Fee of £1 per annum to be paid by each Member quarterly, in advance.

4. The Ordinary General Meetings of the Society will be held on the Second Wednesday of each month, at 8 p.m.

5. Meetings for Experiment and Instruction will be held on the Fourth Wednesday of each month, at 8 p.m.

6. The Business of the Ordinary General Meetings to consist of the Reading of Papers on various subjects connected with Electricity and Telegraphy, to be followed by discussion on the papers read. Papers not to exceed half an hour in time of reading, and Members to be limited to ten (10) minutes in their remarks.

7. The Committee of Management to be responsible for the production of papers and the providing of business at each Meeting.

8. The Subscription of "Corresponding Members" to be Ten Shillings per annum.

9. The Transactions of the Society to be published periodically, should sufficient funds be obtained, and a copy to be furnished to each Member.

10. No Administrative Business of the Society to be transacted at a General Meeting unless a quorum of not less than one-third of the Town Members of the Society be present.

11. No Alteration of the Rules or Constitution of the Society to be made unless notice be given at the previous meeting.

12. Any gentleman intimately connected with the practice of Telegraphy in this or the neighbouring colonies shall be eligible for Membership of this Society.

PROGRESS REPORT.

THE following pages give a tolerably full account of the transactions of the Society during its first quarter. The Committee of Management have thought it advisable that this should be done, in order that a correct notion might be formed by Corresponding Members of the manner in which the Society conducts its work.

During the second quarter, which has just expired (January 31st), the meetings of the Society have been held regularly, and well attended. Twenty additional members (ten Town and ten Country) have joined the Society, making a total of 109 members, and the movement, after six months' trial, may be said to be firmly established. It was determined by formal motion at the eighth meeting of the Society, on November 25th, that one of the two meetings held every month should be specially devoted to Experiment and Instruction; and at the tenth meeting, December 23rd, a Systematic Plan of Instruction was agreed on, to consist of the following subjects, in the order given:—Batteries; Electro-magnetism (including Galvanometers, Electro-magnets and Instruments); Lines (including Construction and Testing); Switches; and Repeaters.

Of the papers read during the past quarter those most worthy of notice were: One by Mr. Geo. Smibert, on "The Origin of the Voltaic Current;" one by Mr. D. J. McGauran, on "Galvanic Batteries;" and a short elementary lecture on "Electric Telegraphy," by Mr. L. S. Daniel.

Fig. 3 – Further Pages from First Publication, 1875

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This last paper was prepared as an introduction to the exhibition of the Electric Telegraph at a public entertainment, which was given by the members of the Society at the Melbourne Athenæum, on Monday, 1st February, 1875. This entertainment, which was presided over by Mr. Turner, the Deputy Postmaster-General, was very successful, and the Melbourne press was unanimous in pronouncing it one of the most interesting lectures ever given in the city. This success was in a very great measure due to the liberality of the Postal Department, which supplied in the most willing manner the instruments and materials necessary for the exhibition of the electric telegraph. It is with great pleasure that the Committee of Management have to report that in every way, every possible encouragement has been given to the Society by the Deputy Postmaster-General, and by all the officers of the Postal and Telegraph Department with whom the Society has been brought in contact; and they take this opportunity to thank these gentlemen on behalf of the Society for the good services they have rendered it.

It will now be a matter for the consideration of the Committee and of the Society as to what form the matter published by the Society shall take in future. The first instalment of periodical works on Electricity and Telegraphy has been received in the current numbers of the "Telegraphic Journal," and the published "Transactions of the Society of Telegraph Engineers." Further instalments of other and similar publications are shortly expected, together with a number of the best and latest works on Electricity and Telegraphy; and it may probably be found of more advantage to supply the country members with copious extracts from these publications, keeping them at the same time sufficiently informed of the actual transactions of the Society, than to expend their subscriptions in merely publishing these transactions in full. It has already been determined that the whole of the funds arising from the subscriptions of country members shall be expended in printing the matter to be periodically issued to them. It therefore rests with the country members of the Telegraph service to determine the extent of the publications to be issued by the Society, by the extent to which they will support the Society in becoming members of it. Without any country members at all

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the Society will continue to exist, and will perform good work among the town members. With the co-operation of the country members, this good work may be extended to the whole service; besides which, an *esprit de corps* would then, as a natural result, exist among the whole of the members of this important branch of the Postal service. These considerations, the Committee think, should induce all in the service to join the Society, even if, individually, any should consider they did not at once receive a fully adequate return for their small subscription.

Fig. 4 – Further Pages from First Publication, 1875

THE TELEGRAPH ·ELECTRICAL SOCIETY.

THE first Ordinary General Meeting of this Society was held on Wednesday, 12th August, at 8 p.m., at the Melbourne Athenæum, Mr. D. J. McGauran in the chair.

The minutes of the previous meeting having been confirmed, the Chairman called upon Mr. L. S. Daniel to read a paper he had undertaken to produce on "The Object, the Use, and the Working of the Telegraph Electrical Society."

Mr. Daniel then read as follows :—

It is with considerable diffidence that I have undertaken to be the first to address this newly formed Society; but as, from the first, I had determined upon doing my best to assist it by every means in my power, I felt that I could not well decline coming forward, at the request of the Committee, on the present occasion.

The subject on which I propose to try and gain your attention is that of the Society itself. I think that we should thoroughly understand why we are met here to-night, and why we have formed this Society. To put the matter in its simplest form, I would say that we are met here to gain power. Knowledge is power, and our object is to increase our knowledge. The acquisition of power will increase our value, will cause attention to be drawn towards us, and will improve our position. I need scarcely say that, if our value be increased, and our position improved, we may naturally expect a tangible recognition of this improvement; but I confess that I would never have thought of putting the matter in such plain language as I find it in the *Journal of the Telegraph Engineers' Society* of London. While I was searching for material from which to form the present paper I came across the following passage in a lecture on the advantages

Fig. 5 – Further Page from First Publication, 1875

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of scientific education, published in that journal, and addressed to the Telegraph Staff of London, by Mr. W. H. Preece, C.E., and Member of the Society of Telegraph Engineers. He says:—

"There is no doubt that a knowledge of the technical details of telegraphy will eventually lead to an increase of the emoluments of those who are now engaged in the Department." (Mr. Preece, I may remark, is an officer of the British Postal Telegraph Service.) He goes on to say that: "So much is it considered necessary that a certain portion of technical matter should be known by all, that all learners will be required to qualify and receive a certificate of a certain knowledge of the construction and adjustment of the different apparatus they are required to learn. Promotion from one class to another will be made dependent upon such certificates. It is intended to establish two grades, and those who enter these grades will be required to pass through a certain examination. Bonuses will be given as rewards to those who pass these examinations, in proportion to the skill and talent they display. The first grade will include those who, in addition to the knowledge required by them in the ordinary discharge of their duties, can localise faults, understand the construction and use of testing boxes, tangent and ordinary galvanometers, and have some knowledge of the elementary principles of electricity and galvanism. The highest grade in addition to all this will be required to understand thoroughly the higher classes of apparatus, such as translators, Hughes's, Wheatstone's automatic, and to use Wheatstone's bridge and resistance coils, and to pass an examination in the principles of electricity and magnetism."

He adds that *pecuniary advantages must necessarily accrue* to such as avail themselves of the opportunities of acquiring this knowledge; and to put his meaning out of all doubt, he heads this division of the advantages of scientific education with the magic word *Pay!*

With such an authority as this before us I do not think that we need now hesitate to declare openly that one of the results we hope to obtain from the successful establishmeut of this Society is increased pay. I almost think that this result alone would be sufficient in many instances to induce a large number to enrol themselves members, but Mr. Preece points out also that there is pleasure as well as profit in acquiring scientific education, and I may say that I anticipate that many of us may eventually experience great pleasure in the fact that our scientific studies, prosecuted in connection with this Society, will have improved our social position and standing in society. I think, then, that, in saying that this Society is established for the pleasure and for the profit of its members, I shall not be far wrong, and that two better reasons for establishing any Society could hardly be found.

Most of us have been intimately connected with Telegraphy

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for many years; for so long, in fact, that it would be a hard matter for us to adapt ourselves to any other calling; and I think that very few of us have any idea of following, or would wish to follow, any other calling. But, while years have been passing on and changes have been made, most of us must admit that so far as scientific knowledge of our occupation goes, we have been standing still, or almost standing still. I believe that the time will shortly come, when, if we do not arouse ourselves from this lethargic state, we shall find ourselves quietly passed by by a new generation, who will wonder at the ignorance displayed by men who, as they will say, have been all their lives concerned with Telegraphy, and yet know so little about it. This is not a pleasant state of things to contemplate, and I confess that this idea has haunted me for a considerable time, and I hail the present movement as a favourable opportunity for us to commence a new state of things, and to lift ourselves at least up to the level of our fellow-telegraphists in other countries. We are, from our geographical position, much isolated from the great Telegraphic centres, but this should be no obstacle to our being at least their equals in practical and scientific knowledge, and, I may say, with, I hope, a pardonable pride, that I have such faith in Victorian energy and intelligence, that I do not despair of seeing this Society, by its members, become favourably known and honourably ranked among the older and more pretentious European and American societies. But certainly I have no wish to begin "blowing" already as to what we will do. At present we have only to confess that plenty of room exists for our self-improvement.

