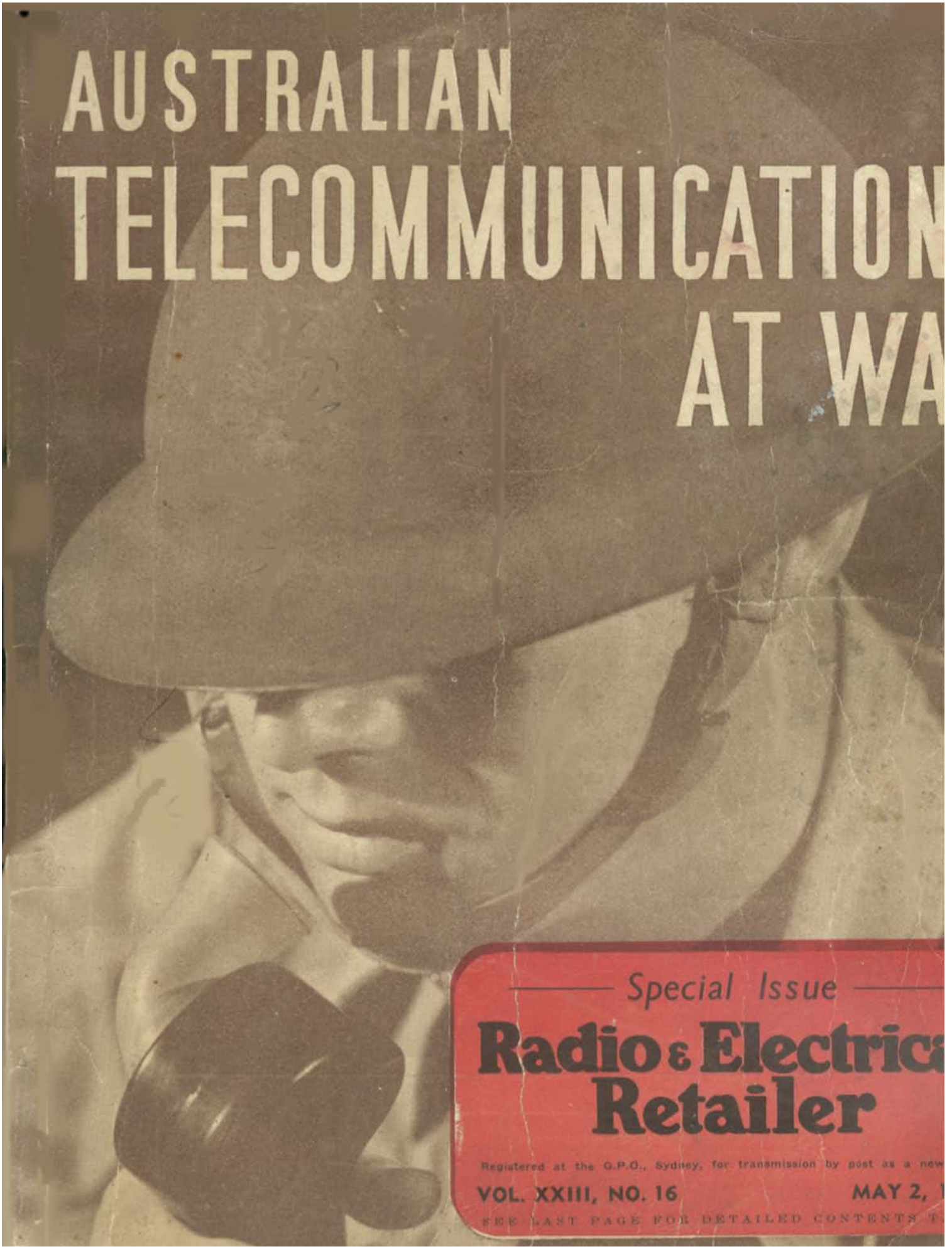
AUSTRALIAN TELECOMMUNICATION AT WA



Special Issue

Radio & Electrica Retailer

Registered at the G.P.O., Sydney, for transmission by post as a new

VOL. XXIII, NO. 16 MAY 2,

SEE LAST PAGE FOR DETAILED CONTENTS T

£13,000,000

— That was the value of the defence equipment produced by A.W.A. for the Allied Nations.

Over 20,000 wireless telegraph and wireless telephone transmitters were manufactured by A.W.A. for the Services, as well as over 70,000 aircraft navigational instruments.

Not only did A.W.A. manufacture a greater variety of apparatus for the Allied Forces, but its output of equipment was larger than that of any other Wireless organisation in Australia.

The fact that A.W.A. equipment is used by Governments, the Allied Services and Administrations, and organisations throughout Australia and the Pacific is fitting testimony to its efficiency.

The enormous variety of types of equipment manufactured demonstrates the advanced stage the Australian wireless industry has attained and the part it has played in the War and international communications. The prestige of A.W.A. in the design and manufacture of high grade wireless equipment was never higher.

With the resumption of peacetime production, A.W.A. scientists, designers and engineers are busy with many new projects in the field of wireless development. Never at any stage of its history — years in which it pioneered and enriched Australia with epoch-making wireless developments — has A.W.A. been so favourably placed to enter the new era of Electronics.

ELESS (A'SIA) LTD.

WIRELESS ORGANISATION

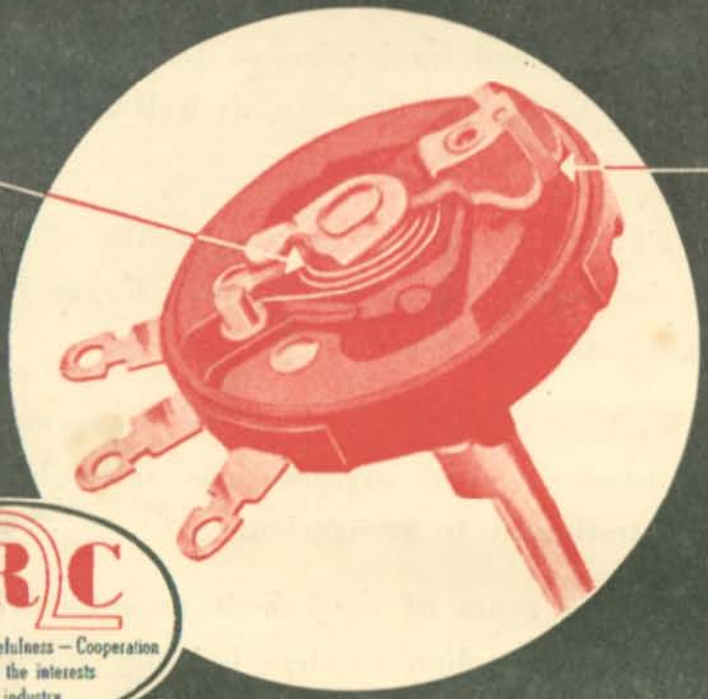
PERMANENTLY QUIET

Silent Spiral Connector...

NO SLIDE
NO FRICTION
NO NOISE

5-Finger "Knee Action" Contact

AMAZINGLY SMOOTH... PERMANENTLY QUIET



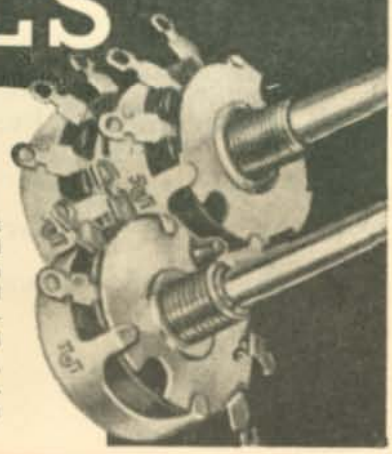
IRC

Initiative — Resourcefulness — Cooperation to advance the interests of the industry

VOLUME CONTROLS

DOUBLY PROTECTED
Against Noise...

Together with the famous 5-Finger "Knee-Action" Silent Element Contact and the many other features of standard IRC Type C Controls, the new Type CS unit offers an additional noise eliminating feature in the Silent Spiral Connector. This exclusive IRC development provides continuous electrical connection between centre terminal and volume adjustment arm. Sliding metal-to-metal contact, the most common cause of control noise, is eliminated. Thus you have double assurance of remarkably smooth acting controls that are quiet and STAY quiet.



Sole Agents for Australia:

Wm. J. McLELLAN & CO.

BRADBURY HOUSE, 55 YORK ST., SYDNEY • PHONE BW2385

Coil with hair-springs fitted, approximately double actual size.

Miss Smith

has a steady hand . . . .

And she certainly needs it for the job of fitting hair springs to University meters—the heart of all University test equipment—is a vitally important one.

Such work is only one of a number of delicate operations involved in the manufacture of University instruments and typifies the many unseen but extremely important processes that assure your permanent satisfaction when you specify "University."

University

The name to trust in Radio and Electrical Test Equipment.

DISTRIBUTORS:

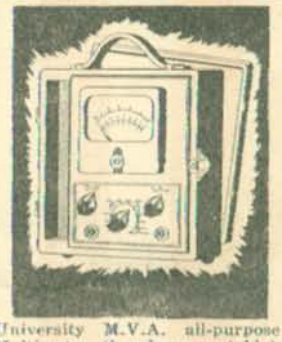
N.S.W.	: All leading Distributors
Queensland	: Homecrafts : J. B. Chandler Pty. Ltd. : A. E. Harrold
Victoria	: Vealls Electrical & Radio Pty. Ltd.: Hartleys Ltd.: Replacement Parts Pty. Ltd.: Victorian Agent, J. H. Magrath Pty. Ltd.
Sth. Aust.	: Radio Wholesalers Ltd.: Gerard & Goodman Ltd.
W. Aust.	: Atkins (W.A.) Ltd.
Tasmania	: W. & G. Genders Pty. Ltd.
New Zealand	: Allum Electrical Company Ltd.

RADIO EQUIPMENT PTY. LTD.

375 KENT STREET, SYDNEY, N.S.W.

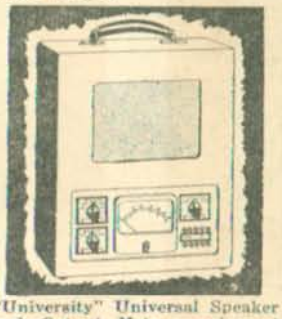
Telephones : M6391-2. Telegrams : "Raquip," Sydney

University meters include voltmeters, ammeters, milliameters, micro-ammeters, etc. Sizes 2", 3", 4" and 5".



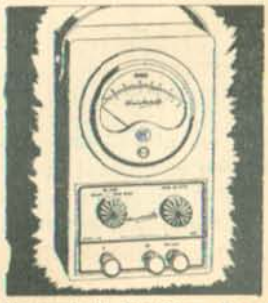
University M.V.A. all-purpose Multimeter (bench or portable) giving complete AC/DC measurements together with output meter ranges.

University Supertester is an extremely versatile Valve and Circuit Tester featuring an extraordinary valve and condenser roller test chart.



"University" Universal Speaker and Output Meters make set testing quick and easy. No power connections required, just plug in to any type speaker socket.

A new "University" five band oscillator for the alignment of all types of radio receivers.



"University" Earthing Resistance Tester is much sought after by maintenance electricians, and is typical of University's industrial test gear.

Fully illustrated literature available upon request.

Appreciation

AUSTRALIAN MILITARY FORCES

MASTER-GENERAL OF THE ORDNANCE

B78316.

HEADQUARTERS
VICTORIA BARRACKS
MELBOURNE S.C.1

16 November, 1944.

Dear Sir,

It is desired to express appreciation of the special effort made recently by your employees to deliver, on the scheduled dated, a quantity of Wireless Sets No.108, Mk.III. Whilst the efforts of the whole of the radio industry to supply the equipment needed by the Services deserve commendation, the special case of the Wireless Set No.108 justifies particular reference.

The Commander-in-Chief has recently emphasized publicly the need for renewed efforts in support of the activities of our fighting troops in forthcoming campaigns, and the supply of equipment at the proper time was of the utmost importance, in view of the tasks before us.

The employees concerned are to be congratulated on the satisfactory outcome of their efforts.

Yours faithfully,

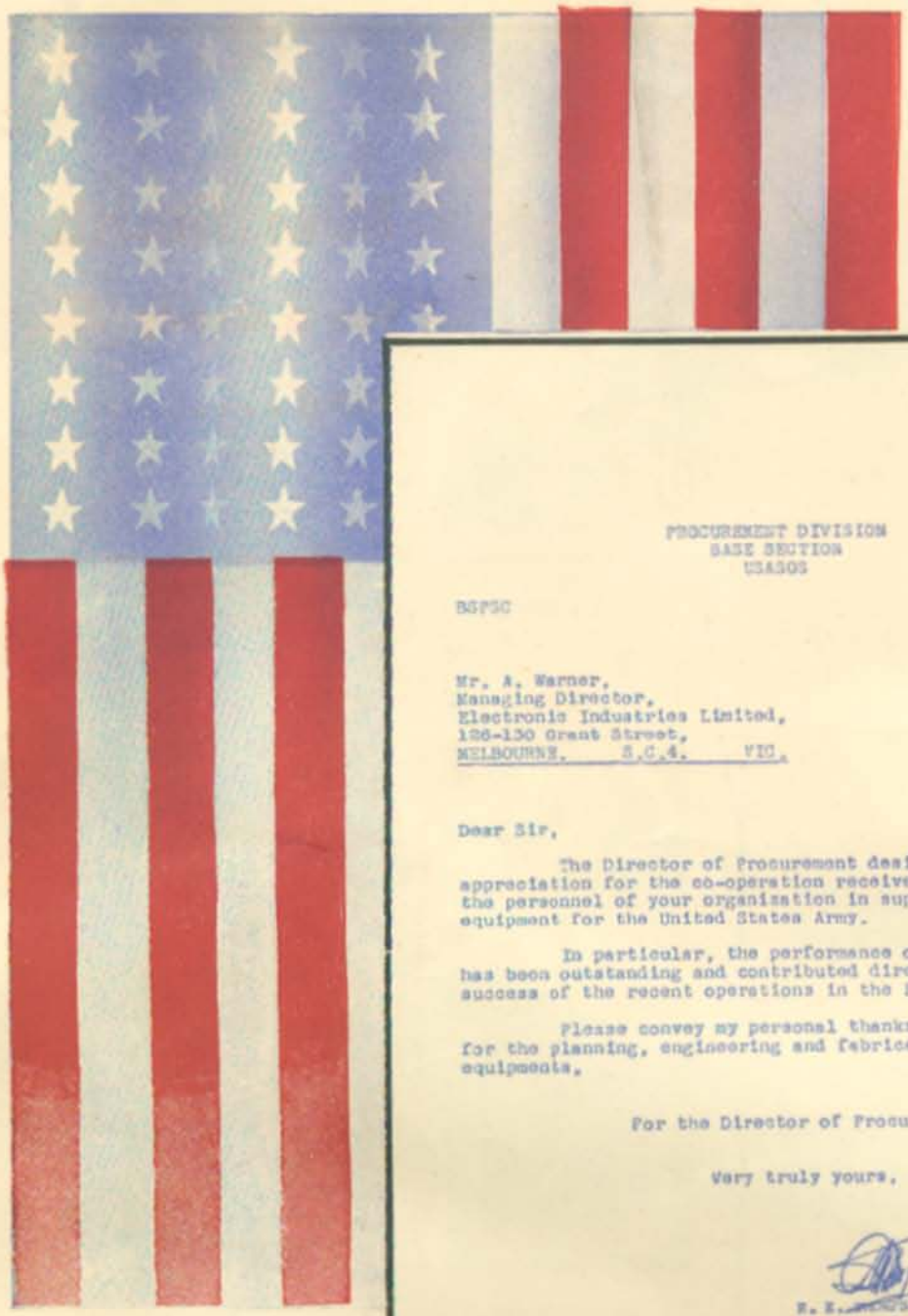
(L.E. BEAVIS) Major-General,
Master-General of the Ordnance.

The Managing Director,
Messrs. Radio Corporation Pty. Ltd.,
Grant Street,
SOUTH MELBOURNE.

ASTOR

Proudly we played our part by the manufacture of such vital equipment as FM and AM Communication Receivers, Aircraft Transmitters and Receivers, Field Transmitters and Receivers, Naval Two-way Communication Equipment, Radar Equipment, RaySonde Meteorological Equipment, Piezo Electric Crystals, Vibrators. Now in production—Domestic Radio, Car Radio, Phono-radio and Electronic devices of all descriptions.

RADIO CORPORATION PTY. LTD.
Division of Electronic Industries Ltd.



Appreciation

PROCUREMENT DIVISION
BASE SECTION
USASOS

BGPSC

A.P.O.927,
4 December,1944.

Mr. A. Warner,
Managing Director,
Electronic Industries Limited,
126-130 Grant Street,
MELBOURNE, S.C.4. VIC.

Dear Sir,

The Director of Procurement desires to express appreciation for the co-operation received from you and the personnel of your organisation in supplying Radio equipment for the United States Army.

In particular, the performance of the ATR-4A has been outstanding and contributed directly to the success of the recent operations in the Philippine Islands.

Please convey my personal thanks to those responsible for the planning, engineering and fabricating of these equipments.