I have said that this paper which I am now reading would be "On the object, the use, and the working of this Society." To a great extent the two first terms are identical, but on closer inspection it may be seen that an inquirer might ask us "What is your object in forming this Society?" and when told what our object is, he might say, "And what is the use of it?" and then, "How do you propose to work it?" I will therefore endeavour to answer our imaginary querist in the order of his questioning. What, then, is our object in bringing this Society into existence. It is, as we have already declared in general terms at our preliminary meetings, "for the promotion of the knowledge of Electricity, more especially as connected with Telegraphy." That is no doubt a good abstract answer; but I will now endeavour to give some details as to what I consider should be the object of the Society. It should help us to acquire a thorough knowledge, theoretical and practical, of the means used by the most advanced telegraphists to carry on their work. and we should endeavour to so perfect ourselves in this knowledge that it should be just as easy for us to thoroughly understand the use and theory of, say Wheatstone's Bridge (I select

Fig. 6 – Further Pages from First Publication, 1875

this because I confess that I really know nothing whatever about it) as of a simple Morse instrument. I have no doubt that to most of us, years ago, the mastering of the theory of the Morse instrument was considered a very satisfactory intellectual feat, and I remember when I thought I had some claim to consider myself well advanced in electrical knowledge when I had thoroughly mastered the deep mysteries of a repeating switch! I need not say how many years ago this occurred, but I bring it forward as an illustration of what I think will be the case if we apply ourselves honestly to the study of other problems connected with Electric Telegraphy, which, I am sure, cannot appear more mysterious to any of us now, than the repeating switch did to me years ago. In acquiring this knowledge we must be careful not to look too far ahead at first. Many a tourist has turned back from the ascent of a high mountain from losing heart at the apparently inaccessible heights as seen from the foot, where a more sensible traveller, plodding carefully on, arrives at the summit without perhaps having actually encountered any obstacles. I believe that if we do not lose heart at first, but plod carefully along, examining *more* the ground that we are *going over* than the difficulties before us, we will ultimately arrive at a very respectable height of knowledge of Electrical Science. The knowledge of Electricity as confined to Telegraphy is not, however, the sole object of this Society. Electricity in any form is so intimately connected with the present system of Telegraphy that it will be one of the ends of the Society to encourage, as far as its limited means will allow, the prosecution of researches into that inexhaustible mine of science.

A third object of this Society will be to endeavour as much as possible to keep its members posted up in *Electrical News*, by means of journals or other periodicals issued by kindred Societies in Europe or America. Of course, the extent to which this can be done must depend on the funds available for doing it.

If, then, I say that the direct objects of this Society are: 1st, The acquiring of knowledge of the higher branches of Electric Telegraphy; 2nd, The acquiring of knowledge of Electrical Science in the abstract; and thirdly, the keeping its Members informed of the movements and changes that are taking place in the great centres of Telegraphy; and that, by acquiring this knowledge, they indirectly gain *power*, and very probably *pay*, I think that will be sufficient answer to the question of "What is the object of this Society?"

I might pass over the second question, "What is the use of such a Society?" by simply saying that the objects above stated *prove* the utility of the Society; but a little more may be said on the subject. A good *practical* telegraphist might say, "Why not leave these things to men of science? So long as we can work *their inventions* to *their* satisfaction, and to the satisfaction of our

superiors, what need have we to put ourselves out of the way to learn what we can probably very well dispense with?" To that question I would answer, that, if any one has no objection to working like a mere machine, no one has any right to interfere with him. I would be sorry to see any one join this Society against his inclination. A man-machine is a very useful machine, not always as useful as an inanimate one, but possessing some advantages which the latter does not. Now, I do not mean in the least to say, or to imply, that those members of the Telegraph Department who do not join this Society are machines, but I do say, that this Society will be an excellent means of preventing many of its members from quietly subsiding into that unenviable condition. I, myself, cannot help feeling that there is an actual necessity for me to join a movement of this description in order to prevent myself degenerating, so far as office work goes, into a mere machine; and by devoting a small portion of our spare time to the study we propose, I believe that we will improve our standing as telegraphists very materially. I also think that it is due from us that we should establish a Society of this description in the chief city of Australia, or, I suppose I may say, of the Southern Hemisphere; and should we be successful in the working out of the objects of this Society, a body of efficient practical and theoretical telegraphists will be formed, of the *utility* of which, depend upon it, there will be *no doubt*, and the demand for which will never fail.

This brings me to the last question, "How will the Society be worked?" To that the answer can scarcely be so explicit as to the two first questions. We do not as yet know our strength, either intellectually, numerically, nor financially. But as we may hope to have a sufficient number of members to keep the Society at any rate alive, it will be worth while to devote a few minutes to the consideration of how we may carry on the work we propose to accomplish. Firstly, as we have already agreed, by the reading of papers contributed by the members, and by discussion thereon. I need scarcely say that it will not be necessary that these papers should be original, either wholly or in part, so long as the reader is honest euough to give the name of the author. We may come to that in time, but at present I incline to think that in most cases the less originality there is about the papers the more solid instruction they are likely to contain. In this paper, with which I am taxing your patience to-night, originality is of course essential, as it treats of no scientific facts, but simply of the establishment of a new and original Society, and therefore I regret I have had very little opportunity for anything like plagiarism. I would suggest that the papers read be more numerous than long. I think that after a few examples of what the papers should be like, but few of the members will find any difficulty in contributing their share.

Fig. 7 – Further Pages from First Publication, 1875

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Should, however, the contributions of papers fall short, it will be easy for the Committee to fix upon any subject for discussion, the text book being some well known work on Electricity. While the papers are being read, those members who wish to profit by them will no doubt take notes. This taking of notes is a most important matter. Mr. W. H. Preece in his lecture makes a special point of it. He says :—"You should always carry with you a note-book, in which everything fresh, everything striking, should be at once jotted down, and there secured as food for reflection. You will thus habituate yourselves to the most invaluable method of fixing upon your mind facts which will be of subsequent use to you. Unless difficulties are recorded when they are met with, or new ideas seized upon and noted down at once, they are apt to escape the memory altogether. I recommend you strongly to write your notes neatly and carefully, and not to destroy them ; if they are written on the same sized paper and kept together under their proper subjects, they will prove a never failing source of profit and pleasure." In addition to the reading of papers, it may be at times found advantageous for the members of the Society to meet at the Telegraph Office in order to see practically demonstrated some fact brought before them. I anticipate no difficulty being thrown in our way to such a proceeding, and I may say that I believe this was one reason why the admission of members was restricted to the Post and Telegraph Department. Were strangers admitted, there might possibly be objections raised to their being allowed access to the Telegraph Operating Room.

There is a branch of knowledge which will be found necessary to the student of Electric Science, and which will require special attention on the part of those to whom it is not familiar. I allude to mathematics, and I cannot do better than once more quote Mr. Preece on this point. He says :—

" Mathematics is one of the mind's most valuable assistants. It only needs interpretation ; its name frightens. The word mathematics has an alarming sound. Algebra, trigonometry, and the differential calculus are terms that inspire terror into the minds of the uninitiated. But each of these subjects, if energetically grappled with, proves to be so simple that, after once the stile has been crossed, you look back and smile upon the difficulties which apparently encumbered the path, but which existed chiefly in the imagination. . . . No one should be deterred by the letters and symbols which are used to designate mathematical processes, and particularly those who are so used to arbitrary symbols as telegraphists. *Geometry and Algebra are indeed essential* to the skilled telegraphist, and it is difficult for any one to comprehend the higher branches of his profession until he has mastered the elementary principles of these two branches of pure mathematics. It is the application of algebra which enables the telegraph

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engineer to tell the distance of a fault in a submarine cable to within half a mile, and to direct the sailor, with unerring accuracy, to the spot where he must apply his repairing apparatus. It is trigonometry which enables the sailor by the observation of the sun and stars to direct his ship, though in the middle of the ocean and far away from lands, to this very spot. It is the differential calculus which enables the electrician to obtain the greatest possible speed of working with the least consumption of materials out of his submarine cable."

Another important point to be considered is that of mutual help. Of course there may be always some few who can get on well enough by themselves, but I think that when anyone becomes a member of a Society of this description he is bound to a certain extent to adapt his strength to the average strength of the Society. We are not now preparing to start for a RACE, but for a JOURNEY, and we may have some very rough ground before us. Let us make up our minds to mutually assist each other over any difficulties we may find on the way, and let us make this Society take the place of the *cord* with which Alpine tourists fasten themselves together, and which, though perhaps checking the more rapid advance of some individuals of the party, proves on many occasions the means of a safe journey to the whole of them.

To return to the practical working of the Society, I may say that I think that for the present we will have to confine ourselves to a great extent to the means we have ready to hand, and will have to leave experiments alone until we become stronger in finance. But we have a great deal to learn without even going outside our own office in search of novelties. How few of us, for instance, could set a Wheatstone instrument right if anything went wrong with it, simply because we have never taken the trouble to ascertain the theory of this instrument. There is again the Duplex system of Telegraphy, which I remember thinking, some few years ago, was a wild impossibility, yet which I hope, before long, we will have explained and practically demonstrated to us by one of our members who has devoted a great deal of his time and attention to this problem. Seeing this and other problems practically demonstrated at the Telegraph Office will be one of the advantages of our having restricted the admission of members to the Post and Telegraph Department. In the matter of books, I am happy to say that we have received such assurances of support and encouragement from the heads of the Telegraph Branch, that I believe our slender finances will not be called upon to provide these necessary auxiliaries, but that the Department will be able to let us have the use, under certain restrictions, of any works which we may consider necessary for the prosecution of our studies. In the same way, I believe that we shall experience no difficulty, perhaps, in having access (of

Fig. 8 – Further Pages from First Publication, 1875

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course under restriction) to many useful instruments now in Mr. Ellery's possession or care.

I would also suggest that, as some of the members may be rather backward in even the rudiments of the theory of Telegraphy, we should have, for those who care to attend them, fortnightly meetings (alternating with the Ordinary General Meetings), which might be held in a room of the Telegraph Office, and at which some member, I am sure, could always be found who would be willing to impart to others what knowledge of Telegraphy he may have beyond what the others possess. In this manner we all could be brought up to a more even standard of knowledge of Electricity than exists among us at present, and in a short time the stronger men of science would not find their weaker comrades act as an incubus on them, but they could all go on steadily together.

It only remains for me to point out how country members may assist in working the Society. There are over a hundred country stations If we can induce say only sixty country members to join the Society, I believe we would be able to publish half-yearly a journal containing not only the transactions of the Society, but much other matter (extracted from various works and journals to which we hope to have access), which country members would otherwise never meet with, and which I feel sure will be, to them, fully worth the small subscription they are asked to contribute, even were not the knowledge that by so contributing they are raising the status of the body to which they belong a sufficient inducement to them to join the Society. It is to the country members then that we must look, if we are to make this movement anything more than a local one, as it is extremely doubtful if a sufficient fund would be obtained, by the subscriptions of town members alone, to enable the Society to disseminate throughout the whole Department the information they hope to gather by their labors. I feel, however, that I have occupied your time more than sufficiently. I hope that, having once got over the difficulty of starting these meetings, we will spend them more profitably than by reading such papers as I have produced to-night. It was due, however, to the first meeting that something of this sort should be gone through. It is a first push, though perhaps a rather rough one, to the Telegraph Electrical Society, and, thanking you for the patient attention with which you have honored me, I will conclude by hoping for the Society every possible success.

Some discussion among the members ensued, and a vote of thanks was unanimously given to Mr. L. S. Daniel for his paper.

It was also unanimously resolved that the address just read should at once be printed, and copies sent to all the country offices, the members present undertaking to defray the expense of so doing by voluntary subscription.

Second Ordinary General Meeting.

AUGUST 26TH, 1874.

Mr. CHAS. W. MILLER, chairman. Eighteen members present.

The Secretary announced that, in accordance with the resolutions carried at the previous meeting, the address read by Mr. L. S. Daniel had been printed and copies forwarded to every telegraph station in Victoria.

The Secretary had also, in accordance with instructions from the Committee of Management, subscribed on behalf of the Society for the following periodicals: *The Telegrapher* (New York), *The Telegraphic Journal* (London), and *The Transactions of the Telegraph Engineers' Society* (London).

Mr. George Smibert then read the following paper on "Electricity," illustrating his remarks with numerous experiments:—

WHAT IS ELECTRICITY?

The question I have chosen for the subject of this paper, namely, "What is Electricity?" is one which has occupied the attention of philosophers for upwards of a century; and I must confess, at the very outset, that they seem to be as far from a satisfactory solution as ever, though many experimental philosophers of the present day express a confident hope of yet being able to give an answer to the question which will satisfy all the conditions of the observed phenomena.

It will be inferred, then, from what I have here stated, that I do not pretend in this paper even to make a bare attempt at setting the question at rest, but only to lay before you a brief exposition of the various theories which have been propounded to, in some manner, account for the marvellous phenomena attributed to some force in nature and to which the name of electricity has been given.

In order, then, the better to understand our subject I purpose exhibiting some of the fundamental electrical phenomena, and then endeavor to apply the theories in explanation of the various actions thus observed.

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Fig. 9 – Further Pages from First Publication, 1875

Fig. 1.—Committee—Back row: E. S. Howson, W. J. Dawson, H. J. Rutherford, G. H. Bussell, F. Prior, O. A. Junck, E. A. Batty. Front row: M. J. Fitzgerald, G. H. Morgan, H. W. Jenvey, C. E. Bright, T. Howard.

Fig. 10 – Reproduction of Photograph from Ref. 1 showing Mr. H. W. Jenvey (front centre) a Foundation Member of the Original Telegraph Electrical Society, 1874. (At the time of the photograph (1908) Mr. Jenvey was with the committee members of the newly formed Postal Electrical Society).

SPEED OF WORKING THE MORSE INSTRUMENT.

Some interesting details of the speed of working the Morse system are given by Mr. F. L. Pope in *The Telegrapher*. Six days' work on five of the busiest lines in the New York office resulted in the transmission of 5,753 messages, containing 234,546 words. This gives an average of 191 messages of 40.8 words (7,800 words), as the work of one line for one day. The average number of words per message seems high, but it is evidently caused by the occurrence of long press messages. Two instances of fast transmission of ordinary messages are given, viz.:—

330 messages in 6 hours 30 minutes, 50.7 per hour
136 „ „ 2 hours, 68 per hour.

As it may be interesting to some of our readers to know what has been done in Victoria, we may mention that, on the occasion of the last Melbourne Cup race, 216 messages were sent from the Racecourse to Melbourne, on one of the wires, in 1 hour and 58 minutes, being at the rate of 109.8 per hour. At the Cup of the previous year, 135 messages were sent in 1 hour 5 minutes, being at the rate of 124.5 per hour. It must, however, be borne in mind that the average number of words in these race messages did not perhaps exceed 20 (address, signature, &c., included), and, on account of the frequent occurrence of the same names, abbreviations could be used to a great extent. As a matter of swift penmanship on the part of the receiving operator (he having written everything in full), these performances could not easily be surpassed.

TELEGRAPHING THE ST. LEGER, 1874.

Large as is the business of the Telegraph Department in connection with the race meetings of the United Kingdom, that transacted at Doncaster during the past week fairly eclipsed anything ever attained before. Last year, when close upon 13,000 messages were forwarded and received during the four days of the meeting, including 4,000 on the St. Leger day, it was thought that an outside limit had been reached, for on no previous occasion had anything like that number been realised in so short a time. But last week the total number for the four days reached the astounding figure of 16,500 messages, being an average of more than 4,000 a day; while on Wednesday 6,144 were forwarded and received between the town and Grand Stand offices. Of the total number forwarded, close upon 1,500, containing upwards of 110,000 words, equal to sixty columns of the *Times*, were sent on behalf

of the press; while not far short of 250 were sent to the continent and abroad. There were just under 4,200 messages for delivery to such vague addresses as the "Grand Stand," the "Betting Ring," &c.; and on the huge board where the messages are displayed until called for by their owners as many as 400 might be seen at one time on the St. Leger day. The ground and passages were strewn with empty envelopes; and on no previous occasion has anything like the number of messages arrived at a racecourse for delivery to their somewhat erratic addresses as on Wednesday week at Doncaster.

The scene at the telegraph counter immediately after the great race almost baffles description. The Post Office had advised the senders of "result" messages to be prepared with stamps, or stamped message forms, in advance; and so largely had this advice been followed that several hundred messages were thrust at the clerks through the small pigeon-holes within a few minutes of the decision of the St. Leger. Within about half an hour, not far short of a thousand messages had been thus handed in; and inside the office, after the din and confusion outside had subsided, some dozen or more instruments might be heard clattering away with their never-wearied tongues of steel. London, Manchester, Leeds, Sheffield, Newcastle, Edinburgh, and Glasgow were all being communicated with simultaneously from the Grand Stand; and throughout the meeting as many as four wires were worked to the central station in London, and two to Manchester. Naturally, there was some little delay on Wednesday, from the simple fact that more messages were handed in at one time than the wires could possibly carry. But within two hours of the decision of the race—viz., at 5.35—the office was practically clear of work, notwithstanding that upwards of 2,500 messages had been disposed of since its opening, about noon. Inside the office there was just as much regularity and method as there was din and confusion outside; and the only incident which momentarily distracted the attention of the clerks was the tumbling of a man through the skylight, who had presumedly got up there for the purpose of handing in a message, so as to avoid the crush at the counter.

At Doncaster a staff of twenty-eight clerks and nine messengers was employed, in addition to the ordinary staff of the office, which numbers five clerks and four messengers. The Wheatsone system of working was brought into extensive operation, and the working power of the office would be equal to that of about fifteen or sixteen ordinary wires. The arrangements were, as usual, in the hands of the special staff attached to the chief office in London, assisted by contingents from Manchester, Liverpool, Leeds, and Birmingham.—*Times (London).*

W. H. Williams, Printer, 68 Elizabeth street, Melbourne.

Fig. 11 – Extract from T. E. S. Journal, Vol. 2, 1875

NOVEL TELEGRAPHY IN CANADA.

A NUMBER of gentlemen interested in scientific matters recently assembled at the office of the Dominion Telegraph Company, to witness some very wonderful experiments on an apparatus which has been invented by Mr. A. Graham Bell, son of Professor A. M. Bell, of Tutelan Heights. This gentleman claims to be able to transmit musical sounds over a telegraph wire. A person singing or speaking, for example, at one end of the wire, every note or word will be distinctly heard at the other end—not only the words would be heard, but the tones of the voice also would be readily recognised by any one who had heard them before. Another very important improvement, which Mr. Bell claims to be able to put into use, may be described as follows:—A man wishing to send a message to Hamilton, for instance, writes it on shellac paper. It is received by a boy, who puts into a machine made for the purpose. The message is received in Hamilton by another boy, who brings it forth from a similar machine copied upon a piece of shellac paper in telegraphic impressions or written like copper-plate. Pictures drawn in shellac can also be sent and received in the same way. If this system can be put into use and worked effectually it will do away with telegraph operators altogether. But the most important feature which Mr. Bell claims is that he can transmit 30 or more messages over a single telegraphic wire at one and the same time. The way he proposes to do this is as follows:—On a wire running from, say, Brantford to Toronto, Mr. Bell would place 30 or more instruments at Brantford office. All these instruments will be tuned to different pitches. A corresponding number of instruments to be placed in Toronto office, each of the instruments tuned in unison with the corresponding instruments in Brantford. An operator can then transmit a sound on any one of these instruments, and none but that at the other end of the line which is in unison will correspond. Therefore, 30 or more operators can work together on the same wire without in any way affecting the others. This seems very wonderful, but Mr. Bell claims to be able to put it into practical use, and if he succeeds it will certainly be the greatest mechanical discovery since the invention of the telegraph itself.

Mr. Bell's explanation and practical experiments were very satisfactory, and every person present seemed convinced that he had got hold of a good thing, and one which only required time to bring it into general use. Strange to say, two other gentlemen, one an electrician named Gray, of Chicago, and the other a scientist in Copenhagen, have hit upon the same ideas, but it appears Mr. Bell was ahead of them both, and got his discoveries

entered in the patent office at Washington ere they appeared upon the scene. He is backed by Boston and New York capitalists. The way in which Mr. Bell first got his idea was in blowing on a single chord inside a piano. He noticed that all the other chords which were in unison were affected thereby. A gentleman present when Mr. Bell was explaining said that when the whole thing was put into working shape a concert given in San Francisco could be easily heard in New York.—*Brantford Expositor.*

EXAMINATION QUESTIONS.