For the Director of Procurement:

Very truly yours,

R. E. [illegible]SON,
Lt. Colonel, Signal Corps,
Chief, Signal Branch.

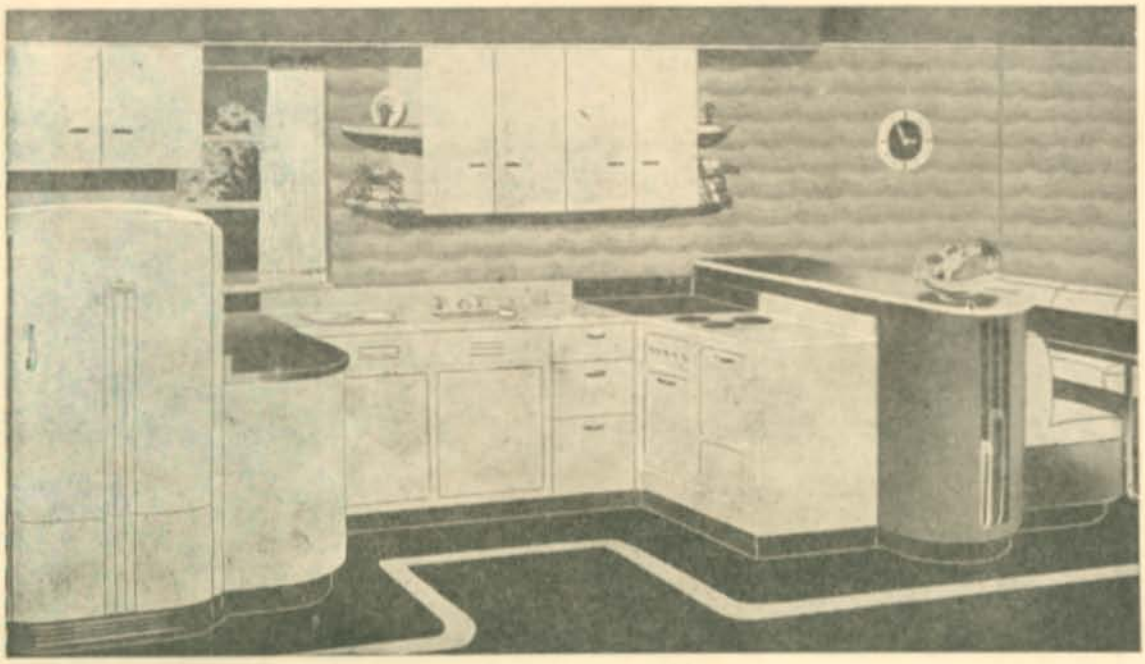
Proudly we played our part . . . Astor supplied communication equipment for every branch of the Services on every fighting front . . . . the Australian Military Forces, Royal Australian Air Force, and Royal Australian Navy, the United States Army and United States Navy, the Netherlands East Indies Forces and Free French Forces.

ASTOR

RADIO CORPORATION PTY. LTD.
Division of Electronic Industries Ltd.

Basic Ideas

for post-war major appliance business



HOTPOINT ALL-ELECTRIC KITCHEN from full-page colour advertisement in WOMEN'S WEEKLY

When the boom comes, sure it will be easy to sell anybody's stock. In the first rush, price, quality, guarantees, they won't count as long as you've appliances to sell. NICE BUSINESS, you'll think, NO LOOKING BACK NOW. Until one day, you might be getting more calls from dissatisfied customers than for new sales and the boom will rebound. That's the picture at its worst, but it can happen—has happened before.

You can side-step these dangers with Hotpoint merchandise. Traditional Hotpoint quality, highest in the past, will outstay competitors to-morrow. If you're aiming at major appliance business after the war, you'll be in the field for years to come if you sell Hotpoint.

To keep the famous name before post-war customers a new series of colour advertisements in top journals is now being released to stimulate a lively interest in kitchen planning—the hub of major appliance selling. These advertisements will do much to develop potential business for Hotpoint traders when the last shot is fired.

Each advertisement of the new series gives suggestions for a kitchen layout of appliances, cabinets and cupboards. When the time comes, brochures and other promotional sales aids will be available for all Hotpoint dealers to use in their sales drives.

AGE Hotpoint

The name Everybody knows

ELECTRIC SERVANTS

AUSTRALIAN GENERAL ELECTRIC PROPRIETARY LIMITED

Sydney, Newcastle, Lismore, Melbourne, Brisbane, Townsville, Rockhampton, Adelaide, Hobart, Launceston.
W.A. Agent: Atkins (W.A.) Ltd.

PHILIPS VALVES

A TYPE FOR EVERY SOCKET OF EVERY RADIO

PHILIPS ELECTRICAL INDUSTRIES OF AUSTRALIA PTY. LTD.

Sydney — Melbourne — Adelaide — Perth — Brisbane

INCANDESCENT AND FLUORESCENT LAMPS; LIGHTING EQUIPMENT AND FITTINGS; RADIO RECEIVING AND TRANSMITTING VALVES; RADIOPLAYERS; RADIO TRANSMITTERS; SOUND SYSTEMS; MEDICAL AND INDUSTRIAL X-RAY AND ELECTRO-MEDICAL EQUIPMENT; INDUSTRIAL AND MEDICAL INFRA-RED APPARATUS; ELECTRONIC DEVICES; RADIO ACCESSORIES; ELECTRICAL MEASURING INSTRUMENTS; METAL PRESSINGS AND STAMPINGS

A Tremendous

473 WAR PROJECTS !

KRIESLER typical adaptability is again proven by its ability to use its initiative in developing so many varying major War projects.

Transmitter No. 123 MRSN.340 • Waterproof Reception Set No. 7 MRSN.2665 • 1000 Wa
Transmitter 722 R.A.A.F. 176921 • 5D/611—Box Adaptor ACS.3249, 384373, YA.1620 • 7A/1588
Machine Gunsight ACS.3211, 4115 • Navy Emergency Lamp 52162 • Clear View Screen and Filt
40186, 18444, MH2/1189N, 12136, 12107, 2348 • G5C/1002 Interference Suppressor Box FSC.659
YA.1299 • Mosquito Aircraft Junction Box 'A' FSC.9334, FSC.12886, FSC.18486, FSC.18946, FSC.200
Mosquito Aircraft Junction Box 'B' FSC.9633, FSC.12888, FSC.14618, FSC.18927, FSC.20077 • Mosqui
Aircraft Junction Box 'C' FSC.9336, FSC.12887, FSC.20080, FSC.18969, FSC.18489, FSC.146
• Mosquito Aircraft Junction Box 'D' FSC.3855, FSC.12889, FSC.14622, FSC.18481, FSC.1896
FSC.20079 • Mosquito Aircraft Junction Box 'E' 3864, FSC.12998, FSC.20071, FSC.18480, FSC.2000
FSC.14629 • Mosquito Aircraft Junction Box 'F' 3863, FSC.12999, FSC.14630, FSC.19413, FSC.2002
FSC.20073 • Mosquito Aircraft Junction Box 'J' 3872, FSC.12908, FSC.14631, FSC.18349, FSC. 188
FSC.20066 • Mosquito Aircraft Junction Box 'L' FSC.12924, FSC.14628, FSC.18350, FSC.1890
FSC. 20072 • 98N785A Invertor Junction Box—Loran FSC.35079, FSC.20928 • 5C/883 Fuse B
4115 • G5C/886—8-way Fuse Box 4291 • 6A/1200—12RS Resistance Units 4115 • 681/1386 17R
Resistance Units 4115 • 6A/1386 17RS Resistance Units YA.1877 • G5D/2051 Resistance Unit 146
• G5C/1775 Resistance & Rectifier Unit YA.1449, YL.3198, YA.3816, YA.1968 • 5C/942 Socket
3-way Dural 7349, YA.1640 • 5C/859 Ground Starter Socket 7349, YA.3972 • 5C/892 Socket Ty
'F' 7349 • 5C/599 Socket 7442, 304610 • 5C/591 Socket 7442 • 5C/457 Socket 7442 • G5C/958 7-w
Dural Socket YL.2784 • 5C/956 Socket YA.1354 • G5C/501 Tail Lamp Socket 12441 • G5C/9
3-way Brass Socket YA.1726, YA.2011 • 5C/936 Switch Type 'B' 7349 • 6D/148 Immersion Swit
7349, YA.1368, YA.4340 • G5C/896 Magnetic Switch 72485, 72486 • 5C/897 Magnetic Relay 7349
5C/372 Identification Switch 7442, YA.4318 • G5D/608 Jettison Switch YA.4233, YA.2468
G5C/930 Switch YA.2345 • G5C/844 Bomb Firing Switch YA.1400 • 5C/1968 Switch Box 73
• G5C/1616 Accumulator Cut Out Switch 14647/98, 14636/98 • 5C/884 Link End 7349, YA.4352

....and so many more that space does not permit publication. KRIESLER War Effort is only surpassed by its Post War Effort !

KRIESLER

War Effort

KRIESLER is justly proud of its War Effort and here listed below is PROOF of the outstanding amount of vital equipment made for the Services.

5C/793 Lamp Type 'B' 7349 • G5C/558 Downward Lamp 12441 • G5C/557 Downward Lamp 12441 • G5C/1553 Warning Lamp 12441, YA.4302 • G5C/1069 Warning Light YA.4272 • G6285 Warning Lamp YA.2672 • Life Saving Raft Lamp EOE/IW TRANS-CD1262-44 • G5C/890 Plugs Type 'F' 72620-1 • G5C/540 Push Button 14617 • G5C/598 Plugs 304610 • G5C/898 Push Button Switches YA.1451, YA.2011 • G6A/715 Fuel Traps FSC.31608 • G5C/516 Terminal Block FSC.31214 • G5C/868 Terminal Block 14667, YA.4059 • G5C/1302 Windscreen Wiper 12441 • G5C/2125 Undercarriage Indicator 12441 • J176 Oxygen Service Valve 12713/98 • G5C/13205 Type 'AB' Suppressor Box YA.2897, FSC.18313 • G5C/1614 Suppressor Box FSC.18424, 17319 • G5C/870 Suppressor Box 72352 • G5C/876 Suppressor Box YA.1624, YA.1960 • Type 253 Suppressor Units MRSN.2939 83911/5 Hex. Bolts & 83911/4 Hex. Bolts YA.3639 • 31.SS3220 Screws YA.3467 • 83860 Ferrules YA.3706 • SS.3447 Ferrules YA.4131, YA.3967 • 88866/4A Ferrules YA.2883 • APCS/40 Ferrules YA.2781 • SS2590/4, /5, /7 Bolts YA.3195 • 14F 3982 Bolts YA.3713 • 3F5129 Special Stud YA.3684 • Radar Video Filters MRSN.2994 • Radar Strobe MRSN.2983 • Radar Scope MRSN.2983 • H.P. Telephone MRSN.2840 • Freddie Phone MRSN.2024 • Radar A.W. Mk. V Modulators MRSN.2815 • Radar Y10DB/500066 Pre-Amplifiers MRSN.2726 • Tropic Proofed Resistors MRSN.2440, MRSN. 2330 • Radar Pre-Amplifiers MRSN.2611 • Fuses MRSN.2325 • 6 Valve Dual Wave A.C. Mantel Receivers A.M.E.N. 2464/1463. 27419, RW.27547, RW.27644, Junction Box "A" RW.27708, RW27820, RW.26465, R.W.26843, 32544 • "B" RW.27712, RW.26367, R.W.26447, 26952, 26611 • "C" RW.26727, 26722, 26729, R.W.32559, 32747 • "C" RW.26727, 26722, 26729, RW.32559, 32747 • "D" RW.27595 • "E" RW.27712, RW32777, RW.26717 • "F" RW.27616, R.W.27582 • "J" RW.26435, 26735, 32522 • "L" RW.2776, RW. 26223 • RW. 26521, G5C/1002 Suppressor Box RW.27752, RW.27659, RW26203, RW.26554, RW.26321, YSL.824, RW.28473, RW.28636 • RW.32633. G5C/1614 Suppressor Box RW.27419, RW.27547, RW.27644, RW. 26521, RW. 32504, RW.32633.

LEADERSHIP is earned and forged in the fires of War... today that same Leadership is seen most positively in the KRIESLER SEALED RADIOS....truly the Radios of the Future NOW!

RADIO

. famous before the War

. . on the job throughout the War

. . away to a flying start in Peace—

ECLIPSE RADIO—First with the Finest

The pre-war reputation enjoyed by Eclipse for radio assemblies of supreme quality and precision caused us to turn, willingly and not without pride, to 100% war-production right up to V-P day. Having done all that every fighting service in the South-West Pacific called for, Eclipse has already turned its long experience to peacetime radio of the best.

MONARCH

—the Mantel magnificent

Peter Pan

"Is the Tone that tells"

These two famous brands are coming off the lines in an ever-increasing flow. The four and five valve mantels (A.C. and vibrator types) are already well-established in public favour, and a full range from consoles to portables will be with the trade in a very short time. A franchise for Eclipse Radio is your passport to Good Business.

ECLIPSE RADIO PTY. LTD.

A DIVISION OF ELECTRONIC INDUSTRIES LTD.

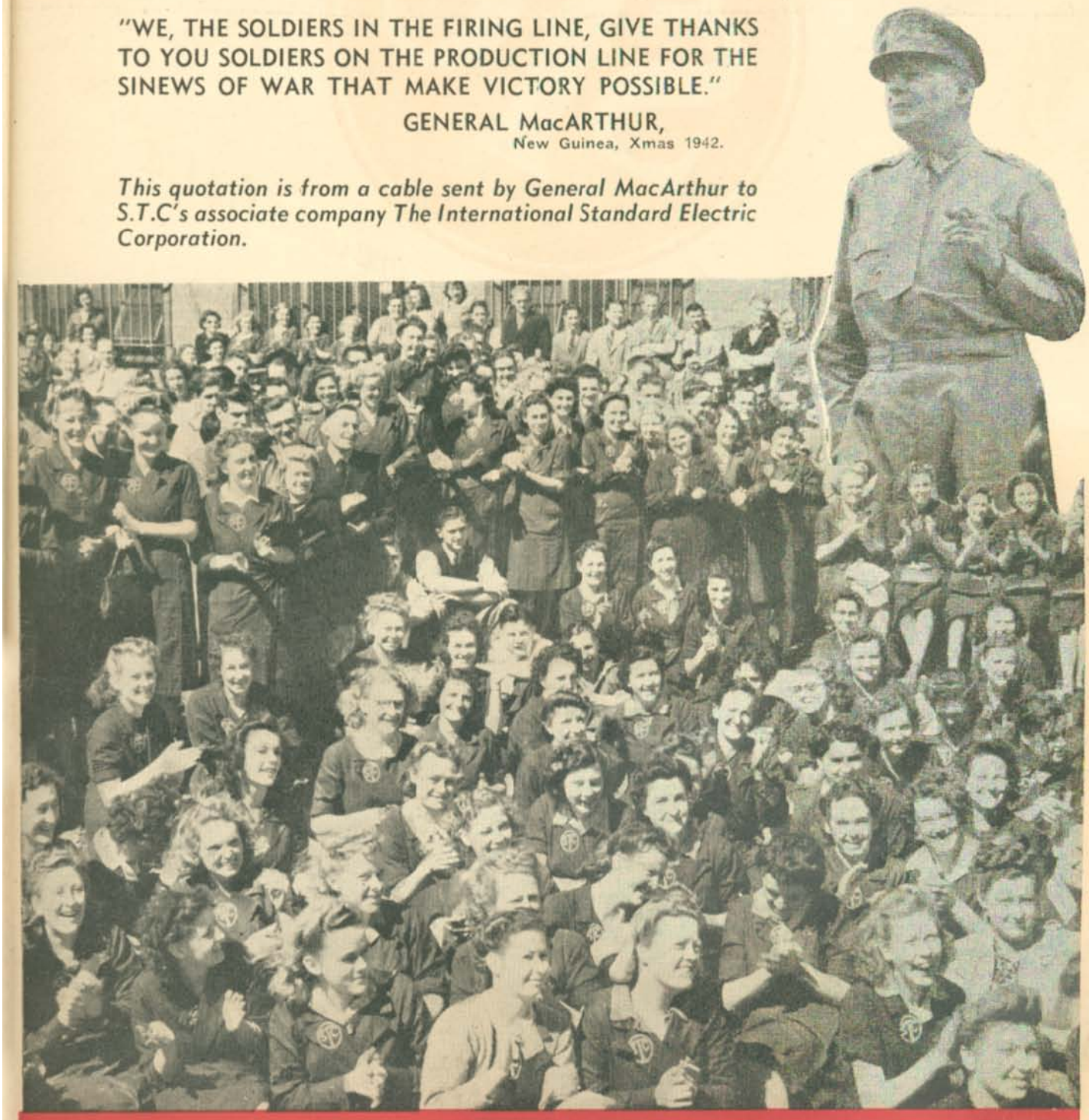
11 STURT STREET, SOUTH MELBOURNE

Glimpses of the WAR EFFORT

"WE, THE SOLDIERS IN THE FIRING LINE, GIVE THANKS TO YOU SOLDIERS ON THE PRODUCTION LINE FOR THE SINEWS OF WAR THAT MAKE VICTORY POSSIBLE."

GENERAL MacARTHUR,
New Guinea, Xmas 1942.

This quotation is from a cable sent by General MacArthur to S.T.C's associate company The International Standard Electric Corporation.