THE loss to the Society of one of its most active town members, Mr. D. J. McGauran, has been much felt at the meetings since his departure, and has been the means of stopping for the present the "voluntary examinations" it had been determined on holding; Mr. McGauran having been selected as one of the examiners. In order, however, to fulfil a promise partly made in the last pamphlet issued, the Committee append a series of questions which every telegraph operator ought to be able to answer satisfactorily, and which really have been used as a test for the competency of some officials connected with the telegraph service:—

1. Describe any ordinary form of galvanic battery, and show the direction in which the current flows.
2. Which arrangement will give the greater *quantity*—four (4) cells with large plates, or eight with small plates?
3. Describe the forms of permanent magnets, and the properties they possess.
4. Describe an ordinary galvonometer and its uses.
5. Is there any method in which, by means of a galvonometer, the direction in which a current is flowing can be ascertained?
6. Which is the best conductor—water or a solution of sulphate of copper? Place relatively as the best conductors—silver wire, gold wire, copper wire, steel wire, iron wire, iron annealed wire, brass wire, platinum wire, &c.
7. What is the meaning of the term "insulation?" What is the best insulating substance known? What should be the principles of a system of insulation?

Fig. 12 – First Mention of Telephone, 1876; also Examination Questions

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8. What is meant by the term "resistance?" Has a relay or a register usually the greater resistance? Which has the greater conductivity, No. 8 or 10 wire?

9. What is meant by residual magnetism? What is its cause? What its effect? What its cure?

10. Is there any necessity for soldering the joints on a line? What is the result of leaving them unsoldered?

11. Describe a relay and the principles of its adjustment.

12. What would be the effect upon ten cells connected in series if ten cells joined up the reverse way, zinc to zinc and copper to copper, were connected to them?

13. Why is the current weaker in wet than in dry weather?

14. How would you localise a fault seeming to occur in the following ways: 1. A cross between two, three, and four wires; 2. Dead earth; 3. Partial earth?

15. What is the result of adding a high resistance to a circuit?

16. In case of total interruption to circuit, how would you ascertain whether the line was on the ground or suspended in the air?

17. What kind of battery would you use, and how would you dispose it, to overcome high resistance?

18. Trace diagrams showing the following:

    1. Two stations closed circuit.

    2. Three stations open circuit.

19. Upon what basis should the electro-motive force of a line be calculated?

Should any member find a difficulty in answering these questions, or have a doubt as to the correctness of his or her answer, the Committee of Management will be happy to give any answers asked for, in the next issue.

The Committee have to acknowledge, with thanks, the receipt from Mr. W. Warren, Superintendent Eastern Extension Australasia and China Telegraph Company, Georgetown, Tasmania, of a well-executed map, of recent date, showing very clearly the great lines of telegraph over the whole world.

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The death is announced, on the 10th April, of Mr. Henry Salkeld, aged forty-five years, for many years Post and Telegraph master at Yackandandah, and latterly at Smythesdale.

New Member: Mr. T. G. Brent, Electric Telegraph Office, Wilson's Promontory.

A Correspondent from Clunes suggests that a page of the Pamphlets issued by the Society should be set apart for "Answers to Correspondents." The Committee of Management can only repeat that they are anxious for correspondence from members, and, not only one, but any number of pages will be set apart most willingly for correspondence, when it comes.

The present being the last quarter of the second year of the Society, members are requested to remit their subscriptions, where due, as soon as convenient, in order that the Annual Report of the Society may not be delayed.

Chief Telegraph Office,
May, 1876.

Fig. 13 – Remainder of Examination Questions from 1876

both transmitters, and, though very ingenious and quite practicable, it has been found better to employ two relays, so that each reciving operator may adjust to his liking.

(From *The Telegraphic Journal*).

An accident of an extraordinary nature occurred recently at the Holte Theatre, Aston, near Birmingham. The stage was lighted by two electric lights, and when the candles were not burning two brass connections used for the purpose of crossing the current were hung up over the orchestra. After the performance of the pantomine Mr. Bruno, the euphonium player, was leaving with the other members of the band, when, presumably out of curiosity, he caught hold of the two brass connections referred to. The man in charge called out to him, with the object of warning him of the danger he was incurring. The caution, however, came too late. Mr. Bruno received the full shock of the electric current generated by the powerful battery which supplies the whole of the lamps in the building and grounds. The shock rendered him insensible. A medical man was at once sent for and restoratives were applied, but Mr. Bruno died in about 40 minutes afterwards. If the connecting wires had been insulated in the usual way it is evident that the accident would not have occurred.

A new use has been found for the telephone. Captain Greer, of the Ordnance Department, U.S. Army, Springfield, Mass., employs it to determine the time of flight of small-arm projectiles at long ranges. Two telephones, provided with Blake transmitters, were used. One was placed within a few feet of the gun and left open to receive and transmit the sound of the discharge. The other was in the shelter-proof, which was about thirty feet in front of the right edge of the target. A stop watch, beating fourths of a second, was used in connection with it. The telephone being at the ear, the instant the sound of the discharge was received at the target the watch was started, and, on the bullet striking, was stopped.

If rumour speaks truly, we are to hear shortly of another scientific invention worthy to stand beside the telephone or the phonograph in point of interest. Announcements of a mysterious *telephote* or *diaphote*, the discovery of two rival American inventors, have lately appeared in the paragraph columns of the non-scientific press, the instrument or instruments in question being declared capable of transmitting light as the telephone transmits sound. The rumour to which we allude, however, and of the truth of which we have authoritative information, is based upon the fact that Prof. Graham Bell has deposited in the Smithsonian

Institution a sealed package containing the first results obtained with a new and very remarkable instrument first conceived by him during his sojourn in England in 1878.—*Nature.*

The *Natural History Journal* publishes an account of a method of producing facsimiles of plaster-casts in electrolytic copper. The cast is first boiled in stearine, and then blackleaded over ; it is then placed in a sulphate of copper bath, and connected to a very weak battery, so that a thin but firm coating of copper is deposited all over the surface. The cast is next baked so as to destroy the cohesion of the plaster particles, which are shaken out in the form of dust, leaving only the copper coating as a shell ; the latter is then varnished outside, and again placed in a copper depositing bath, and thickly coated with copper inside. Thus solidity is obtained, the outside surface of the shell retaining its sharpness of outline.

The shares of the Edison Electric Light Company, par value 100 dols., which at one time sold at 5,000 dols., have since fallen to 1,700 dols. It is stated that many of the extraordinary statements published in regard to the electric light were made solely with a view of enhancing the value of these shares.

THE EXTERMINATION OF THE KELLY GANG.

The Telegraph Service was not unrepresented at this terrible affair. Mr. H. E. Cheshire, who was acting as Post and Telegraph Master at Beechworth, volunteered, with Line-Repairer Osborne, to accompany the train which left that town on the morning of the 20th June for Glenrowan. They arrived there during the thick of the fray, and Mr. Osborne having, in a most plucky manner, climbed a pole while bullets were flying about him, communication was established with Melbourne, and Mr. Cheshire was enabled to keep the colony—indeed the neighbouring colonies also, for the excitement extended equally to them—informed of the progress of events until all was over. The Postmaster-General has expressed a high sense of the conduct of Messrs. Cheshire and Osborne in this affair. Messrs. D. Mickle and P. Cregan, operators from the Melbourne office, were also despatched to the scene of combat, but did not arrive there until the hotel had been burnt, and the dead and charred remains of the bloodthirsty Kelly gang had been taken from the smoking ruins of the hotel.

We are also glad to observe that Superientendent Hare, in his report on this affair, alludes to Mr. Saxe, of the Benalla Telegraph office, in the following complimentary terms :—" I would also bring under your notice the great services rendered by Mr. Saxe, Telegraph Master at Benalla. The police in the district found him

Fig. 14 – Some Interesting Extracts from the T.E.S. Journal of 1880

always ready to assist them at any moment, day or night (Sundays inclusive), and he complied with everything he was asked to do most readily and cheerfully. I would therefore urge upon you the desirability of bringing his conduct under the notice of the hon. the Postmaster-General, with a view to his promotion in the service, as you are well aware, from your own personal knowledge, of the many services rendered to us by him."

THE Committee have to acknowledge with thanks the receipt from Mr. C. Todd, C.M.G., Postmaster-General of South Australia, of the Meteorological Observations made at the Adelaide Observatory during the year 1878. They are most complete of their kind, and, while reflecting the highest credit on the compilers, will form a record of great value to meteorologists. The general "get up" of the volume is also remarkably good, and the Adelaide Government Printing Office deserves great praise for the typographical portion of the work, which is excellent. A rainfall map of the colony is attached, and shows in an interesting manner the amount of rainfall in the various parts of the colony; Southport, in the Northern Territory, taking the lead with the large amount of 76.89 inches. The maximum temperature (in the shade) was 113° 8 on 10th January, the minimum being 36.0 on 24th June and 14th July. There were thirty-two overcast days (on which not less than 9-10 of the sky was covered at any time), but which were more than counterbalanced by fifty-seven clear days (on which the amount of cloud did not at any time exceed 1.0). The total rainfall (in South Australia proper) was 22.083, which fell on 112 days, and the barometer ranged from 30.578, on 6th May, to 29.401, on 18th July.

NEW MEMBERS.

Mr. Burrill Johnson, Melbourne.
Mr. J. F. Smith, H.M. Customs, Melbourne.
Mr. M. L. Bagge, Royal Mint, Melbourne.
Mr. E. F. Innes, E.T.O., King George's Sound, W.A.
Mr. F. S. Andrews, E.T.O., Farina Town, S.A.
Mr. J. C. W. Chandler, E.T.O., The Peake, S.A.
Mr. J. Skinner, E.T.O., Barrows Creek, S.A.
Mr. J. W. Watt, Melbourne.
Mr. C. A. Atkin, Hotham.
Mr. Thos. Biddle, Victorian Railways, Werribee.

Death.

On 1st May.—Miss A. H. Belling. E.T.O., Rutherglen

W. H. WILLIAMS, Printer, 83 Queen street, Melbourne.

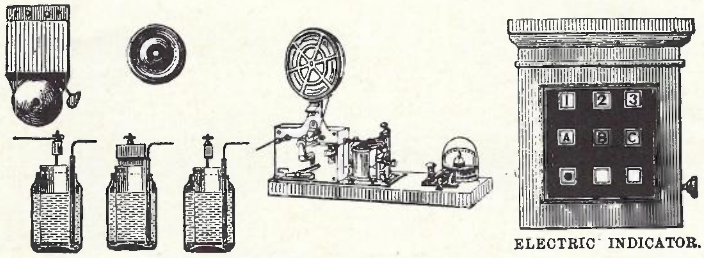
FIGHTING BY TELEGRAPH.