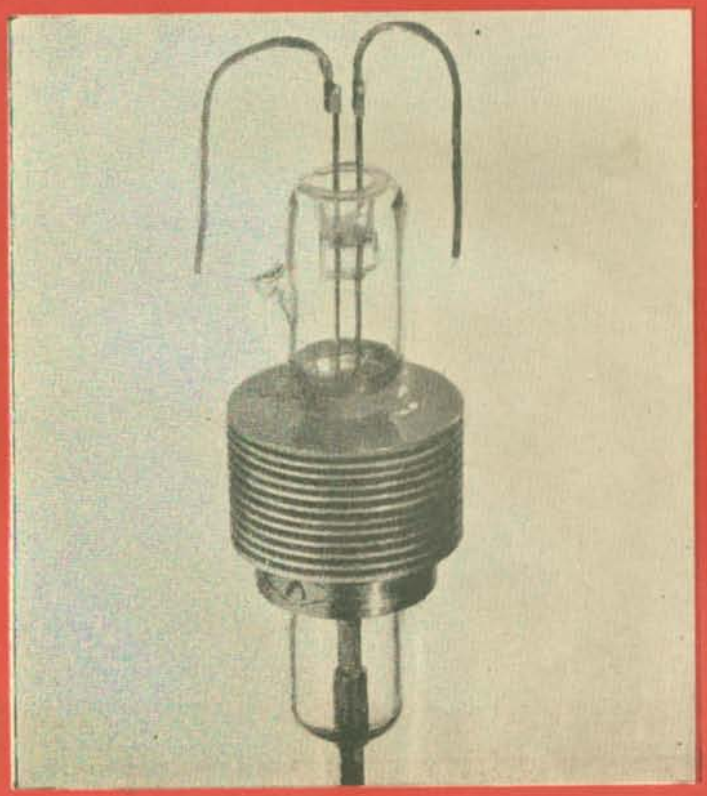
S.T.C's 2000 EMPLOYEES WERE HAPPY TO BE OF SERVICE!

WAS

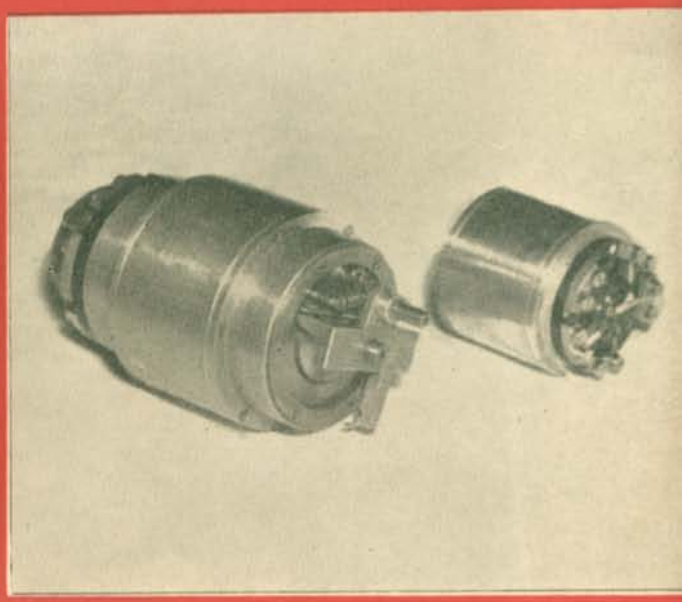
STC

Standard Telephones and Cables Pty. Ltd.

ELECTRONIC VALVES FOR RADAR EQUIPMENT



"MAGSLIP" UNITS FOR THE ELECTRONIC GUN PREDICTORS



Above: Previously manufactured in Great Britain only, these intricate electrical units, essential parts of electronic anti-aircraft fire control equipment, were produced by S.T.C. at the request of the Australian Army authorities.

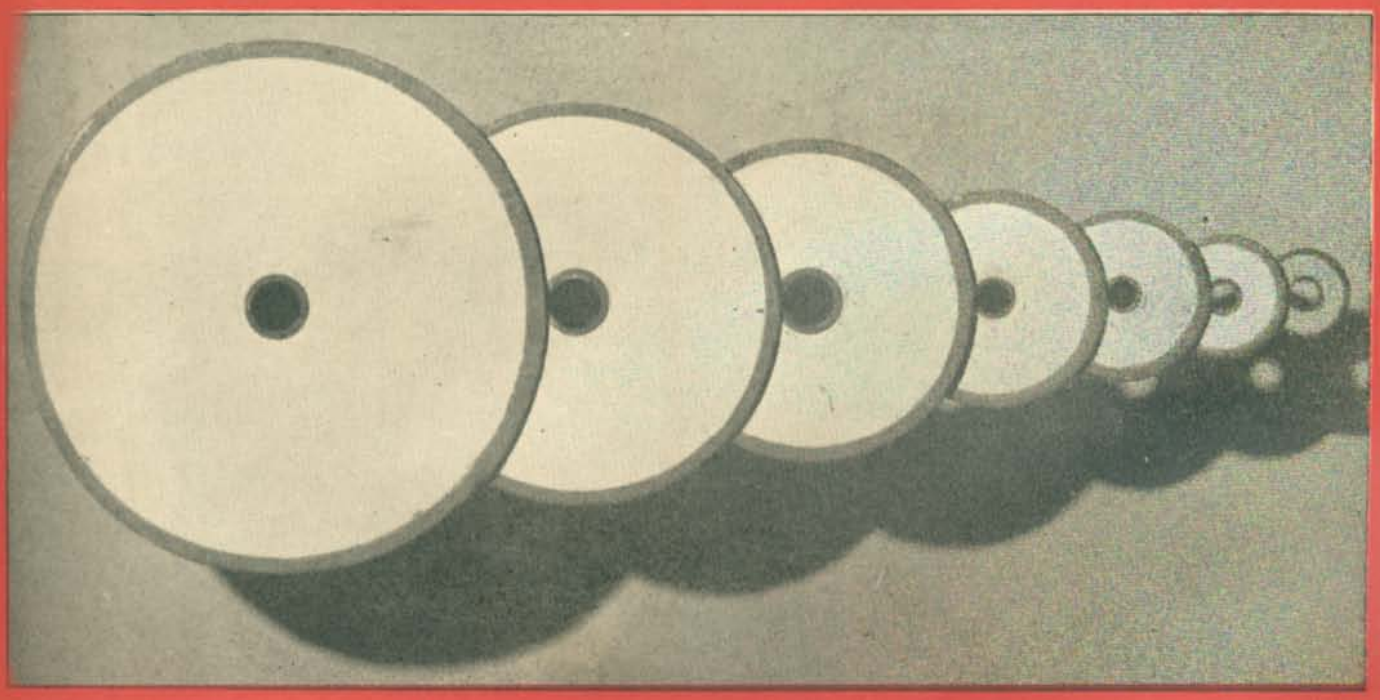
Left: The first radar valve made in Australia.

FIRST

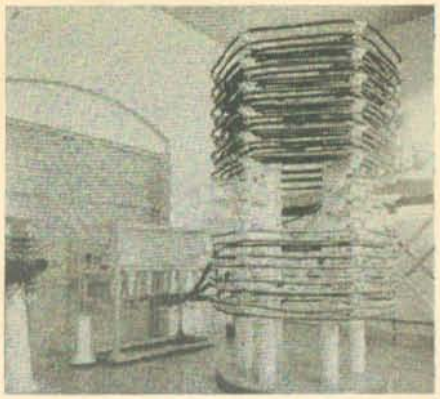
TO MANUFACTURE IN AUSTRALIA
THESE HIGHLY IMPORTANT CONTRIBUTIONS
TO AUSTRALIA'S WAR EFFORT!

The need was urgent. The difficulties to be overcome were immense. Australia from its own resources had to procure electronic valves for radar equipment, intricate units for electronic anti-aircraft gun control equipment and metal rectifiers for the Fighting Services and essential industries. None of these had been previously made in Australia but S.T.C's technical and manufacturing resources and experience gained in pre-war precision manufacture enabled the company to develop and produce this vitally essential equipment.

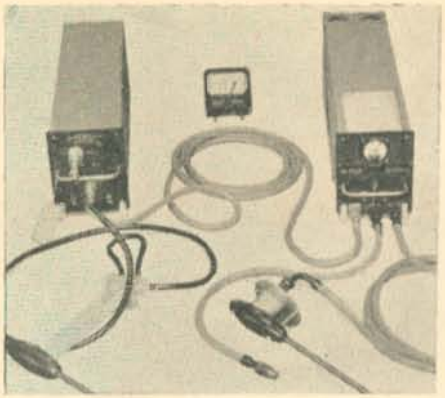
RECTIFIER DISCS WHICH MADE POSSIBLE THE MANUFACTURE OF METAL RECTIFIER EQUIPMENT



Production of S.T.C. Selenium Rectifier Discs rendered Australia a service of national importance at a time when rectifier equipment was urgently needed. S.T.C. Selenium Rectifiers were used for providing direct current potentials from fractions of one volt to as high as 60,000 volts and for rectifying current from 1 milliampere up to several thousand amperes.



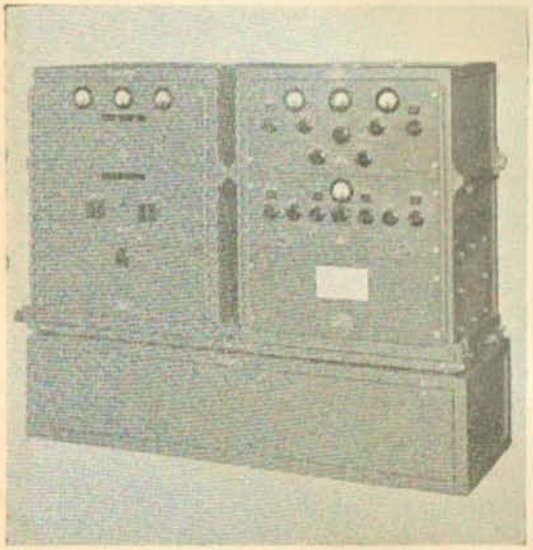
Aerial loading coil (right) and aerial tuning variometer (left) of the S.T.C. 200 kilowatt radio transmitter at the Royal Australian Naval Station, Belconnen, Canberra. The aerial loading coil is over 15 feet high.



S.T.C. Height Indicators gave pilots of Torpedo Bombers visual warning when too high or too low to release their torpedoes. Many squadrons of R.A.A.F. Torpedo Bombers were equipped with this apparatus.

S.T.C. equipped many mobile radio stations for the U.S. Army. This close-up view of one shows a High Frequency Radio Receiver and part of the control equipment.

S.T.C. type "L" field telephone which the Company produced in thousands for the fighting forces of Australia.



S.T.C. type A.T.20-500 watt transportable radio transmitter designed and manufactured for the R.A.A.F. Production of these equipments which were supplied in large numbers was one of the Company's outstanding achievements.

S.T.C. manufactured much carrier telephone equipment which played a highly important part in the nation's telecommunications throughout the war. Picture shows the assembling and wiring of S.T.C. Carrier Telephone and Voice Frequency Equipment.

Before the War

we did it well

During the War

we did it better

Now the War is over

We'll do it better still!

VICTORY
is made up of a lot of little things

THE first excitements of victory have died away. Already the war is receding into the background of our thoughts . . . but let us not forget that many of the *little* things which contributed to the colossal achievement of victory actually *grow* in significance with the passing of the years.

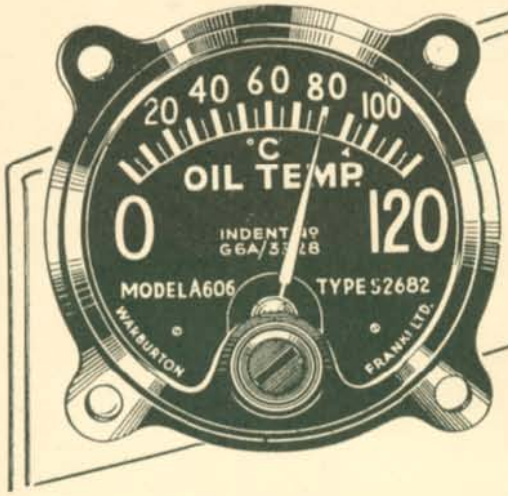
In the gigantic sum total of the United Nations' war effort the contributions of Philips Engineers, scientists and craftsmen, though great in themselves, could but play a subsidiary part. Nevertheless, in the making of those contributions, in the development of radio and sound equipment, direction finders and a score of other special war requirements, Philips have discovered and applied new principles, new efficiencies and new conceptions which, in their peacetime role, will place Philips products even further in advance than they were when the struggle for Victory began.

PHILIPS

Philips Electrical Industries of Australia Pty. Ltd.
Sydney — Melbourne — Adelaide — Perth — Brisbane

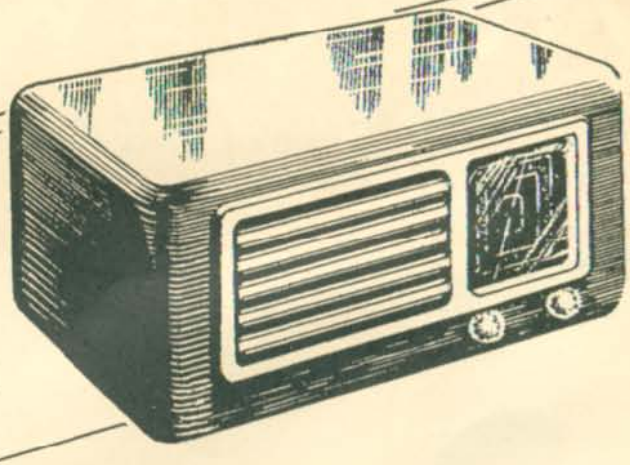
INCANDESCENT AND FLUORESCENT LAMPS; LIGHTING EQUIPMENT AND FITTINGS; RADIO RECEIVING AND TRANSMITTING VALVES; RADIOPLAYERS; RADIO TRANSMITTERS; SOUND SYSTEMS; MEDICAL AND INDUSTRIAL X-RAY AND ELECTRO-MEDICAL EQUIPMENT; INDUSTRIAL AND MEDICAL INFRA-RED APPARATUS; ELECTRONIC DEVICES; RADIO ACCESSORIES; ELECTRICAL MEASURING INSTRUMENTS; METAL PRESSINGS AND STAMPINGS.

AS IN WAR . . .



Warburton Franki achieved, through their experience, knowledge and skill, the production of highly accurate electrical instruments and, in surmounting the difficulties involved, established a name for resourcefulness and dependability . . .

SO IN PEACE . . .



Warburton Franki have turned their skill, supplemented by the experience gained in war production, to civil projects. Frigidaires, Weston instruments, and the popular Stromberg - Carlson radios are just some of the items with which the reliable name of Warburton Franki is associated. For all electrical requirements you may depend upon Warburton Franki for excellent and experienced service.

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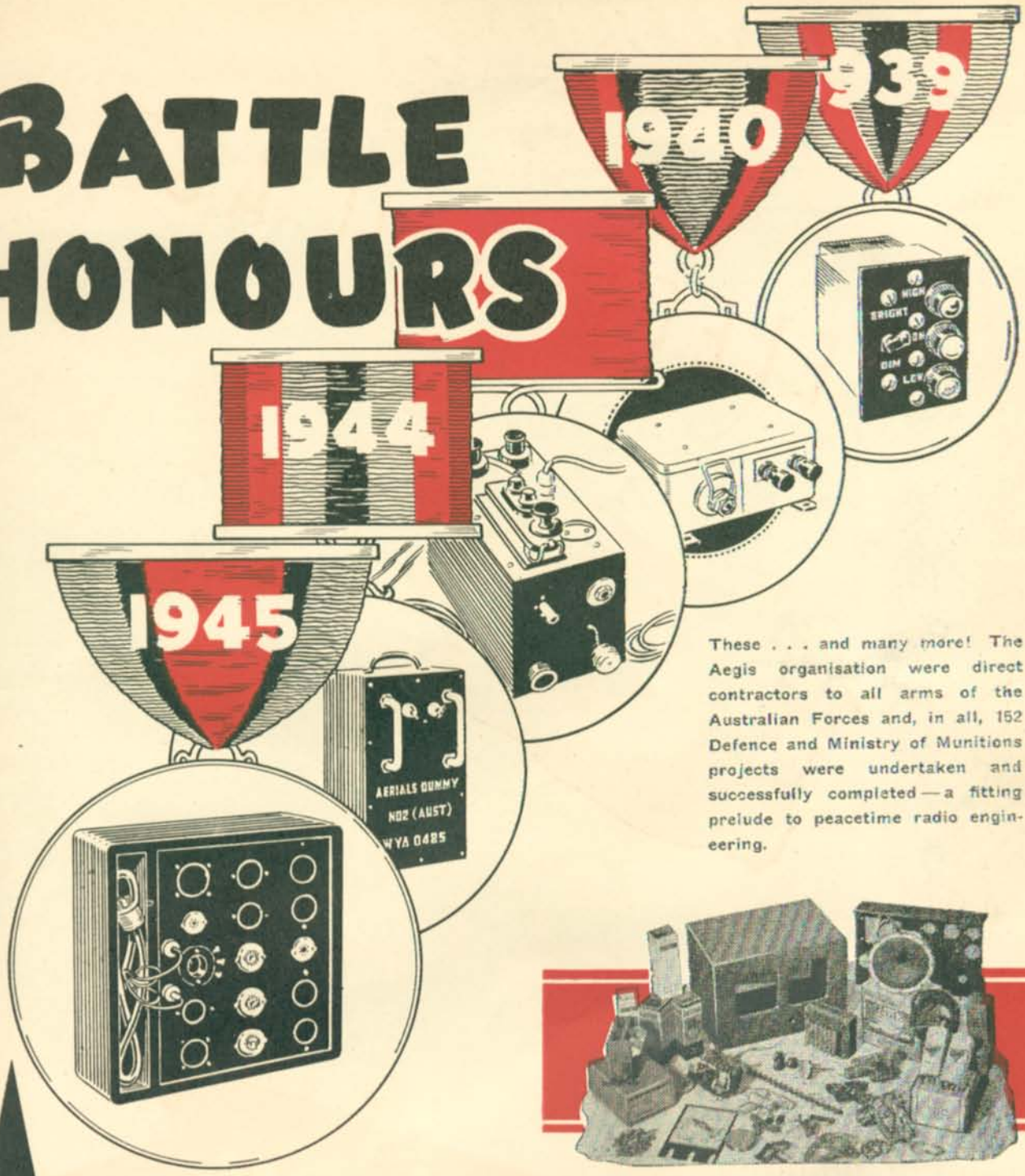

These . . . and many more! The Aegis organisation were direct contractors to all arms of the Australian Forces and, in all, 152 Defence and Ministry of Munitions projects were undertaken and successfully completed — a fitting prelude to peacetime radio engineering.

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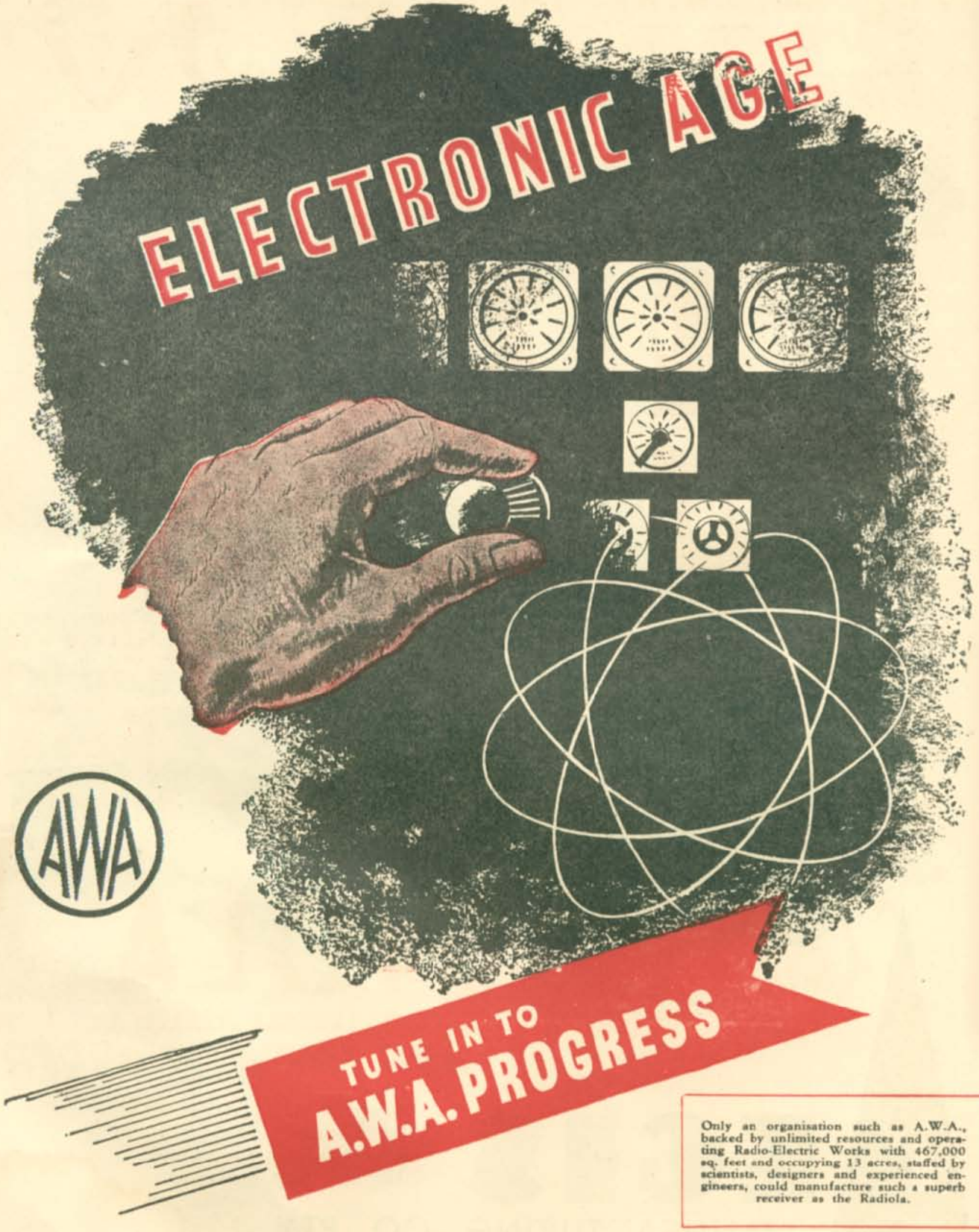

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AUSTRALIA'S NATIONAL WIRELESS ORGANISATION

FOREWORD

NO particular originality is claimed for the idea of telling the story of "Australian Telecommunications at War" in these pages—the job done by the Australian Radio and Electrical Industries in furthering the National War Effort was so meritorious that somebody just had to do it, and it was merely a logical conclusion that the publishers of Australia's oldest Radio and Electrical trade newspaper should undertake that job.

Similarly, little originality can be claimed for much of the information presented in these pages—most of it has appeared, or will appear at some time, in the records of the Services and Government Departments, or exists in the individual files of those firms that contributed so much to the total effort—what we have done is to sift out the facts and collate them so that the achievement may be viewed as a whole and in its proper perspective.

The net result has surprised even those of us who were rather closely connected with the production and operational aspects of the war effort—once again, it was a case of being unable to see the forest for the trees—and we feel that our readers will share the same respect for the magnitude and successful consummation of the task which was undertaken by an industry that had no experience or precedent to guide it in the technique of wartime production.

The next few pages present the official view on "Australian Telecommunications at War", and the mass of information following tells its own story—we need say no more, other than to express our sincere appreciation for the universal co-operation which has made this publication possible.

THE EDITORS.

SEE LAST PAGE FOR DETAILED CONTENTS TABLE

MINISTER FOR MUNITIONS.

Dear Sir,

As Minister for Munitions during the period of the operations of the Radio and Signals Supplies Directorate, I would like to state that the contribution made by the Radio Industry to the nation's war effort was not only of outstanding importance in the Commonwealth's defence, but represented an outstanding technological triumph for Australian manufacture.

Although a well-established Radio Industry existed in Australia before the war, by far the greatest bulk of its production of necessity consisted of domestic radio receivers, with factory, plant and facilities designed to meet those requirements, and not the demands of total war.

The story of how the Industry, in co-operation with the Radio and Signals Supplies Directorate, was transformed to meet the new conditions represents an inspiring chapter in the history of Australia's home front activities.

The magnitude of this accomplishment can be realised when it is considered that not only was the gross output of the Industry as a whole greatly increased, but at the same time the number and diversity of its items of manufacture were at least trebled, a majority of them being articles never previously made in Australia.

An example of the tremendous technical advances made by the Industry over these years was the development of Radar equipment manufacture. Although the first practical tests in Radar, the most versatile weapon produced by the war, were carried out overseas as late as 1938, its highly technical processes were being undertaken in Australia by 1942, and during the years that followed Australian Radar equipment proved its worth in every Pacific battle area.

The potentialities of radio are only now even being foreseen, so that the Industry stands to-day on the threshold of what may well prove to be illimitable expansion. It is plain from the experience of the war years that whatever radio's future applications are, Australia will be able to keep well in the forefront of its development.

Yours faithfully,

Norman Makin

(Norman Makin)

The Editor,
Radio & Electrical Retailer,
146 Foveaux Street,
SYDNEY, N.S.W.

£17,000,000 Worth

of Basic Telecommunications Equipment

The following statement from the Hon. Norman J. Makin, Minister for Munitions, covers the activities of the Munitions' Directorate of Radio & Signals Supplies from June, 1942 to October, 1945, and provides a first-class indication of the volume of production which may be credited to the Australian Telecommunications Industry.

Impressive as the figures are, however, they are still only an indication—the total achievement is even more impressive—as they refer largely to the production of basic equipment items during the last three years of the war and do not include the considerable production effected earlier under Contracts Board arrangements and the concurrent manufacture of accessory and related items (such as batteries and generating sets) which was regulated by the Directorate of Supply and the Ordnance Production Directorate. Information concerning the activities of these agencies will be found elsewhere in this publication.

RADAR, Radio, and Signal equipment valued at £16,896,994 was manufactured in Australia between June, 1942, and October, 1945, and delivered to the Australian and Allied Armed Services.

Of this amount, which was produced under the direction of the Radio and Signals Supplies Directorate of the Munitions Department, Radar equipment accounted for material to the value of £2,190,019, Radio equipment £9,410,614 and Signals equipment £5,296,391.

So far as signals equipment was concerned, practically no field wireless or field telephone equipment had been manufactured in Australia before the war, and Australian industry was now faced with the necessity for hurriedly changing over to production standards of the quality, performance and reliability laid down by British industry.

The first practical tests in Radar, the most versatile weapon produced by the War, had been made in England and America only as late as 1938, and its highly specialised technical processes were still in the early stages of experiment at the outbreak of hostilities. Prior to January, 1942, only experimental items of radar equipment had been produced in this country.

To meet the growing demand from all branches of the Armed Forces for every type of communication equipment, the Munitions Department created the Directorate of Radio and Signal Supplies in June, 1942, and vested in it the responsibility for directing all future production along these lines.

Concentrating its efforts upon building up manufacturing capacity, and upon obtaining the maximum output from established units, over the first three months of the Directorate's existence the output of the industry averaged £330,000 per month.

Increasing demands from the Services indicated that production approximating £6,000,000 annually would be required, and by November, 1943, this rate was achieved, production for that month representing in value £517,000.

While this increased productivity represented a notable achievement, probably the most important aspect was the technological development which had taken place in order to make these figures possible.

Radio, Radar and Signals equipment manufactured in Australia proved of outstanding merit in the South West Pacific area, and was regarded as being more suitable to the conditions prevailing in that sphere than material produced in any part of the world.

A big factor in establishing the high quality of the Australian product was the research work carried out by the Munitions Supply Laboratories and by private bodies, whereby certain processes were incorporated in the manufacture of equipment, protecting it against the ravages of the atmospheric and mycological conditions experienced in tropical and sub-tropical areas.

Some idea of the scale upon which equipment was manufactured following rationalisation of the industry can be obtained from the fact that field cable delivered to the Services aggregated a total length of 216,000 miles, or nearly the distance from the earth to the moon.

Over 100,000 telephone units were delivered, as well as 200,000 steel poles, and nearly 9,000 switchboards.

More than 12,000 radio transmitters, 9,000 radio receivers, and nearly 19,000 transmitter-receivers were also delivered.

Although it was not until well on in 1942 that production of Radar equipment got really under way, Australia manufactured practically every type of airborne, shipborne, and ground-operated Radar units, ranging from 100 lbs. sets to assemblies of several tons.

Altogether 2,076 items of Services' Radar equipment and 9,085 items of general Radar test equipment were manufactured over the period.

Navy's Tribute

As received from the Secretary, Dept. of the Navy

DURING the recent conflict tele-communications have been developed to a very high degree of efficiency, particularly in the three Services, due mainly to the general mechanisation and rapidly changing methods of modern warfare, and the consequent demand for speedy and flexible communication systems.

Radio communications have played a major role in the Royal Australian Navy, both at sea and on shore, during the recent war years, and have helped in no small measure to enable the successful actions to be carried through in various theatres by our ships, as well as in the saving of many lives at sea. The air protection of any Naval force also requires efficient communication between ships and aircraft.

It may be said that every action fought at sea and every landing made on shore by seaborne forces depended for its ultimate success to a great extent on the efficiency of the communications.

Radar equipment also played a very important part in all of these operations, in giving warning of approaching enemy aircraft and surface craft, and as a navigational aid. A large number of these sets, as well as many types of radio equipment used by the three Services, were developed and manufactured in Australia and proved most efficient and reliable.

In the South West Pacific Area tropical conditions were met with which were far more severe than any experienced before, and the normally designed equipment was found to be unsuitable in some places. This necessitated special research into this particular disability and a more rigorous manufacturing technique for tropical radio equipment. That these demands were admirably met on behalf of the Allied Services, speaks volumes for the untiring efforts of the Radio and Electrical industry in Australia, and particularly for the skill of the men and women associated with the production of this highly specialised equipment.

The Department of the Navy therefore desires to pay a high tribute to the Radio and Electrical Industry of Australia for its skill in producing, under most difficult wartime conditions, first rate equipment for use by the Naval Forces of Australia and her Allies. Experience during the recent war shows that the Industry has the capacity for providing the equipment required by the Fighting Forces, and it is essential in the years to come that every effort be made to keep abreast of the latest technique in all classes of radio equipment.

Army's Tribute

As received from the Secretary, Dept. of the Army

IN these days of mechanised warfare where rapid, positive communication is more vitally important than ever before, the demand has been created for a fast, flexible and mobile communication system, and radio is the main method of communication that will meet these requirements.

The failure of but one link in the chain of communications in the field may adversely affect an operation and cause the loss of many lives. However, during the recent conflict, Australian-made Signal equipment has amply justified the reliance placed upon it by the Armed Services.

A glance backwards over the past war years shows an accomplishment of production of Telecommunication equipment of considerable magnitude by the Radio and Electrical Industry of Australia; in fact, equipment to the value of more than £10 million was made for the Australian Army alone.

The demand by the Services in the South West Pacific Area for equipment that would withstand the rigours of the tropical climate and continue to operate under adverse conditions was fully met by the equipment produced by the Australian Industry, and the information and technique gained during manufacture of all types of components has been not only of considerable value to Australia, but also to overseas authorities who have acknowledged the great assistance to them in meeting similar problems.

This accomplishment was made possible by the skill and effort of men and women who have been associated with the industry for a number of years, together with that of hundreds of others who have joined the staffs of the various firms since the outbreak of war.

Full and grateful recognition of their skill and spirit of loyalty must be given to all concerned in maintaining a fine record which has brought distinction to the whole industry.

While paying tribute to this excellent effort, it is considered that there is still a need for continued interest and co-operation by manufacturers with the Services in order to keep up-to-date with Army requirements in telecommunication equipments, and for facilities for the production of Army equipments to be ready in case of a future National emergency.

Air's Tribute

Oswald F. Mingay, Esq.,
Mingay Publishing Coy.,
146 Foveaux Street,
SYDNEY, N.S.W.

Dear Sir,

I am indeed most grateful for this opportunity to thank the Australian Radio Industry for the magnificent part it has played during the war.

2. This war has been largely an electronic war, in which the employment of Radar and Telecommunications has been one of the main factors which contributed to victory by the United Nations over the enemy.

3. That the R.A.A.F. has been able to make large-scale use of Radar and Telecommunication equipment against the enemy is due to the untiring efforts of the Australian Radio Industry in designing and manufacturing, against time, high-grade radio equipment, which has proved its worth in the field. In some cases, Australian Radar and Telecommunication equipment has been acknowledged to be the best in the world, an achievement of which the Australian Radio Industry and, indeed, all Australians should be justly proud.

C. Jones

Air Vice-Marshal,

CHIEF OF THE AIR STAFF.

Figuratively speaking, the initial onset of war in 1939, caught the telecommunications industry "with its pants down", not only in Australia, but in all Allied countries. The Australian industry probably had less training than any other for war production and it speaks volumes for its adaptability and tenacity of purpose that it was able not only to overcome this disability, but also to develop to such an extent that, in less than six years, it produced highly-specialised Service equipment conservatively estimated at a total value of £40,000,000

Summarising

The Value of Industry's Achievement

In the preceding pages there is presented what might be termed the "official view" of Australia's war effort in the production of telecommunications equipment, and a heartening view it is—when the responsible Minister of the Federal Government and spokesmen for the three Armed Services come forward and, in almost identical terms, unreservedly praise the work of an Industry, that Industry is justifiably entitled to consider that it has "earned its salt".

However eulogistic as are the commendations expressed by the Government and Services, they only tell part of the story—referring, as they do, largely to the *results* rather than the *magnitude* of the Industry's achievement. Even the figures quoted on page 34, impressive as they are, do not fully cover this aspect, as they deal primarily with only a section of telecommunication production—that section under the control of one Directorate of the Ministry of Munitions.

To obtain a complete picture, it is necessary also to include the not inconsiderable production under control of the Department of Supply and Development and the work carried out by the Postmaster-General's Department as co-ordinating contractor during the period prior to the advent of Munitions control; the vast production of ancillary equipment organised by the Munitions Directorate of Ordnance Production; and the continued production of "Contracts" items such as batteries and electrical apparatus—when these all are considered, it is found that a figure of £40,000,000 is a conservative valuation of the equipment produced by the Industry during the war.

To convey the true immensity of this achievement it is necessary briefly to review the status of the Industry in pre-war days. As industries go, it still was in its swaddling clothes—there virtually was no serious production of any radio or related equipment prior to 1930, and several years after that elapsed before production settled down to a rational basis.