THE proceedings before the coroner at Huntingdon, on the 2nd February, in the Abbots-Ripton collision case (says the *Times*) recal the existence of a curious pastime in working the telegraph. When two stations want to send a message at the same time, and neither will give way, they are said to "fight." Each operator grasps the handles of his instrument tightly, and moves them rapidly and irregularly from side to side; the result being that the needles are violently agitated, even to "clicking" loudly, and the "face" of the instrument assumes quite an excited aspect. Such, or something like this, may be assumed to have been the case when the Abbots-Ripton signalman wanted to send his message to Huntingdon for "doctors and help," and somebody else on the circuit would not let him. "Fighting" on the wires was a common practice in the early days of the telegraph, when nothing but the double-needle instrument was used—so common, indeed, that a fine used to be imposed on clerks who broke the handles of their instruments in this warlike occupation. Battles of this kind were not always confined to two persons; for when there were more than two stations "in circuit" others would join in for the mere fun of the thing, and a "free fight" would often ensue. The improved forms of telegraphic apparatus have reduced "fighting" very much, although they have not altogether done away with it. The simpler forms of recording instruments still admit of telegraph clerks giving rein to their angry passions on the wire, the rapid up-and-down motion of the keys taking the place of the violent swaying to and fro of the handles. But the arts of peace as well as that of war are studied by the telegraphist in his spare moments, and the gentler passions often find vent through the wire. It has been stated that long courtships have been maintained between persons hundreds of miles apart, who never saw each other, and that there is now a telegraphic sign for "love's first snowdrop, virgin kiss." One of the latest inventions in telegraphy, known as the "duplex" system, is a great peacemaker, for it enables the operators at either end to charge at each other as much as they please without disturbing the continuity of transmission, thus removing all inducement to "fight." What an American humorist has said of a railway collision—viz., that it is an effort on the part of two trains travelling in opposite directions to pass each other on the same track—is true of the attempt to send two messages on the same wire at the same time by the needle telegraph, but not of the "duplex" system, by means of which this feat is now very generally accomplished throughout the world.

Fig. 15 – (i) Fighting by Telegraph, 1876
– (ii) Remainder of Kelly Gang Report, 1880

ELECTRIC BELLS & INDICATORS,

FOR PUBLIC AND PRIVATE BUILDINGS.



J. E. EDWARDS, PATENTEE,

MANUFACTURER OF

Telegraph Instruments, Electric Bells, Indicators

Galvanic Batteries. Galvanometers, &c.

35 & 37 ERSKINE STREET,

HOTHAM HILL, MELBOURNE.

J. E. EDWARDS' NEW PATENT INDICATOR is very simple and reliable, which enables him to supply a first-class Indicator at a lower price than any other of even inferior workmanship. Estimates for fitting a series of bells in hotels, mansions, etc., will be furnished on application.

All orders, accompanied with cash remittance, will receive immediate and careful attention.

It is now conceded that the ringing of house bells by means of **Cranks**, moveablo **Wires**, and **Oscillating Pendulums**, which are uncertain of action, confusing to the persons attending them, and, in short, clumsy contrivances, are altogether things of the past. On the **Electric Bell System**, all pulling, tugging, and the grating noises occasioned by the cranks, and consequent breaking of the wires, are done away with; for, however distant **The Electric Bell** may be, or however tortuous its course, it can be rung by the slightest pressure of the finger on a little ivory button; and, as the electric wires do not move, the wear and tear, as on the old system, is entirely avoided. In order to secure an entirely satisfactory result three things are necessary, viz., the exclusive use of first-class and highly finished materials—the employment of skilled workmen—and the superintendence of a person of long practical experience.

With these at command. J. E. EDWARDS (who was connected with the Melbourne Post and Telegraph Department for upwards of Ten years) is able to execute in a first-class manner any orders entrusted to him. He has had the honor to execute work on a large scale, and attained results highly satisfactory at the following public and private buildings:—

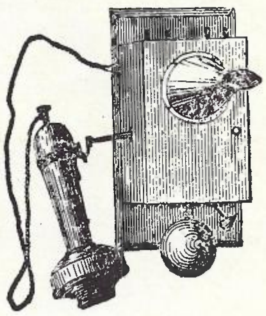
The Treasury	Royal Mint	Crown Law Offices
Parliament Houses	General Post Office	Messrs. Sands & McDougall
Beechworth Asylum	Crown Law Offices	The London Chartered Bank
Ararat Asylum	Melbourne Town Hall	Registrar-General's Buildings.

And many other buildings.

The Bells and Indicators may be seen in operation in Melbourne.

Fig. 16 – Early Advertisement for Electric Bells, 1877

J. E. EDWARDS'S



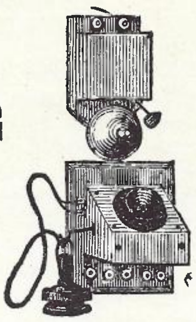
No. 1

AUSTRALIAN

LOUD-SPEAKING

Combination

TELEPHONE.



No. 2

The EDWARDS TELEPHONE was awarded **First-class Prize Medal at the Sydney Exhibition of 1879-80,** and is acknowledged to be a great success. It is guaranteed to work as loud as an ordinary speaking tube, enabling persons miles apart to converse with the greatest ease, as though they were in the same room. Among the establishments in which the telephone has been fixed and given every satisfaction are the following, viz. :

Messrs. McLean Bros. & Rigg's line, since February 1878, when it superseded the Wheatstone ABC instrument previously used.

The Melbourne Omnibus Company's line, two miles long, since October, 1879.

The General Post Office and the Customs Departments.

Mr. Hosie's various establishments in Bourke street east; and many other places throughout the colonies.

The Telephones are made in various forms, the two principal ones, adapted especially for business uses, being styled Nos. 1 and 2 (as drawn above); which can be specially recommended wherever communication is required between the principals and employes in commercial houses, between central and branch banks, between mining managers and the employes in the mine, in large hotels or mansions, and in factories of every description.

These Telephones are of first-class manufacture, simple in construction, and can be used by any person after an hour's instruction and practice.

One Telephone only is sufficient for listening. The right hand is thus left free for writing down the message as received.

Printed directions are forwarded with each set of apparatus.

All orders, accompanied with cash remittance, will receive immediate and careful attention.

Full particulars and estimates will be furnished on application to

J. E. EDWARDS,

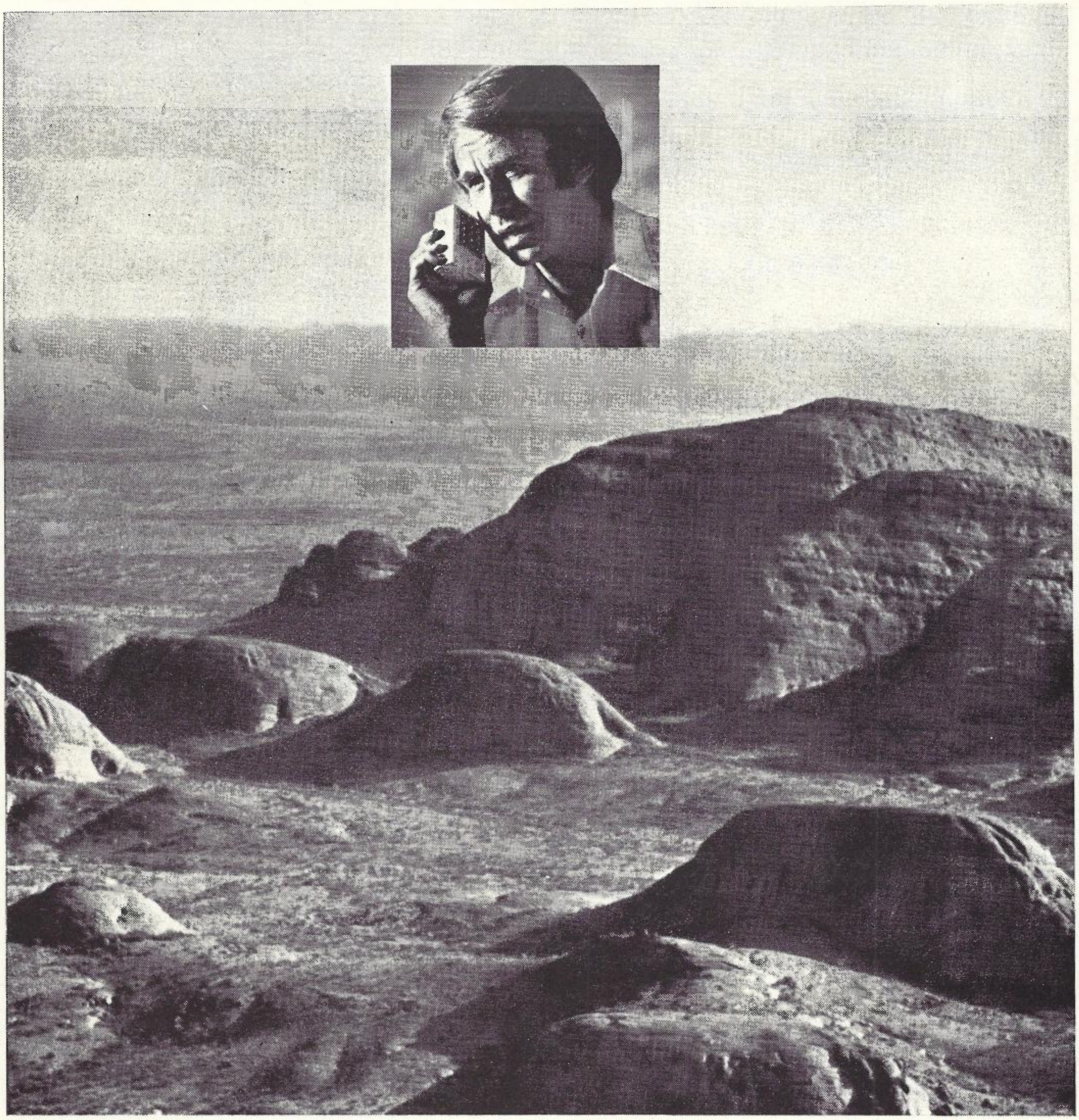
133 LITTLE COLLINS STREET EAST,

(ABOVE RUSSELL STREET,)

MELBOURNE.