Admittedly, the Industry grew fast, but even at its best, factory production never exceeded a total value of £3,000,000 per annum, and of that about 80 per cent. was represented by domestic broadcast receivers. The remaining 20 per cent. of production—a mere £600,000 per annum—was made up of broadcasting and commercial equipment of various types.

Compare this with the effort of the past six years, when production, even after a slow start, averaged over £6,000,000 per annum, mostly made up of equipment produced to standards far in advance of even the best commercial practice of pre-war years—it requires no great feat of mental arithmetic to reach the conclusion that, at its peak, the Industry produced more precision equipment per *month* than it did in any complete pre-war year.

The achievement of this volume of production becomes even more impressive when one pauses to consider the enormous difficulties that had to be surmounted. Two factors alone—manpower and materials—reached such proportions as to discourage all but the stoutest hearts, and when one adds in the difficulties experienced, especially in the early days, with Services' procurement procedures and the mastering of new production techniques, it almost becomes a matter of wonder that the Industry was able to produce anything at all, much less multiply its pre-war figures many times.

Another factor which must not be neglected in any endeavor to assess the overall contribution of Australia's Telecommunication Industry to the war effort is the *scope* of its activities—production during the war years encompassed an almost bewildering variety of items, all related to "the transmission of intelligence over a distance," some of them of a precision and complexity undreamed-of in pre-war years. This diversification of production, while meritorious in itself, as yet another example of the adaptability of the Industry, made the total achievement all the more remarkable, as it meant that only in rare instances were manufacturers able to gear up for anything remotely approaching "mass production"—in the vast majority of cases, production was of the "short run" variety, while for some items the total requirement was so small as to barely take it out of the "hand-made sample" class. In almost every case, however, a considerable amount of preliminary research and development was required, thus calling for an extremely disproportionate amount of highly technical and skilled manpower.

It will be of interest at this stage to examine the total production figures of the Industry and see how the figure of £40,000,000 was made up.

Commencing with the figure of almost £17,000,000 quoted by the Hon. Norman Makin, we find that this is almost entirely made up of basic equipment items—radar, radio, and telephone—produced under control of the Munitions Directorate of Radio and Signal Supplies during the period from July, 1942, until mid-1945. A considerable amount of equipment was still in production at that time, and although many cancellations were effected after V-P Day, it would be safe to put the total value of DRSS production down at a round figure of £20,000,000.

Concurrently with this production, the Ordnance Production Directorate of the Ministry of Munitions was supervising the manufacture of electrical generating sets and alternators, switchgear, wires and cables, and a considerable number of ancillary items required for association with the equipment produced under DRSS control and, while no detailed figures are available, an examination of the items and quantities delivered places the value of this equipment at somewhere around the £5,000,000 mark.

But this is not all of the story—until the end of 1944, all dry batteries and accumulators, of which vast quantities were used, were produced entirely under Contracts Board arrangements, and while no figures are available for accumulator production (due to the difficulty of segregating "vehicle" and "signal" types), a reliable source places the total value of dry battery production alone at over £1,000,000.

All of the figures given above refer largely to production, during the last half of the war, of items specifically designed to meet Service requirements, and to complete the picture it is necessary, not only to consider the production of Service items earlier, but also the considerable purchases of "trade pattern" items which were effected right through the war period. For obvious reasons, it is impossible to arrive at a total valuation of all these items, but, as much of the early production was in accordance with orders placed by the Department of Supply and Development (now Supply and Shipping), through its Contracts Boards, and this was also the channel for many "trade pattern" purchases, a useful indication of the value of this business is provided by the fact that "Contracts" deliveries of electrical and wireless equipment during the war years totalled over £9,000,000. Some of this may overlap with deliveries credited to other sources, but the amount of any overlap would be much more than offset by direct Services' purchases under "Local Purchase" arrangements, of which no record is available.

One other "production agency" remains to be taken into consideration—the Postmaster-General's Department, which, during the early war years, was the official co-ordinating contractor for Services' purchases of telecommunications equipment, and later carried on as a major equipment contractor and supplier of basic communications services. Much of the material and equipment employed in satisfaction of these contracts was supplied by industry at large, and while it is not possible to obtain any reliable estimate of the total value of goods and services supplied by and through the P.M.G.'s Department, information available leads one to believe that the £5,000,000 balance of our £40,000,000 total is credited to that agency.

An interesting cross-section of the production program is given by a published statement from the U.S. Army Services of Supply. This statement was made before the Sydney BREIF Club in May, 1945, and indicates that telecommunications equipment and

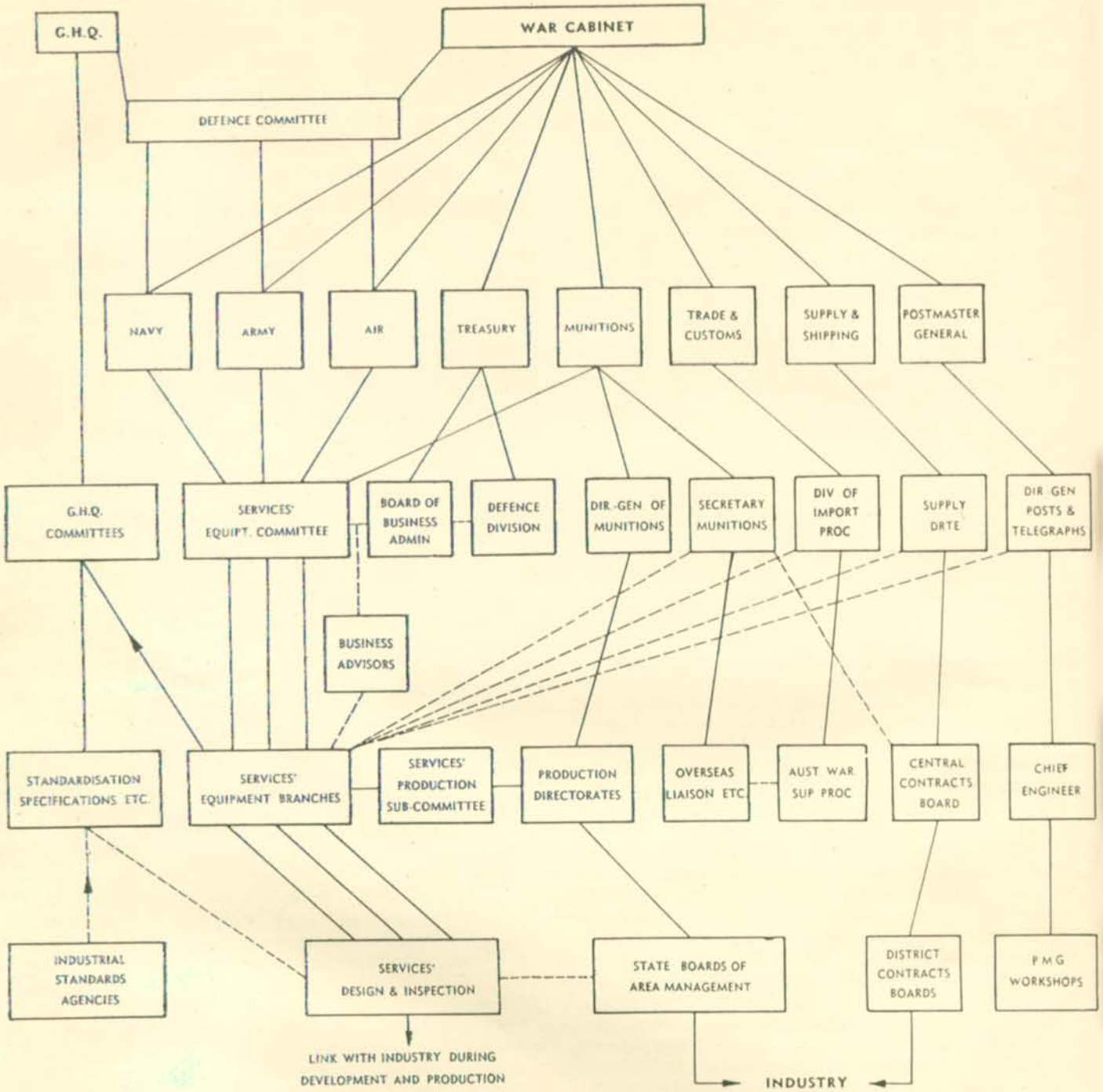
Nearly 600 Separate Organisations Mobilised for Telecom's Production

services totalling some £13,000,000 in value were obtained from Australian sources during the years 1942, 1943, and 1944. Of this total, approximately £10,000,000 was represented by equipment alone, made up as follows:—Radar, 11 per cent.; Radio, 26; Line, 13; Power, 11; Miscellaneous (cable, spares, etc.), 39 per cent. No exactly comparable break-up is available regarding Australian Service purchases, but it would appear that the ratios are somewhat different from those set out above, as it is known that of the £10,000,000 or so expended by the Australian Army on Australian-made telecommunications equipment, about 50 per cent. was spent on wireless and associated stores, with the balance split fairly evenly between line equipment and radar and testing apparatus.

To produce this volume of equipment, the Industry was mobilised and expanded to a remarkable degree, particularly after the advent of the Munitions Production Directorates. It is safe to say that there was not a single organisation of any standing that did not participate in the production programme to a greater or lesser degree, and records available show that at one time or another, there were nearly 600 separate firms engaged in some aspects of telecommunications production, either as contractors, sub-contractors, or suppliers of specialised materials.

Exact quantitative figures for the total effort are difficult to arrive at, but it is known that at least 50,000 radio transmitters and receivers were produced, together with about 10,000 generating sets. On the line equipment side, field cable production reached a total of at least a quarter of a million core-miles, and for pole-line routes, about 200,000 sectional steel poles were produced. Telephone and switchboard production figures ran into many thousands, while a total of over 30,000 cable layers were placed into service. Visual signalling devices played an important part in all operations, and it will come as a surprise to many to learn that over 34,000 signalling lamps were produced by the Industry, which also played its part in the manufacture of about 1,500 searchlight projectors, ranging up to 150 cm. (5ft.) in diameter, many of them radar-controlled by Australian-built apparatus. Finally, a significant development took place in those sections of the Industry devoted to test equipment, and at least 20,000 items of precision testing instruments were produced, together with many thousands of individual meters, for the Services. Not content with this, many organisations broke into new fields and established production of many aero, navigational and fire-control instruments new to this country.

In producing this equipment, many lessons had to be learned, both in administration and production, and the successful culmination of this "home-front battle" is an achievement of which all concerned might well be proud.



The above chart shows, in broad outline, the relationship between the various Service and Government Departments responsible for production of telecommunications equipment during the war years. It is not claimed that the chart is complete in every detail, as the main object of its presentation is to provide a general impression of the administrative background to the Industry's war effort, not to provide a complete analysis of the Government and Services' structure. Similarly, it should be borne in mind that the chart has been drawn up along functional lines, and, generally speaking, does not purport to show the relative precedence or status of the agencies depicted.

Commencing at the top, we have the factors controlling operational and administrative policy, with their executive linkage in the form of the Defence Committee. From this basis, control devolves on the various responsible departments, wherein individual policies are determined. Co-ordination of effort takes place on the next level, where production potentials are determined and related to operational requirements (G.H.Q. and Services' Equipment Committees), finance (the Board of Business Administration and Defence Division of the Treasury), materials supply, etc. At this level, priorities generally are determined, manpower allocated, and so on.

With all of these points resolved, action passes to the responsible procurement and production directorates and in due course is passed on to the agencies acting as direct links with Industry.

Development & Procurement of Service Equipment

TO establish a functional background for much of the information presented in later sections of this publication, and to provide a more complete understanding of the machinery involved in the development and procurement of Services' equipment, this article provides a general review of the administrative structure of the Australian Services and outlines the basic considerations governing the procedure employed.

Before proceeding to examine the general structure of the Services and their relationships with other Government bodies and Industry at large, a few general observations are in order and, as a starting point, we cannot do better than quote a passage from the Army letter of appreciation which appears on page 36.

In this letter, Mr. F. R. Sinclair points out that "The failure of but one link in the chain of communications in the field may adversely affect an operation *and cause the loss of many lives.*" The italics are ours. Human lives are at stake every time a piece of telecommunications equipment is placed in operational service by the Armed Forces.

This point, elementary in concept as it may seem, sometimes appeared to escape the notice of those who found occasion to take exception to the seemingly-harsh and unrelenting demands of the authorities responsible for the design and inspection of Services' equipment.

Fortunately, such an attitude was not typical and it is to the credit of Industry at large that the utmost co-operation was readily forthcoming whenever a problem seemed impossible to resolve or a special effort was required. This co-operation was especially manifest during the latter half of the war period, when the advent of Inter-Service Standardisation Committees and increasingly-effective liaison machinery brought Industry into consultation during the preparation of equipment specifications.

Reverting now to the Services' structure for the development and procurement of telecommunications equipment, it is rather important to point out that the set-up in Australia differed from those in most other Allied countries in that the three Services each maintained separate Branches for operations and equipment. Thus, in the Royal Australian Navy, the operational aspects of Signals were the responsibility of the Director of Signal Communications, while the Naval Stores Branch was responsible for all provisioning action. In the Army, sections of the General Staff (the MGRA and SO in C) were responsible for the operational application of Radar and Signals, respectively, and all equipment matters were the responsibility of the Master-General of the Ordnance. A similar set-up was in force in the Royal Australian Air Force, where operational requirements were laid down by the Air Staff and translated into terms of orders, etc., by the Director of Telecommunications and Radar in conjunction with the Equipment Branch. In all cases, the purely production aspects only were handled by the Ministry of Munitions or the Contracts Board.

The Australian set-up worked very well, particularly after the advent of the Munitions' Production Directorates and the further rationalisation which was brought about in 1943 by the establishment of an Allied Services' Signals Equipment Standardisation Committee, comprised of representatives of all Allied Services operating under GHQ directives and authorised to bring into consultation representatives of the PMG's Dept., Munitions and CSIR. This Committee did sterling work and, in addition to its primary function of eliminating duplicate production of similar equipments performed a very valuable service in supervising the preparation of a number of Inter-Service Specifications covering testing procedures, components and materials. In this later phase of its activities, the Committee worked very closely with the Standards Association of Australia, and through this agency, liaison was established with professional bodies such as the Institution of Radio Engineers, as well as with Industry at large.

It may fairly be said that a considerable measure of the success achieved in the production of Australian-made telecommunications equipment was due to the excellence of the liaison arrangements which were maintained at all stages of development and manufacture.

The pattern for this effective liaison was established fairly early during the war, with the creation by the Council for Scientific & Industrial Research of a high plane Radiophysics Advisory Board, on which the Services were represented by senior Staff officers, with the object of co-ordinating Radar research. Later, when Radar entered the production stage, the activities of this Board were supplemented by a lower-plane technical committee on which the Services were represented by those officers directly responsible for the production and application of Radar equipment.

Similar arrangements were established by the Ministry of Munitions to cover all phases of production—the high-plane liaison in this case being effected through the Services' Munitions Committee which was convened by the Director-General of Munitions and comprised the senior executive officers of the Services. Here again, the work of this Committee was supplemented by other Committees on the Directorate level—notably from the telecommunication aspect, the Radio & Signal Stores Production Sub-Committee,

which was convened by the Munitions Director of Radio & Signal Supplies and attended by the responsible Equipment Directors of the Services. Still other Committees, usually known as Working Committees, were organised in conjunction with each of the Services to cover the development and progression of individual projects.

One of the biggest strides forward in Service-Industry relationships was made by CSIR early in 1943, through its Scientific Liaison Bureau, when it convened a conference of representatives of Service and Government representatives with a view to formulating plans for a concerted attack on the problem of tropical deterioration. As a result of this conference, a party of civilian scientists, under Service leadership, was enabled to spend some time in operational areas in New Guinea and on its return, published a Report ("Report on the Condition of Service Material under Tropical Conditions in New Guinea") which did much to convince Industry at large that "tropicalisation" really was something to be regarded seriously.

Publication of this Report was followed up by the establishment of six Inter-Service Committees which functioned in co-operation with CSIR and the Standards Association of Australia and published a series of Australian Interim Specifications covering materials and packaging for use under humid tropical conditions. In addition, CSIR, through the SLB, was able to establish a Tropical Scientific Section which functioned in operational areas under Service sponsorship and provided facilities for continued "on the spot" investigations by civilian scientists and engineers.

Services' Procedure

The information given above presents a broad picture of the arrangements established in Australia for Inter-Service and Industrial liaison in matters of equipment development and production, and it now will be of interest to have a closer look at the purely Service aspects. For this, we are indebted to the Departments of Army and Air, who have made available official summaries of procedure, on which the following material and the chart on page 43, is based. The information from the Dept. of Air outlines a set-up which is broadly applicable to all three Services and is given first. The Army story is somewhat more detailed and is read in conjunction with the chart.

In the RAAF, the need for any piece of signals equipment is created when the Air Staff defines an "operational requirement" in terms of the results to be achieved. The Signals Staff translates this operational requirement into a technical specification and forwards a submission to the Equipment Branch covering such questions as estimated cost, deliveries required and, if appropriate, suggestions as to potential sources of supply. On receipt of this submission, the Equipment Branch obtains the necessary approval for the expenditure involved—it is unnecessary to discuss the mechanics of this, it being sufficient to say that they vary according to the amount and the operational urgency of the particular case—and places an official order, usually through the Dept. of Air secretariat, on the Ministry of Munitions for appropriate action by the Directorate of Radio and Signals Supplies. The Ministry of Munitions, having full knowledge of the technical resources and existing commitments of every manufacturer in the industry, then determines what particular manufacturer should receive the contract and places an order accordingly.

During the currency of any contract, the RAAF technical officers were available to ensure that specifications were interpreted correctly, and to authorise design changes found necessary during the developmental stages, having regard to the fact that under the RAAF system of specifications, the final development of a new equipment and the early production stages were substantially concurrent. For contractual reasons these design changes were effected through the Ministry of Munitions machinery.

In common with the other Services, RAAF officers attended the meetings of the previously-mentioned Munitions' Radio & Signal Stores Production Sub-Committee, which met at frequent intervals during the war to review the progress of all contracts and to adjust deliveries as between the different Services of these items common to two or more of them.

The development of radar necessitated some departure from the procedure outlined above, for reasons which will readily be apparent, as since radar introduced entirely new techniques, "operational requirements" could be defined only with knowledge of what was practicable at any stage in the development of a rapidly expanding art. Moreover, there was no established industry with experience to relieve the Services of detailed developmental work, while the need for secrecy created special problems of its own. Consequently, in respect of radar equipment, the development and design was largely carried out by the Radio-Physics Laboratory of the Council for Scientific and Industrial Research in close collaboration with the operational and technical staffs of the Services. With these differences, the procurement of RAAF radar equipment was effected through the same organisation and procedure as signals equipment.

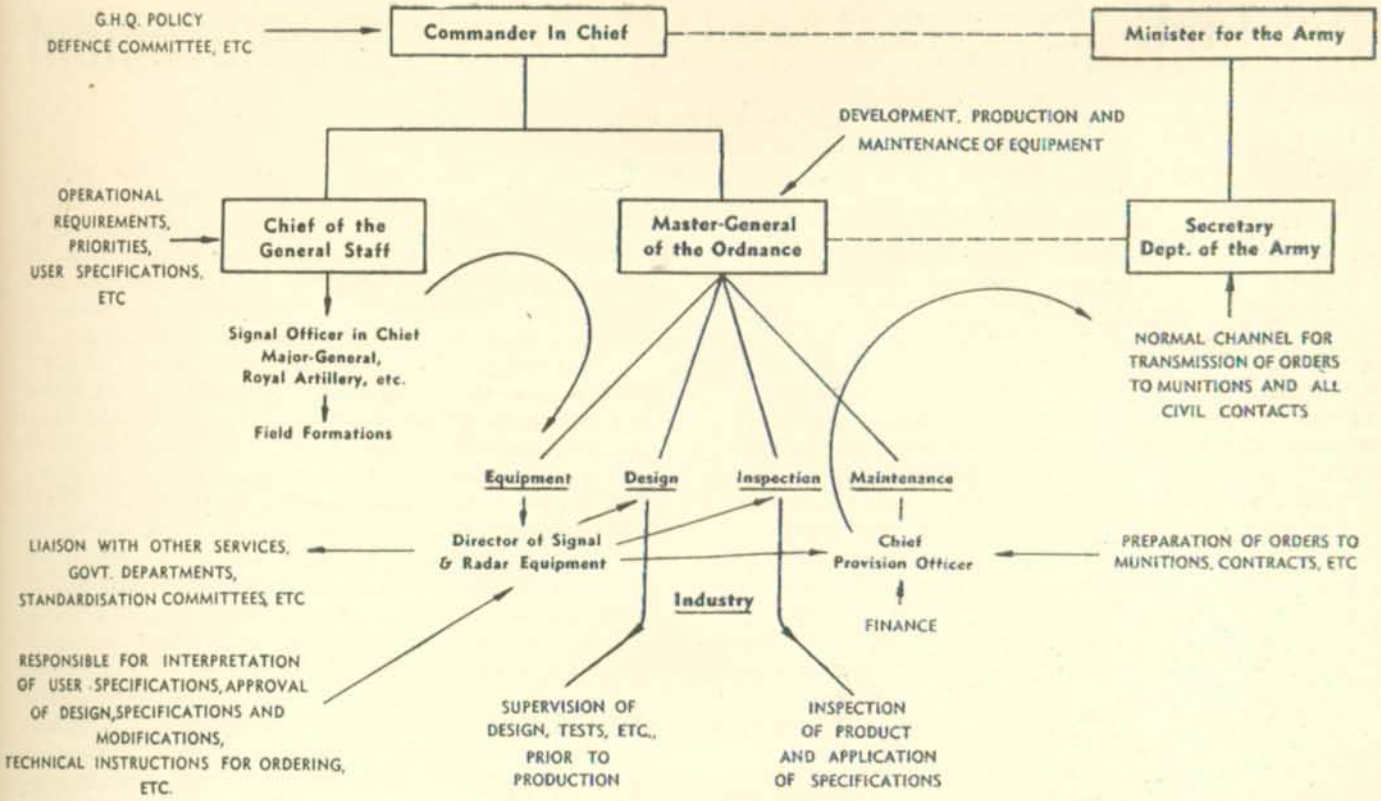
While this outline of RAAF equipment procurement procedure applies broadly to the other Services, the procedure followed by Army is a little more elaborate in some respects and is examined in greater detail.

Reference first should be made to the accompanying chart, which shows the division of responsibility between the Branches of the General Staff and the Master-General of the Ordnance. Both are (or were, during the war years) under the direct control of the Commander-in-Chief, and both depended on the Secretary, Dept. of Army, as the Minister's representative, for major contact with civilian agencies.

After delineation of overall policy by the C-in-C, who also held appointments as Commander, Allied Land Forces on General Headquarters, SWPA, and as a member of the Defence Committee, the operational aspects of equipment requirements were determined by the appropriate General Staff advisers and co-ordinated by the General Staff Specifications Committee into a formal statement of "User" requirements known as the General Staff Specification.

This statement included considerations of forward policy, the priority to be accorded to the equipment and the basic scale of issue, besides the operational characteristics such as range, weight, method of transport, etc., and was forwarded to the Master-General of the Ordnance Branch for appropriate action.

The four Divisions of this Branch all shared responsibility for the equipment at some stage of its career, but as an initial project, action passed immediately to the Equipment Division, where the Director of Signal & Radar Equipment assumed responsi-



bility for interpretation of the General Staff Specification with respect to development and production of the equipment. This Directorate maintained close liaison with the "User" services and with the authorities responsible for all detail aspects of development, inspection, maintenance, etc., and so was in a position to arrange for conversion of the GS Specification into a detailed statement of production requirements.

At this stage the work is split up—details of the requirement are passed to the Design Division of MGO Branch for preliminary consideration with respect to preparation of a production specification; the recommended Scale of Issue is notified to the Maintenance Division (Chief Provision Officer) to permit the necessary calculation of total quantities required, including initial equipment, reserves and usage rates; and the CPO is also given details to enable him to make financial arrangements and prepare developmental and production orders for transmission to the Ministry of Munitions through the Army Secretariat. The army authorities responsible for Inspection and field maintenance also are advised and requested to submit recommendations based on past experience for any desirable features to be embodied in the new equipment.

Following on this action and selection of a suitable contractor by the Ministry of Munitions, a Project Conference is called by the Army Director of Signal & Radar Equipment and at the conference the attendance usually comprises representatives of the "User" arm or service; the Design, Inspection and Maintenance Divisions of MGO Branch; the Production Directorate of the Ministry of Munitions; and the nominated manufacturer, under the chairmanship of the DS & RE.

At this conference, the requirement is considered in detail, design policy is defined and opportunity occurs for discussion of matters affecting development and production. Further conferences may be held after the manufacturer has had an opportunity for further investigation of the project and, in any case, a Working Committee usually is nominated to provide immediate consideration of matters arising during the pre-production stages.

In most instances, the actual development of Army telecommunications equipment is carried out by the manufacturer, in close collaboration with Army Design, which is in a position to give a detailed interpretation of requirements, although any major departures must be referred back to the DS & RE for decision. Design Division also produces a draft working specification which, after consideration of the results obtained from pilot or developmental models of the equipment, eventually becomes the working Specification for Inspection purposes.

After consideration and approval of the pilot models and sealing of the final specification, the Design Division link with Industry ceases and the Inspection Division takes over as the sole Service avenue for issue of instructions to the manufacturer, other than those related purely to production priorities, quantities, etc., which are issued by the Munitions Board of Area Management in accordance with arrangements made by the appropriate Production Directorate of the Ministry. In such matters, the instructions are initiated within Army by the DS & RE after reference to appropriate authorities.

After the advent of the GHQ Inter-Service Committee referred to previously, all projects were considered by the Committee before development and production was initiated by the Services and, wherever possible, endeavours were made to standardise work along existing lines and thus eliminate any unnecessary developmental or production activity. This resulted in considerable Inter-Service usage of a number of items of equipment and production benefited appreciably.

Production Control and Materials Procurement

*by Oswald F. Mingay **

TELECOMMUNICATIONS play just as important a part in war as they do in peace. The everyday public acceptance and importance of the telephone and telegraph service which has grown during the past 50 years and with acceleration over the last 25 years in Australia, passes almost unnoticed by the "man in the street", even by high ranking officials and business men, until their own telephone goes out of order or the telegram is unduly delayed.

Is it any wonder therefore that at the start of World War II, the important part required of telecommunications in war was unapppreciated by too many people in high places?

But the picture at V.P. day (August, 1945) was totally different and that difference was largely achieved since "Pearl Harbour" in December, 1941. The rapid advance of the Japaneses forces shook Australia profoundly and overnight the picture began to change, so that at the cessation of hostilities, the results achieved in designing and manufacturing telecommunication equipment in Australia for use of the Allied Armed Forces in the South-West Pacific Area were meritorious and earned the expressed gratitude of the Government and the various Commanders, including the Americans who experienced what even this sparsely-populated country and its seven million people could really do.

Co-ordination of Industrial Activities

The procurement of this and other equipment, in 1941, was still in the hands of the Civil Contracts Board as of peace time days. There existed no facilities for appraising the productive capacity of the whole industry, for assisting manufacturers in the expansion of plant, obtaining of materials or elimination of "bottlenecks" so common in war time production. Manufacturers found it hard to meet the demands of all the Services and considerable difficulty was experienced in determining priority of production or delivery. This state of affairs was intensified with the arrival of the Americans early in 1942, and the final effect was an even more serious congestion in production which revealed in all its nakedness the inefficiency of the system under which the Australian authorities were then working.

The first untangling step was taken in January, 1942, with the establishment of the office of "Controller of Radar Production" at Ministry of Munitions with Lt.-Col. S. O. Jones (who had recently returned from service with the A.I.F. Signals in Middle East) being appointed as that Controller. With his prewar experience as a radio engineer in the P.M.G.'s Department, Colonel Jones organised industrial facilities and the essential radar equipment production got under way. Prior to this, several manufacturing concerns were producing some communication equipment for the Army and Air Force and a little for the Navy.

It soon became apparent that all industrial facilities would have to be co-ordinated, organised, encouraged and assisted to produce the vast schedule of telecommunication equipment required by all the Services, including the US Forces in the SWPA. Therefore, Colonel Jones, having made good progress in Radar production, was asked to undertake the additional responsibility of directing the production of all radio and signal equipment required by the SWPA Forces. Along with his then Assistant Controller (Mr. W. J. Richards, of the Marconi Company), he organised the Directorate of Radio and Signals Supplies within the Ministry of Munitions structure and promptly set up three specific Divisions, i.e., Radar, Radio and Signals.

The Directorate as such, commenced functioning in June, 1942, with a staff of about 33, but rapidly expanded until the staff was about 100 persons. It was first necessary to gather together under the Directorate all the outstanding contracts placed by the Commonwealth Contracts Board on behalf of all the Forces, check these with what orders or contracts the Industry held, get these organised in their right perspective and then to survey the productive capacity of the industry's facilities available. It was immediately realised too, that the demands from the Fighting Forces for this important Telecommunications equipment was likely to be far greater than existing facilities could produce and, in fact, greater than previously visualised by the Services.

Shortage of certain raw and processed materials which hitherto had been imported, added to the problem, necessitating the adaptation of local material. This all called for a vast amount of development and research work, both on the part of Industry and also, in many instances, the technological resources of such organisations as the Council for Scientific and Industrial Research, all of which were seriously overloaded.

One of the many things learned by Industry, the Forces and the Government was the absolute need for attention to forward planning. It was not fully appreciated by the Services that from the moment they thought of some new requirement, it would take up to two years to develop, design, produce and place it in the hands of the sailor, soldier or airman to use in "operations". That lesson has surely been learned.

Prior to "Pearl Harbour", the prewar methods of the Commonwealth Public Service and Federal Treasury were trying to operate under a steadily growing war pressure, in accordance with a procedure planned in prewar days when Australia's eventual commitment could scarcely be visualised. Each of the Services had to search out manufacturing facilities to develop and fabricate the prototype. Then tenders

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would be called and ultimately the Contracts Board would allot the contract. From then on, the major contractor was virtually "on his own" and his own resources were in most cases insufficient to cope with the multitudinous problems that arose every day.

Modern war does not permit such "time delays" nor are costs the prime factor—as was learned almost too late. In order to overcome these difficulties the Director-General of Munitions (Mr. Essington Lewis —managing director of Broken Hill Pty. Ltd.) was clothed by Federal Cabinet with very wide powers and his delegation of these powers through the Production and Finance Directors, facilitated co-ordination of industry which in turn produced astounding results for a country already beset with other responsibilities almost beyond its capacity.

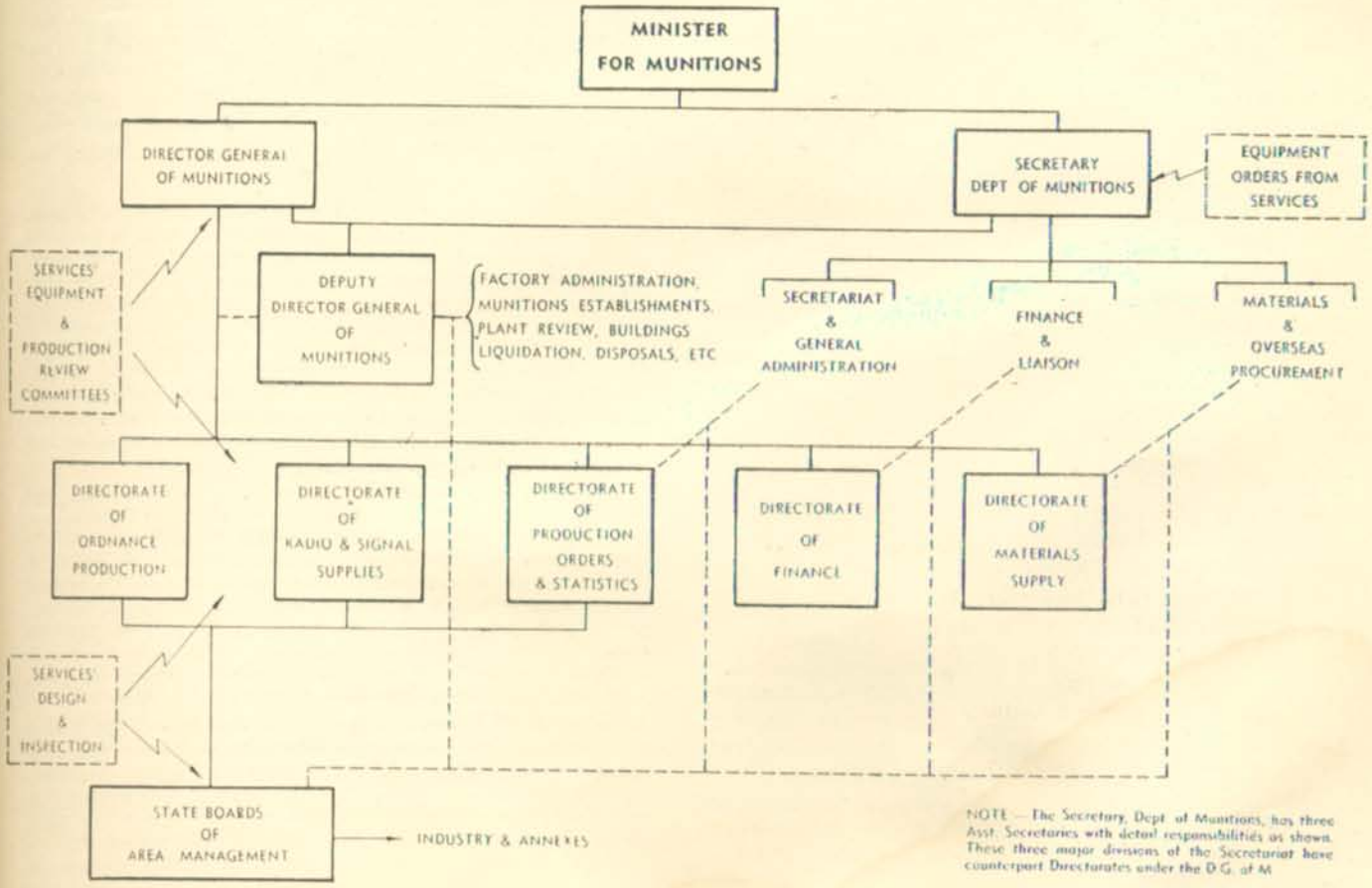
Prior to the formation of DRSS, the production of some telecommunication equipment was co-ordinated by the P.M.G.'s Engineering Branch, with the "official procurement" channelled through the Department of Supply's Central Contracts Board, which functioned with District Contracts Boards in each State. Although each of the Services was represented on the Central Contracts Board, the set-up was not adapted for highly-specialised production, and as Service demands rapidly grew and the complexity became more involved, particularly as regards the efficient co-ordination of industry, the bulk of the orders previously handled by Contracts were passed over to the Ministry of Munitions' Production Directorates, except for requirements of existing commercial items designated officially as "trade pattern items", such as dry batteries, accumulators and electrical gear.