Fig. 17 – Early Telephone Advertisement from 1880. (Note that any person can use the Instrument *After an Hour's Instruction!)*

J. E. SANDER joined the Postmaster-General's Department in 1943. He graduated from the University of Western Australia with First Class Honours in Electrical Engineering in 1957, and later, in 1964, travelled to Sweden for two years where he studied telephone switching system design. In 1966 he was awarded the degree of Teknisk Licentiat from the Royal Institute of Technology (K.T.H.) Stockholm. Since 1966 Mr. Sander has worked on telephone system design and regional network planning, and recently he was promoted to the position of Deputy Assistant Director-General, Postal Planning, APO Headquarters.



Just how remote is the pocket phone call?

Your personal telephone. Right there in your pocket. Instantly ready to make a push-button phone call. To any number. At any time. Anywhere at all, in this vast continent.

Far-fetched? Not to the research and development people at L M Ericsson. They're already working on this very possibility.

And much more.

Many of the telecommunications systems that we now take for granted have evolved from the creative processes put in motion by Lars Magnus Ericsson, nearly a century ago.

And so the quiet revolution continues. Bringing untold benefits for us all in the years to come.

L M Ericsson

the quiet revolution

L M Ericsson Pty. Ltd., Head Office and Chief Manufacturing Plant, Riggall Street, Broadmeadows, Victoria 3047.

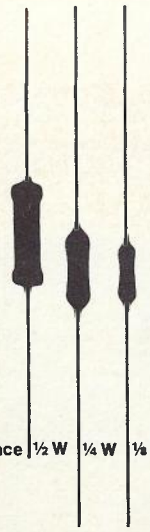
LM265.

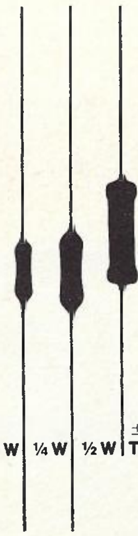
How many styles of resistors Have you been buying?

SIX?

Now you need stock only

ONE Style!





IRC TYPE RG¼
±2% TOLERANCE
METAL GLAZE RESISTOR
½ WATT (at 70°C Ambient)

Body Length 0.25"
Diameter .090"

Small enough to replace many ⅛ watt resistors but with a high stability ½ watt rating, the RG¼ is manufactured in tolerances of ±2% and ±5%.

A calculation of the cost of using ⅛W, ¼W and ½W resistors in both 5% and 2% tolerances will show you can make a dramatic saving by switching to RG¼ 2% tolerance.

That is why we have made the decision to stock the full range of E-24 values in 2% tolerance.

Apart from the question of economy, what other resistor gives you so many benefits?

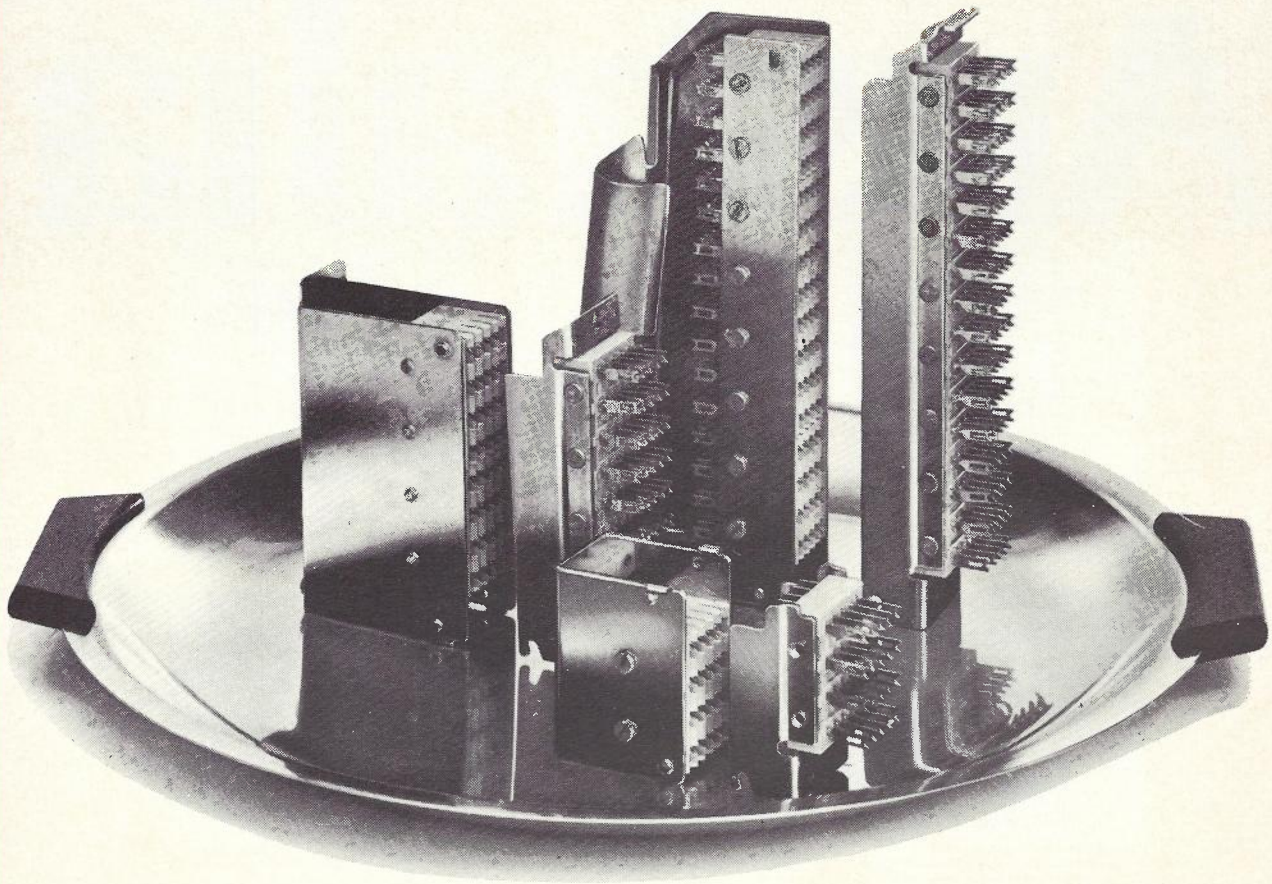
***Rugged:**	Moulded jacket gives protection from roughest handling.
***Lower Temperature Coefficient:**	Less than 200 ppm/°C (.02% per °C).
***Superior Stability:**	At ¼ watt rating Mil. load life is better than 1%. At ½ watt, better than 1.5%.
***Lower Surface Temperature:**	Body temperature rise at ½ watt at 70°C amb. is only 40°C.
***Permanent Colour Bands:**	Acrylic colours remain bright and clear after years of service.
***Leads Solder Fast:**	Exclusive IRC tin-lead alloy plating process results in first class solderability even after years of storage.

Manufactured in Australia by:
IRH COMPONENTS DIVISION
NATRONICS PTY. LIMITED
The Crescent, Kingsgrove, N.S.W. 2208

Please send me information on Metal Glaze Resistors.
NATRONICS PTY. LTD.
IRH COMPONENTS DIVISION
P.O. BOX 71, KINGSGROVE, N.S.W. 2208
Name.............................
Company.............................
Address.............................Postcode.............

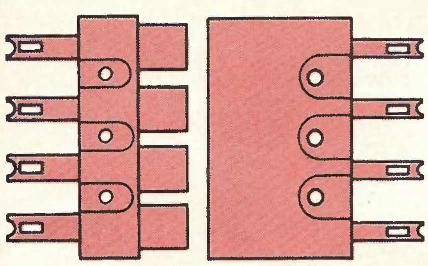
AUSTRALIAN MADE

MG.4/74



Plessey knife and fork connectors economical...rugged...versatile

Knife and fork contact units
ACTUAL SIZE



These economical multi-circuit connectors are reliability proven and of exceptionally rugged construction . . . they are available in standard 20, 40 and 80 way sizes.

Connector frames are of pressed steel finished in passivated zinc and house either 1, 2 or 4 sets of A.B.S. Green moulded modules (illustrated) each of which accommodates twenty knife or fork terminal assemblies.

The modular construction of these connectors makes them an extremely versatile means of quickly effecting multi-circuit linkage . . . Plessey offers these modular contact units as a separate item and any number of such may be arranged and housed to suit the customer's own alternative housing design requirements.

Plessey knife and fork connectors were originally designed for use in crossbar telephone switching equipment and therefore meet the highest quality standards as demanded by Post Office specifications.

Connectors and modular contact units are available ex-stock. Comprehensive literature is available on request to the Professional Components Division.

Melb.: Zephyr Products Pty. Ltd. 56 7231
Adel.: K. D. Fisher & Co. 223 6294
Perth: H. J. McQuillan Pty. Ltd. 68 7111
N.Z.: Henderson (N.Z.) 6 4189

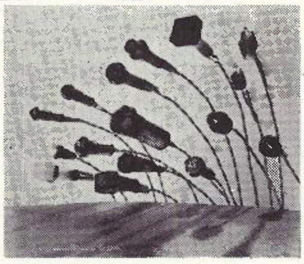
PLESSEY

Plessey Ducon Pty. Limited
Box 2 PO Villawood NSW 2163
Telephone 72 0133 Telex 20384

AC104

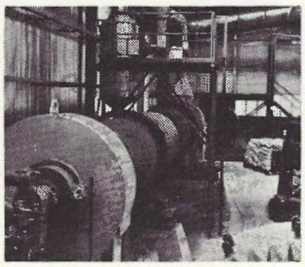
Australia

'PABX' — manufactured by Plessey Telecommunications, this private automatic branch exchange system employs crossbar switching and componentry similar to that used by the Australian Post Office in the national telephone network.