Munitions Organisation and Procedure

As will be seen from the accompanying chart the Ministry of Munitions functioned through a number of specialised Production Directorates, such as the Directorate of Radio and Signal Supplies and the Directorate of Ordnance Production, located in Melbourne, working with the Boards of Area Management, located in each State capital city. In each BAM (as they became known, in this era of initial abbreviations), the various Production Directorates were represented by a similar state division, depending on the quantity of work involved. In New South Wales, where considerable quantities of telecommunication equipment were produced, the BAM in Sydney had a Radio and Signals Division under the control of the N.S.W. Board (with Mr. Alan Fairhall as supervising engineer), working in co-operation with the Production Directorate of Radio and Signals in Melbourne. It was the function of each State BAM to supervise production, organise facilities, remove bottlenecks and attend to the multitude of problems that beset the individual manufacturer, large and small.

In Victoria, the BAM did not function in respect to Radio and Signals as in Sydney, because of the presence in Melbourne of the Directorate staff which performed the supervisory and co-ordinating functions of the BAM.

The basic channel of communication between the Service Departments and the Ministry of Munitions was through the respective Secretariats, where necessary clerical records were kept and a watching brief was maintained on behalf of the responsible Minister. After passing through the Munitions Secretariat, the



Responsibilities of the Munitions Production Directorates

(Continued from page 45)

incoming Order then went to the Directorate of Production Orders and Statistics, which processed it to the appropriate Production Directorate for attention and report as to which State and, generally, what contractor in that State, the "production order" should be placed. The DPO & S then made out a "Production Order Request" (POR) on the BAM in that State, giving all possible details of the equipment required by whom and when. The BAM in turn eventually placed its "production order" on the contracting manufacturer and the BAM appropriate staff assumed responsibility for supervision of production. It was the function of the BAM and the Directorate to do everything possible so that the production could flow with the least delay.

Co-operation with all other Government departments and the various Services was a prime requirement. To get results was not easy. The Directorate of Materials Supply came right into every production picture because that Directorate had its problems too, in trying to satisfy every demanding agency from a "short supply" of almost every material item.

Trade and Customs; Division of Import Procurement

The obtaining of materials from local sources was one problem, but a far greater one was that of overseas materials and here is where the Customs Department entered the picture, as the buying of overseas materials and the shipping of same was no longer a function of private enterprise. The Import section of Customs became known as the Division of Import Procurement, (DIP) which in fact became the one big buyer for all Australia's overseas requirements, regardless of source and items. In turn, it had to deal with foreign governments performing the very same functions in their country.

As the war effort grew and Australia's requirements likewise grew, the DIP under Mr. Arthur Moore (of the Customs Department) formed the Australian War Supplies Procurement with Headquarters in Washington, D.C. Mr. L. MacGregor, of the Australian Trade Commission in Canada, took charge of the AWSP in North America. The need to work through the British authorities located in Washington was enforced by the Americans to secure uniformity and to organise British Empire requirements as a whole.

The application of lend-lease made for considerable "paper work" and also compelled complete justification for every item and quantity to ensure that the war purpose of the American Lend-Lease agreement was strictly adhered to. The "end-use" of lend-lease items had to be for "war purpose" and the Americans made all requesting nations "justify" their demands even to the extent of having independent checks and investigations made by Americans in the country requesting lend-lease. After all, we among the many other countries were asking America, and later Canada, to supply us with materials, etc., that were in short supply and in universal demand, so it was only to be expected that every care should be taken in the allocations made.

As it was the writer's privilege to spend nine months of 1943 in the U.S.A. on behalf of the Radio & Signals Directorate, it is a pleasure to record the assistance given by the U.S. and Canada to Australia's Telecommunications Industry's effort, despite the then high priority of the European theatre of war.

To Great Britain also must go our appreciation of her considerable help in telecommunication matters, given freely, although she, too, was facing many difficulties with short supply of materials and also had to rely on American assistance.

Before concluding this review of the activities of the production control and materials procurement agencies involved in supervising and assisting the Telecommunications Industry's War Effort, it is timely to give some information regarding the work of the separate Divisions of the Munitions Directorate of Radio & Signal Supplies.

MUNITIONS

Radar Division

This Division of DRSS commenced operations during February, 1942, and was the first section of the Directorate in action. Its work entailed co-ordination and expansion of the production already initiated by the PMG's Dept. and CSIR, together with the organisation of supplies of vital overseas components which were in urgent demand by all Services. The man immediately in charge of this activity was Mr. Dave Gray, who was loaned to the Directorate by the Electrical Engineer's Branch of the NSW Govt. Railways, and we are indebted to Mr. Gray for the following notes concerning the work done by the Radar Division of DRSS:—

"One of the Directirate's first tasks was to organise the production of numerous special components and Cathode Ray and Electron tubes required for Radar equipments. Little more than sample quantities of many of these items had at that time reached Australia, and great efforts were called for on such key components, as it was apparent that, while the Radio Industry would be able to produce, in a matter of months, a substantial quantity of Air Warning, Air-to-surface Vessel, Coast Defence and suchlike Radar equipments, the amount of such equipment that could actually be commissioned would be limited by a few special items, such as co-axial cable and various special electron tubes.

"By an energetic combination of local manufacture, the development of locally produced substitutes, and purchases from overseas, the Directorate managed to stock up a Munitions Department Radar store, which became the Mecca of Service Radar officers with urgent need for vital bits and pieces, without which Radar stations could not 'go on the air.' Many and lengthy were the verbal tug-o'-wars between representatives of the three Services to see that the batches of electron tubes or other treasured items went where, to quote an R.A.A.F. stalwart, 'they would kill the most Japs.'

"As production began to get under way it was the Directorate's function to watch the trend of the Services' requirements for equipments and to take action to see that the shortages of 1942 did not recur. It was a case of making the best possible estimate of what would be required in a year's time, and then either taking steps to establish local manufacture or initiating and following through procurement from overseas in spite of the many difficulties associated with the latter alter-

native. Such forward provisioning called for very close collaboration between the Service, Scientific and Munitions representatives concerned, but it was amply demonstrated that only by such means could the Services be kept supplied with the latest and best equipment in a new and rapidly developing field, such as Radar.

"In organising production within the Radio Industry, the Directorate was particularly fortunate in the energetic and enthusiastic manner in which firms responded to the request to venture into the new field of Radar.

"This review has dealt strictly with the production side, and it has not been possible to recount the invaluable assistance and collaboration that were provided to the Industry by bodies such as the Radiophysics Laboratory of the C.S.I.R., the Research Laboratory and Workshops of the P.M.G.'s Department, and the Services' technical and inspection branches."

Signals Division

To provide a complete differentiation between its activities and those of the Radar and Radio Divisions of DRSS, the Division handling Line and Fixed Signal Service stores (telephone and related equipment) was designated the "Signals Division," although this term is something of a misnomer as compared with the usual interpretation of the word. However, the work of the Division was none the less important, and here we have some notes on its activities, by Mr. Vic Magnusson, who took charge of the Division at its inception in July, 1942. It is of interest to note that Mr. Magnusson, as an engineer of the P.M.G.'s Department, handled much of the Services' production carried out by that department during the early war period. It is to this phase that he refers in his opening remarks:—

"At the outbreak of war it was logical for the Army and Munitions Authorities to look to the P.M.G.'s Department for their supplies of communication equipment. This department had been able to meet peacetime requirements for commercial type equipment and had within the organisation a section which could be developed for the manufacture of standard Army design equipment.

"Unfortunately, whilst the P.M.G.'s Department officers were possessed of the technical ability to carry out the work, the organisation under which they were required to function was not adapted to meet wartime conditions. Furthermore, the P.M.G.'s Department did not have the authority or organisation to assess the productive capacity of Australia for communication equipment manufacture. Even if this factor was known, they still lacked the authority to marshal such resources. The general position became very serious when the Japanese entered hostilities, and so the P.M.G.'s Department took steps to shift responsibility to the rightful authorities, i.e., the Department of Munitions. Therefore this work was added to the Ordnance Production Directorate early in 1942. A short time after (July, 1942) the Directorate of Radio & Signal Supplies was formed by Munitions, and the Signals Production Division was established.

"This Division was given the responsibility of producing all Army signalling equipment except the production of radio and radar and visual signalling apparatus. This involved the manufacture and supply of over 100 major projects, with an average output of £160,000 of equipment per month. Pre-war, the standard P.M.G. equipment was imported from overseas, but at the outbreak of war, arrangements had to be made for Australia to be independent of overseas manufacture in the essential items of communication equipment. As a result, all communication items to P.M.G. standard required by the Defence Services were and are now manufactured in Australia.

"The supply of commercial equipment to the Defence Services became of extreme importance when Australia and the adjacent islands became the base of Pacific activities. Civil networks were then made use of by the Services and extended to meet their further requirements.

"The setting up of production lines was the most difficult task, and in many cases materials specified in Army drawings were unknown in Australia. Furthermore, equipment had to be modified or treated to withstand tropic conditions. In many instances substitute materials were used which proved better than the materials specified."

Radio Division

As mentioned earlier, the Radio Division of the Directorate was formed in June, 1942, when the writer (then a captain in Army Signals) was released by Army to accept the post of Radio Production Manager under Colonel Jones.

The need for (1) a quick appreciation of the radio production facilities available and of those to be developed; (2) assembly within the Directorate of all Service contracts outstanding with Industry; (3) a staff capable of handling the work of this Division; and (4) obtaining from the Services, including the American Forces based in Australia, a reliable estimate of, and definite orders for, their requirements, and, what was more difficult to obtain, their forward requirements in sufficient time to permit the acquisition of materials both local and overseas, the design, development and ultimate fabrication, taxed the resources, the patience, and the energy of all concerned to almost breaking point.

Nevertheless, as both Mr. Gray and Mr. Magnusson have said, the co-operation afforded, despite the occasional setbacks, by Industry, the Services, and other Governmental agencies, permitted radio equipments to be produced and delivered in their tens of thousands.

In other sections of this publication, sufficient evidence is presented to show the Radio Division of DRSS played its part well. In January, 1943, I was sent to America by Colonel Jones, chiefly to see why sufficient quantities of required materials were not coming forward and to investigate other problems with which the Directorate was concerned. Returning in January, 1944, I found my Radio Division functioning well, and in April of that year I asked to be released to return to my home town, Sydney, and my own business.

One of the principal difficulties I experienced in the Munitions set-up was the complete independence, based on its original set-up, of the State Boards of Area Management as distinct from the Central Production Directorate in Melbourne. Particularly so was this in regard to Sydney, where the BAM regarded itself as in sole control of the position to the point of almost disregarding the Radio & Signals Directorate in Melbourne. That almost intolerable position made it difficult for the Services who had to approach Munitions through the Production Directorate in Melbourne. The latter could only "recommend" to the Sydney BAM any course of action and, because of that lack of Directorate control, it was most difficult to obtain the desired result.

Nevertheless, the Munitions set-up did achieve considerable result, largely due to the co-operation of its personnel and Industry, despite the "civil service" resistance at high levels in the BAM. Industry appreciates that too, as likewise Australia's Telecommunication Industry's co-operation and contribution to this country's war effort is appreciated by all who had the opportunity of looking at it and those who used that equipment in "operations."

Federal Government Impetus to Industrial Development

Nerve-centre of the electronic activities of CSIR—the NSL building in Sydney University grounds, which houses the Radio-Physics Laboratory.

WHILE every credit is due to the Telecommunications Industry of Australia for its achievements in the development and production of equipment for the Australian and Allied Fighting Services, a publication of this character would be incomplete unless due credit also were paid to the research and development carried out by Government agencies. Generally speaking, this work was unspectacular and, in many of its phases, unknown to the "man in the street;" but it went on continuously and, in some respects, might almost be said to have made possible—and in any case, simplified—the production activity which was the tangible contribution to the National War Effort.

Valuable Research Accomplished by Government Agencies

In addition to this activity on research and development, some Government agencies contributed extensive production facilities and were responsible not only for vital parts of certain equipments, but also completely-fabricated assemblies. A complete list of the agencies responsible for this assistance and co-operation with the Industrial War Effort would read almost like a "Federal Guide," and it is only possible to mention those which played a prominent part. Outstanding in their contributions were the Council for Scientific & Industrial Research and its various divisions, and the Postmaster-General's Department; and it is proposed to deal with these at some length later in this article, as these two organisations played important parts in pure research, production development, and manufacture, and, moreover, performed valuable services as co-ordinating authorities of various phases of all these activities.

Before proceeding to do this, however, tribute must be paid to the work of a number of other Government agencies and public bodies whose activities while perhaps not so spectacular, nevertheless were of considerable importance in the total effort.

Of these, not the least important were the various Universities, whose research facilities were always freely available to both Industry and the Services, and

investigation into problems brought about by tropical deterioration. Noteworthy in this respect also was the work of the Munitions Supply Laboratories (established under control of the Department of Munitions), while this agency also was responsible for the conduct of many "acceptance" tests on components and materials for use in Service equipment.

On the production side, mention must be made of the quantities of petrol-electric generating and charging sets fabricated in the workshops of the Melbourne City Council, the Perth Department of Public Works and the Victorian Government Railways and, last, but not least, the important contribution to Radar production made by the Chief Electrical Engineer's Branch of the New South Wales Government Railways.

This last agency established a special Radar Annexe, under control of Mr. J. G. Q. Worledge, and it is a matter of record that the greater part of the aerial arrays, rotating cabin gear and fire control equipment associated with the Services Radar program was produced by this annexe and its sub-contractors. High tribute has been paid to the quality and speed of execution of the work entrusted to this annexe, and this writer can speak from personal experience of the ready co-operation offered by Mr. Worledge and his assistants when knotty problems required solution—one example in particular, which demonstrates the versatility of the team, being the successful production of a photographic recording assembly for comparing the results of Radar and Predictor tracking of aircraft.

Much more could be told of the activities of these and other Government agencies that played their part in the development and production of telecommunications and related equipment, but space will not permit, and we will now proceed to deal with the work of the Council for Scientific and Industrial Research, whose various operative divisions played such a major part in the mobilisation of Australia's scientific

The CSIR provided the fighting Services with valuable help in many directions, particularly in the field of telecommunications. Its laboratories had the facilities and the trained staff necessary to investigate problems thrown up when modern method of warfare had to be applied in the Pacific Area.

These laboratories came into existence following the establishment of the Council by the Commonwealth Government in 1926 to carry out scientific research for the promotion of Australia's primary and secondary industries. The Science and Industry Research Act, 1920-1945, defines the constitution and functions of the Council, which consists of five members nominated by the Commonwealth Government (one of whom is Chairman), the Chairman of six State Committees, and other members co-opted by reason of their scientific knowledge. The Commonwealth Government nominees form an Executive Committee, which exercises all powers and functions of the full Council in the intervals between its meetings.

The activities of CSIR have necessitated a widespread and adaptable organisation, and centralisation has been avoided by establishing laboratories in different places in the Commonwealth wherever the necessary facilities, contacts and other suitable conditions could best be found. The research work of the Council is carried out within a number of divisions and sections, as follows:—Divisions of Plant Industry; Economic Entomology; Animal Health & Production; Biochemistry & General Nutrition; Soils; Forest Products; Food Preservation & Transport; Fisheries; Metrology; Physics; Electrotechnology; Radiophysics; Aeronautics & Industrial Chemistry; and Sections of Tribophysics Dairy Research; Building Materials Research; Flax Research; and Mathematical Statistics. In addition to the main laboratories in Canberra, Sydney, Melbourne, and Adelaide, field stations are maintained in various parts of Australia. Mention must also be made of the work of the regional stations at Merbein, Griffith, and Deniliquin; the groups engaged in ore-dressing and mineragraphic investigations at a number of centres; the Radio Research Board; and the Council's Information Service.

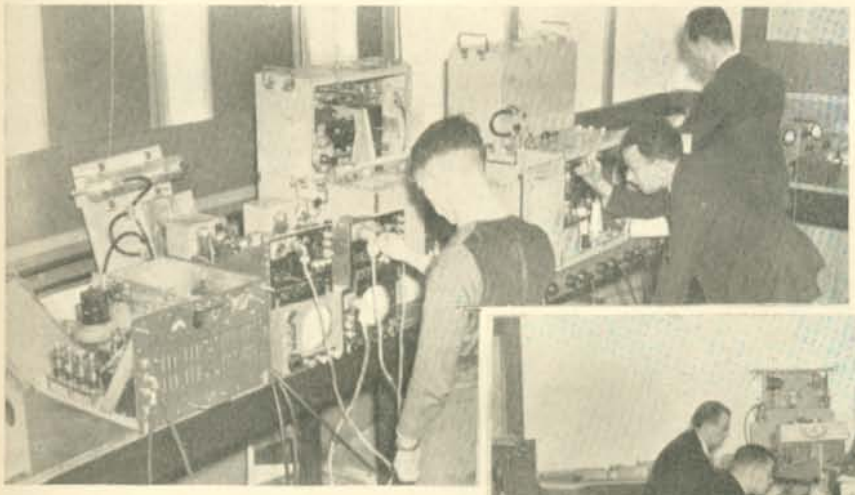
The funds for the Council are provided from two main sources, viz., from Commonwealth revenue by Parliamentary appropriation and from industry directly or indirectly by way of contributions and special grants. During the current financial year funds amounting to £1,170,000 will be expended; of this, £950,000 has been made available by the Treasury.