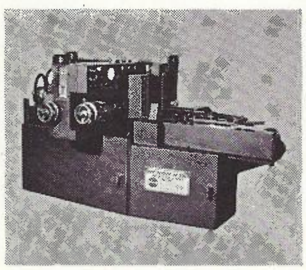


Plessey Rodan indicator lamps designed for compatibility with and to enhance the presentation of electronic, electrical and industrial equipment. These indicator lamps are just some of the vast range available from Plessey Ducon.

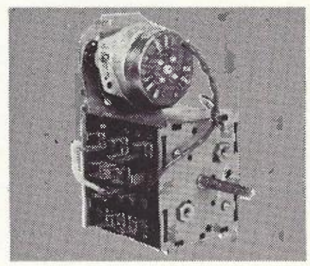
The 'do-it-yourself' stereo amplifier kit from Plessey Ducon. This simple and easy to assemble kit will provide truly first class reproduction at a cost far below that of equivalent powered units.



Plessey Rola is Australia's largest manufacturer of magnetic materials. Under agreement with B.H.P., Plessey have exclusive marketing rights for hematite and ferrite powders produced from Yampi Sound.

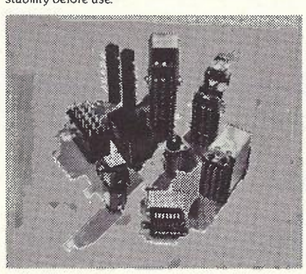


Designed and produced in Australia by Plessey Telecommunications, the 'Computermatic' timber grader completely eliminates the guesswork from visual timber grading. Electronic grading ensures that timber is accurately classified by strength and stability before use.

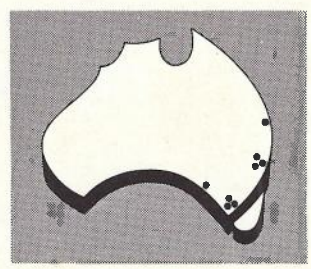


Plessey Mallory interval timer switch — commonly used in automatic washing machines and electric ranges are supplied by Plessey Ducon located at Villawood, N.S.W.

This direct reading digital clock is one of a wide range of models supplied by Plessey Communication Systems. Extremely accurate, the clocks are built for indoor use or weatherproofed and illuminated for outdoors.



Some of the wide range of multi-circuit connectors marketed by Plessey Ducon, all of which are reliability and quality proven.



Number of plants: 8
Factory capacity: 1 million sq. ft.
Employees: 4,000

Plessey

APP69/R1

Now on hand.
Three advanced developments in telephone engineering from GEC.

The GEC 746 table telephone
–an instrument making full use of printed circuit techniques and tropicalised components.
Rugged, reliable– available in attractive colours and a wide-range of options.

The GEC LST4D voice-switched loudspeaking telephone
–hand-free operation with full automatic voice switching so that loud-speaker and microphone cannot be 'alive' at the same time.

The GEC 740 1/2 and 1/3 switching telephone
–independent access to one exchange line from two or three telephones. Also provides an efficient intercom system.

Dial or pushbutton versions available for all telephones.

GEC manufacture telephones for world markets: table and wall-mounting models in a number of attractive colours, loudspeaking telephones, pushbutton telephones and switching telephone systems.....

You couldn't be in better hands.
GEC Telecommunications Limited,
Telephone Division, Whinbank Road,
Aycliffe, Co. Durham, England.
A Management Company of
The General Electric
Company Ltd., of England.

GEC

GF4

The GEC 746 table telephone – You can depend on it. That's the most important thing you can say about a telephone, a very essential tool of modern society. Important as it is, it is often taken for granted.

When you buy a telephone you obviously want good styling at a low price. In the 746 we provide both but more importantly we offer an instrument of high performance and unique flexibility with the widest available choice of options. These options include:

* 1 or 2 switching buttons for recall, shared service, conference, priority access, bell on/off.
* Seven colour options.
* Handset: Lamp calling; deaf aid; press-to-talk.
* Table or wall mounting.
* Dials: 10 or 20 i.p.s; dial lock; C.B. working.
  Number rings – to suit any requirement.
  Pushbutton signalling – three versions available:
  Self-contained MOS loop disconnect for all types of exchange.
  Multifrequency for large exchanges.
  D.C. leg for PAX/PABX exchanges.
* Ringer: High or low impedance. Extension Bell.
* Automatic volume regulator optional.
* Line cord 1.5 m, 2 m, 3 m Plug or Jack.

Someone, somewhere may think they have a requirement that cannot be met by the GEC 746 range. We'd welcome the chance to prove them wrong.

GEC manufacture telephones for world markets: table and wall-mounting models in a number of attractive colours, loudspeaking telephones, pushbutton telephones and switching telephone systems.

Dial or pushbutton versions available for all telephones.

You couldn't be in better hands.

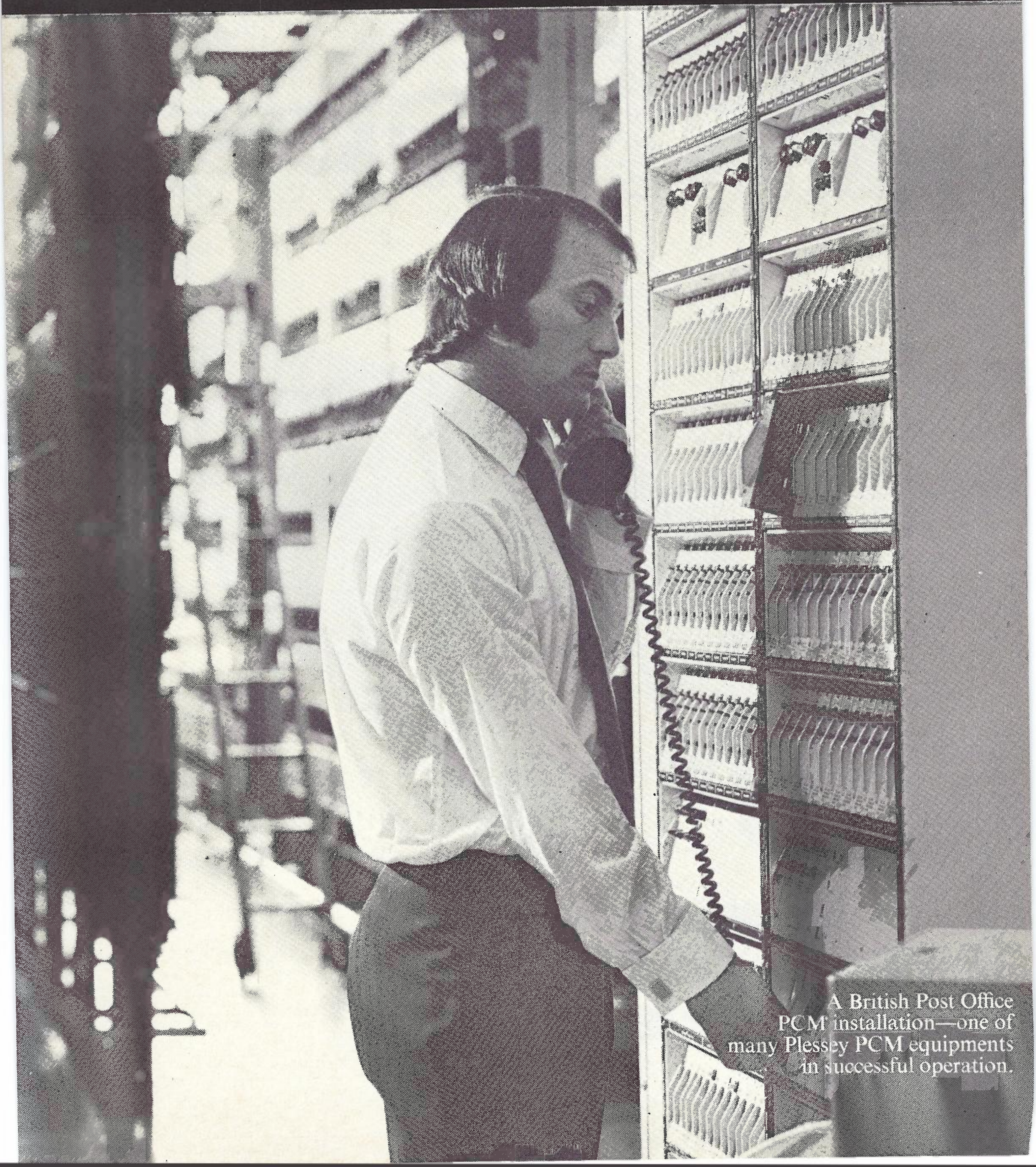
GEC Telecommunications Ltd.,
Telephone Division, Whinbank Road, Aycliffe,
Co. Durham, England.
A Management Company of The General Electric Company Ltd. of England.

GEC

Always at hand.
The GEC 746 table telephone -you can depend on it.

GF2

Speech quantity plus speech quality-



A British Post Office PCM installation—one of many Plessey PCM equipments in successful operation.

That's Plessey system CD30A 30-channel PCM

System CD30A is the latest advance in pulse code modulation transmission equipment, providing 30 high-grade junction telephone circuits on a single four-wire cable circuit.

Designed to the latest CEPT and CCITT recommendations, CD30A provides a versatile system suitable for use with any type of telephone exchange.

Line signal bit rate is the standard 2048 kbit/sec., providing 32 time slots per frame (30 standard speech circuits).

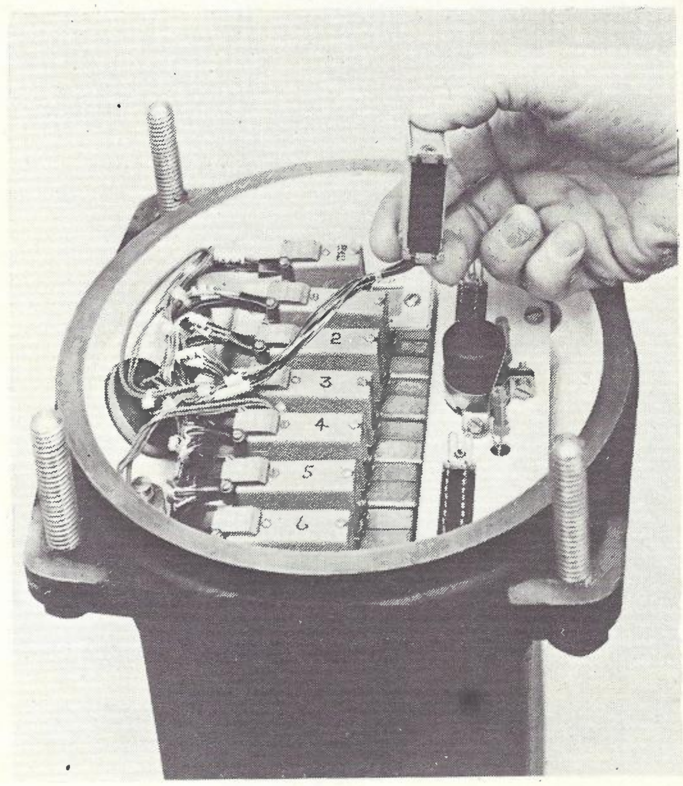
Regenerators spaced at intervals in the transmission path ensure that the bit stream is reconstituted—you get out what you put in.

Fault location and alarm facilities form an integral part of the system design and include remote location of faulty regenerators.

Environment: 0–50°C with 95% humidity.

Discuss your increasing traffic problems with us—the CD30A could be the answer.

For further information please write or telephone:
PLESSEY TELECOMMUNICATIONS LIMITED
Edge Lane, Liverpool, England L7 9NW
Telephone: Liverpool (051) 228 4830.
Telex: 62267



The picture shows a regenerator assembly box containing six regenerator units together with a supervisory unit. Other boxes are available holding up to 36 regenerator units. Only those cable pairs immediately required for transmission of PCM signals are equipped with regenerators, the remaining pairs being equipped with plug-in loading coils—readily replaceable by regenerator units when additional PCM circuits are required.

PLESSEY
TELECOMMUNICATIONS

720 PTG

The Telecommunication Journal of Australia

ABSTRACTS: Vol. 24, No. 2.

BARSCH, K. M., and VOLSKULEN, L. A. M.: 'Introduction of Seven Digit Numbering in the Adelaide Network'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 121.

On 30th September 1973, seven digit numbering was introduced for about 60 percent of the subscribers of the Adelaide Telephone District and its area code was changed from 082 to 08.

The article outlines the network planning and philosophies involved in the change, including the arrangements which allowed most calls to mature for a time when changed numbers were incorrectly dialled on previous six digit codes. The article also covers the methods used to minimise work in exchanges, and testing and commissioning procedures.

COTTERELL, I. R., and DOHERTY, R.: 'Computer Sorting of ADR Non-Action Information'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 154.

The large volume of messages generated by Automatic Disturbance Recording (ADR) equipment requires machine sorting to assist field staff to locate faults and fault trends. This article discusses problems encountered with manual sorting and early computer programs for sorting ADR messages and describes a field trial of the standard method of message sorting using an on-line mini-computer.

FORDHAM, M. T.: 'Design Criteria for Corrosion Protection of Telecommunication Structures'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 144.

The premature failure of corrosion protection systems on telecommunications structures is often due to insufficient attention being paid to constructional details, and to the designer not appreciating that the peculiar local environment at or within a detail is very different from the structure's general environment.

The paper shows the need to appraise and design for the peculiar environment, and describes with illustrations good and poor constructional practice.

The principles and the corrosion protection of high tensile friction grip bolting, as used with extremely rigid radio structures, are dealt with.

HATFIELD, G. E.: 'Colour Television — Some Effects on Australian Post Office Plant'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 107.

Colour brings greater reality to television. Colour however also introduces additional parameters which must be controlled in relaying and broadcasting. The relationship between visible effects on a picture and distortion of test signals is considered.

The Post Office is involved in entertainment television in carrying the signal on cables from studios to operating (switching) centres, in relaying the signal on broadband bearers, in broadcasting the signal from transmitters and in measuring and monitoring both the baseband signal and the radiated signal.

The influence of equipment on colour parameters is examined to help guage the effect on some Post Office operations.

LOFTUS, J. E.: 'An MFC Display Instrument'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 174.

This article describes a test instrument which will store and display in decimal form the Multifrequency Code (MFC) Signals used for signalling between crossbar exchanges and overcomes some of the difficulties encountered with current testing techniques. The instrument was designed by the author and developed in the APO Research Laboratories.

MITTON, L. M.: 'Recent Development in Traffic Route Testing in the Telephone Network'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 136.

Although traffic route testing has long been recognised as an effective technique for supervising the quality of service offered to customers of the telephone system, many small exchanges in the APO network have not had the benefit of this technique because it has been neither economical nor physically possible to accommodate earlier designs of Traffic Route Testers in these exchanges.

The Traffic Route Tester and Remote Call Repeater described here were designed primarily to overcome these limitations. A useful incidental benefit of the Remote Call Repeater enables a section of the network previously neglected from the standpoint of automatic transmission testing to now be covered.

PETCHELL, F. M.: 'Solvents and Safety'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 160.

This article sets out some of the general and physiological properties of solvents commonly used in the telecommunication industry.

A brief outline of the chemical structure and behaviour of several groups of substances is given.

SANDERS, J. E.: 'Centenary of Telecommunications Societies in Australia'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 177.

The first known Australian society to specifically cater for telecommunications interests was called the Telegraph Electrical Society. It was formed in Melbourne, in August 1874, by an enthusiastic group of officers of the Victorian Post and Telegraph Department, and flourished well for a number of years. Unfortunately after 1881 interest in Society activities apparently declined and no records beyond that year can be located.

In 1908 a new society called the Postal Electrical Society was formed which had as its first president Mr H. W. Jenvey, one of the foundation members of the original Telegraph Electrical Society. After some difficult years, including a re-formation of the society in 1932, the Postal Electrical Society survived until it became the Telecommunication Society of Australia in 1959.

In this centenary year of 1974 a selection of some of the very interesting original papers and records of these early societies has been reprinted here (in the original typescript wherever possible) for the enjoyment of modern readers.

ABSTRACTS: Vol. 24, No. 2 (Continued)

SLADE, M. W., and BRIDGEFORD, J. N.: 'Applications of Computers to the Planning of Telecommunications in the APO'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 128.

In the early 1960's it was the practice of the Traffic Engineering Division, Victoria, to manually produce a Junction Provisioning Statement (JPS) for the network which was used for the planning of switching and external plant equipment. However, the manpower required to produce the JPS was becoming far too demanding and so delays in issue were unavoidably long. During 1964/65 work was commenced upon a suite of computer programs to allow automatic production of the JPS.

As the project developed it was realised that because of the speed of the computer, the design process could be extended into the external plant areas to incorporate junction design and statistical analysis of quantities, transmission and costs.

The flexibility built into the computer programs allows alternative telephone networks to be designed and so the MENDAP system may be used also as a forward planning tool.

TURNBULL, R. W.: 'The Telecommunication Society of Australia, Past, Present and Future'; Telecomm. Journal of Aust., Vol. 24, No. 2, 1974, page 99.

The centenary of the Telegraph Electrical Society is being celebrated by its successor—The Telecommunication Society of Australia—in August, 1974. This topical article records for posterity the contributions to the Society by past and present members; gives an insight to the current organisation of the Society; and reflects on the challenges for telecommunications in the future.

WILSON, J. C.: 'The APO Design Guide for Long Line Equipment'; Telecomm. Journal of Aust., Vol. Vol. 24, No. 2, 1974, page 166.

A unified style of construction, together with standardised electrical interfaces, is being introduced for locally manufactured line transmission equipment. This article outlines the problems in achieving the objectives and describes the basic concepts of the solution.

THE TELECOMMUNICATION JOURNAL OF AUSTRALIA

VOL. 24. No. 2. 1974

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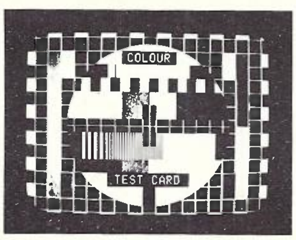

COVER
COLOUR TEST
PATTERN

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The Telecommunication Society of Australia

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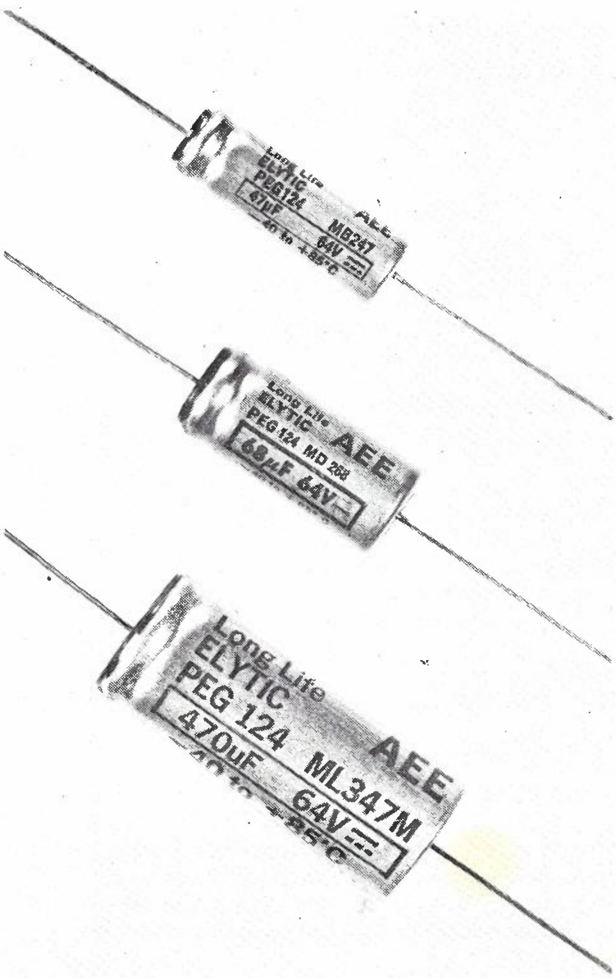

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