CSIR Telecommunications Activities

For about twelve years after its establishment, the work of CSIR was devoted mainly to the solution of problems affecting the agricultural and pastoral industries. However, in 1937, the Commonwealth Government decided to extend these activities so as to provide assistance to secondary industries, and the Council set up several laboratories for work in that field; it was thus able to render to those industries and to the Services, assistance of vital importance almost immediately after the outbreak of war. In the field of telecommunications, the groups primarily involved were the Divisions of Radiophysics and Electrotechnology; and Radio Research Board; the Section of Tribophysics; the independent Scientific Liaison Bureau (now absorbed in the Council's Information Service), and the Scientific Liaison Offices established in London and Washington.

Radar

Very soon after the outbreak of war, and long before there was any mention of radar (or "radio-location," as it was then called) in the popular press, a band of scientists was hard at work in Australia. All available information was made available to the Australian Government in 1939, and a new division of CSIR was set up to undertake fundamental research connected with the new techniques and to carry out the development, design and construction—at least to the prototype stage—of radar and associated equipment required by the Armed Forces in this theatre. This became known as the Radiophysics Laboratory and was located within the grounds of the University of Sydney. The general policy of the laboratory was determined by the Radiophysics Advisory Board, consisting of representatives from all the Services, Ministry of Munitions, Postmaster-General's Department, and



Two views of the CSIR Radiophysics Laboratories, which were responsible for much original research and development on Services' Radar Equipment.

CSIR, and close touch with the changing requirements of the Armed Forces was maintained throughout the war.

The Laboratory has performed valuable work, not only in developing equipment, particularly suited to the special requirements of the war in the SWPA, but also in providing assistance to the Services in the training of personnel in the new techniques, and in the testing, adaptation and use of both local and imported equipment.

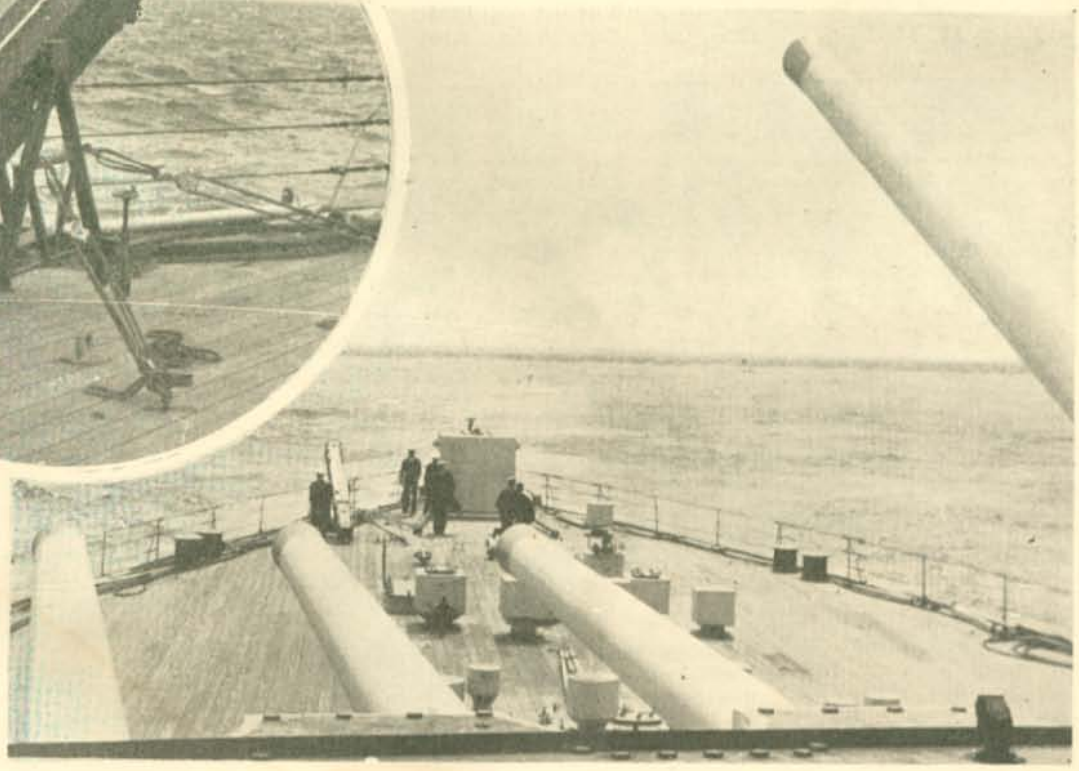
In the early years of the war, when invasion by sea was considered to be imminent, the Laboratory's efforts were largely devoted to radar for coast defence purposes, and equipment installed at all the major Australian ports was of Australian design and manufacture. Perhaps the Laboratory's most successful single achievement, however, was the design and construction of a lightweight air warning radar set for the RAAF. This was asked for immediately after the entry of Japan into the war. The first equipment was actually built in 5½ days and rushed to Darwin when the Japanese were heavily raiding that area. This set, which was the basis of the later LW/AW family of radars, was considerably lighter than similar equipment in use overseas at that time ,and more than comparable in performance. It was rugged, reliable in service, and capable of being transported in a standard aircraft, and hence of particular value for the special conditions of warfare in the Pacific. It came into widespread use both by the Australian and U.S. Forces in this theatre, and upwards of one hundred sets were produced by a Sydney manufacturer.

The full list of projects with which the Radiophysics Laboratory was associated is a big one. It included more modern versions of the sets just mentioned, a radar-controlled searchlight ("Elsie" or S.L.C.), GCI equipment to allow ground-control of fighter interception, equipment to provide navigational aids, such as ASV Beacons and "Rebecca" and "Eureka," and air-warning and sea-search sets for the RAN.

A special section of the Laboratory was devoted to the development of the special valves, including magnetrons, which are essential to the operation of modern radar. In addition to developing Australian versions of valve types originated overseas, original work resulted in new types, satisfying special local requirements. The Australian valve industry was brought early into the picture, and excellent collaboration between it and RPL was maintained.

Further, as the enemy's knowledge and use of radar increased, it became necessary to consider problems of counter measures. This involved, on the one hand, the design of equipment, first, to determine the wavelengths in use by the enemy, and then to render his radar innocuous and, on the other hand, modifying our own equipment to minimise the effects of possible jamming by the enemy.

Needless to say, the techniques of radar which proved such a powerful weapon in times of war, have many valuable applications in times of peace. They have a very obvious application in the fields of civil aviation to provide new and improved aids to navigation, to marine navigation, and to large-scale aerial survey work—to name but a few. Work along these lines has already been commenced at the Radio-



Tests of CSIR Photo-cell Chronometer on HMS King George V—quarter-deck installation on right. Inset, the rigid base sky screen.

physics Laboratory in close association with the Department of Civil Aviation, and with the special needs of Australian airlines borne well in mind.

Radio Propagation

The Radiophysics Laboratory and the Radio Research Board were also concerned in the more basic aspects of radio communications. In most radio circuits reflection from what is known as the ionosphere is involved. Two main "layers" are usually present in this region, and the height and density of these vary, not only with time of day, season of the year, and throughout the sunspot cycle, but also with latitude and longitude of the station on the earth's surface. The highest frequency which can usefully be employed on any circuit is determined almost entirely by the characteristics of the ionosphere at that time.

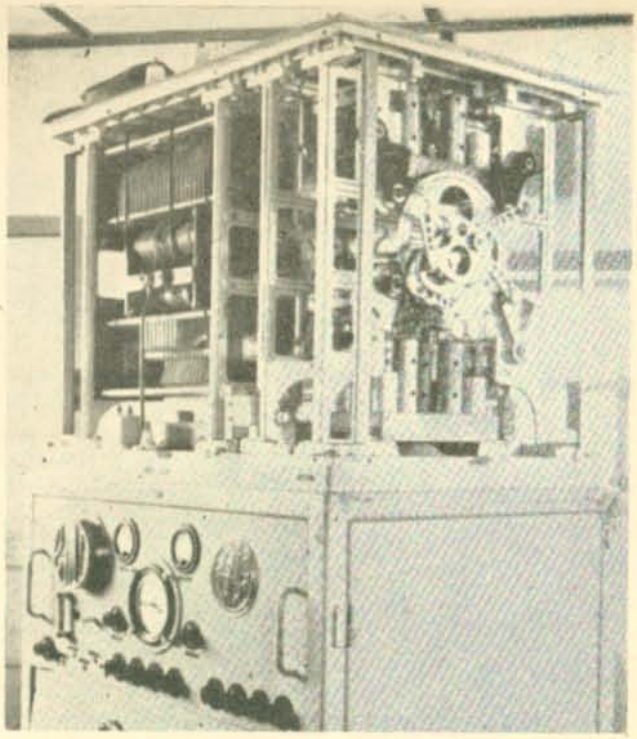
Because this information was so vital to the successful operation of essential military communication circuits, a world-wide organisation (in which the Radio Research Board of CSIR) was one of the three participating laboratories) was set up to collect and analyse the basic ionosphere data, and issue regular predictions of the best radio frequency to use on any circuit at any time in any part of the world. The number of regular ionospheric "observatories" at that time was limited. The Radiophysics Laboratory, therefore, designed and built six automatic recording sets, of which three have been installed in Australia (operated by R.A.A.F.), two in New Zealand (operated by Department of Scientific & Industrial Research), and one in the Central Pacific (U.S. Signal Corps). It has been decided that additional stations are still required, and a further seven automatic recorders are now in course of construction at the Laboratory.

Photocell Chronometer

Radar Techniques introduced blind firing as an element of naval warfare, and thus placed great emphasis on the need for an accurate knowledge of the muzzle velocity of naval guns. As a direct outcome of experimental work being carried out by the Section of Tribophysics (then known as the Lubricants & Bearings Section) on the detonation of liquid explosives, an instrument, known as the Photocell Chronometer, was developed for the measurement of the muzzle velocity of shells, and was used by both the Navy and the Army.

This device uses an electronic timing unit controlled by two photocells, which detect the passage of a shell, to measure the time interval for the shell to travel a known distance. It incorporates a crystal oscillator and can measure time intervals to the nearest 2.5 millionths of a second.

Work commenced in 1942, and before the middle of 1943, a satisfactory sky-screen had been designed and constructed which, with the counter, allowed the velocity of a shell travelling at 3,000 feet/sec. to be measured to an accuracy greater than one part in five hundred. The optical system, photocells, and amplifiers were mounted in a rigid beam exactly 10 feet apart, and when a shell was fired over the beam the reduction in skylight was sufficient to start and stop the counter.



One of the CSIR Ionospheric recorders in process of installation at Momote, Admiralty Islands.

The advantages in portability to be obtained from such a short base are obviously great and particularly valuable where the space in front of a gun is limited, such as on the deck of a ship. In September, 1943, it was decided to use the instrument to measure the muzzle velocity of naval guns at sea, and trials in the 6-inch cruiser H.M.A.S. "Adelaide" and the Dutch cruiser H.N.M.S. "Tromp" were performed. The main difficulty in these trials was the effect of blast on the sensitive amplifiers and fragile photocells and valves in sky-screens, which had to be used as close as 35ft. from the muzzle. Satisfactory results, however, were obtained in both trials.

It is interesting to note that this was the first occasion that muzzle velocity measurements had been made in a ship at sea. Although Photocell Chronometers have been designed in the United Kingdom, Canada, and America, they have not used the high counting speeds and the rigid short-base sky-screens, consequently the instruments have not been applicable to Naval use. The Australian instrument used locally-made components wherever possible, and only two photocells and one other valve, out of a total of over one hundred and twenty are imported. All lenses and the auxiliary collimators used in the optical alignment gauge of the latest sky-screen were designed and produced by the optical munitions annexe of the University of Hobart.

Tropic Proofing

Early in the war against the Japanese, it was found that equipment deteriorated seriously in humid tropical areas. Many of the problems met were common to all stores and equipment, but in addition, however,

there were problems specific to particular sections. Thus, in the field of telecommunications, special importance attaches to breakdown of insulation due to water absorption by materials or condensation on the surfaces of components.

It was soon apparent that, although considerable difficulties were being encountered, no specific or detailed information was available, and thus no planned attack on the problems outstanding could be made. Accordingly, on May 14, 1943, the Scientific Liaison Bureau convened a conference of representatives of the Services, relevant Government Departments, the Munitions Supply Laboratories, and CSIR to formulate a plan of action. Following the recommendations of the conference, a Scientific Mission (including a chemist, mycologist, and a physicist) was despatched to tropical operational areas, a Mycological Panel was set up, and various laboratories undertook responsibility for different aspects of the research work required. The findings of the scientific mission were published by the Bureau in October, 1943, under the title, "Report on the Condition of Service Material under Tropical Conditions in New Guinea." This report emphasised the need for improved methods of packaging and storage (to which at least 75 per cent. of the deterioration was attributed) and the relation of rainfall and relative humidity to the corrosion of metals and the breakdown of organic materials. To determine action on the report a further conference was called by the Bureau and six Inter-Service Committees were set up to handle particular sections of the problems involved, viz.:—(1) Packaging, (2) Corrosion Preventives, (3) Electrical, (4) Organic Materials, (5) Optical Instruments, and (6) Underwater Protection of Ships and Small Craft. These Inter-Service Committees undertook the formulation of specifications common to all Services, and these were published by the Standards Association of Australia as Australian Interim Specifications.

To facilitate co-ordination of the work, the Bureau acted as a clearing-house for all information on tropic proofing and distributed reports from both Australian and overseas laboratories and commitees. Much of the overseas distribution was handled through the scientific liaison offices set up by CSIR in London and Washington, and this materially assisted in establishing reciprocal arrangements whereby valuable information on overseas developments was made available in Australia. Developments on tropicalisation in Australia were summarised by the Bureau at bi-monthly intervals for the Master-General of the Ordnance Branch of the Army and, by arrangement, these summaries were circulated to all interested parties.

In order to undertake testing under actual conditions encountered in the field, a Tropical Scientific Section was established by the Bureau, with the approval of the Services, to operate in forward areas, with particular reference to matters associated with the deterioration of stores and equipment under tropical conditions. The Section maintained a nucleus of a chemist, physicist, and biologist in the field, and from time to time other civilian scientific personnel were attached temporarily to the Section to undertake specific projects.

The Section was available to advise Service authorities on the field use of trial consignments of materials, to test new or modified procedures or equipment, to report on conditions of unusual deterioration, and to advise depots and workshops on the implementation of preventive methods specified by the responsible authorities to combat tropical deterioration. Members of the Section studied the field performance of electrical and telecommunication equipment so that field conditions could be correlated with laboratory investigation. Comprehensive surveys were also made of temperature and humidity distributions in typical stores buildings in New Guinea and of the conditions existing inside packing cases under such conditions of storage. Also a special report was prepared on telecommunication and electrical equipment in armored fighting vehicles.

Following representations to the Army by the Institution of Radio Engineers, three selected members of the Radio Industry were attached to the Section for a few weeks, and opportunities were afforded them of seeing and experiencing conditions in forward areas. They were thus able to personally assess the effectiveness of the improved materials and manufacturing techniques.

Liaison

The Scientific Liaison Bureau of CSIR was set up by War Cabinet in November, 1942. The principal function of the Bureau was to familiarise itself with the facilities for scientific work in the Government and non-Government laboratories in Australia and to ensure that scientific problems arising in the Services, Government Department, and war industries, and not otherwise provided for, were promptly brought to notice of appropriate scientific authorities and that, where necessary, experimental work was carried out to solve such problems. In addition, the Bureau was charged with the promotion of the application of science to war needs in the Services and war industries.

To this end, offices were set up in Melbourne, Sydney, and Brisbane, and Honorary Liaison Officers were appointed in Adelaide, Brisbane, Hobart, Newcastle and Perth. A directory of scientific resources in Australia entitled "Science on Service", was compiled and published early in 1943 followed by a revised edition in 1944.

To assist in the co-ordination of scientific work affecting the war effort and minimise duplication, indexes, were compiled of the relevant research projects being carried out in Australian laboratories and of problems referred to the Bureau. These indexes were available in all States and thus provided ready reference to work in hand or already carried out, when a new problem was received.

Soon after the formation of the Bureau, serious consideration was given to the problems met by the fighting Services in the tropics and, in a short time, this developed into a major project which for a while, dominated the work of the Bureau. These activities have been described in some detail in the previous section.

The Scientific Liaison Offices in London and Washington were established by CSIR in 1941 and were an essential link in the development of telecommuni-

cation equipment in Australia. They enabled the results of work which was being carried out on a great scale in the United Kingdom and the United States to be made available promptly. On the telecommunications side, the principal staff in these offices was provided by the Radiophysics Laboratory. As a result, first hand contact was maintained throughout with such establishments as Telecommunications Research Establishment, Radio Research and Development Establishment, Admiralty Signals Establishment and many others in the United Kingdom; and the Radiation Laboratory at Massachusetts Institute of Technology, Bell Laboratories, Army and Navy Research Establishments, etc., in the United States of America. The office in Washington worked in close collaboration with the Australian War Supplies Procurement Mission, and Australian Services Missions, and also with the British Central Scientific Office and the Canadians. The Empire scientific liaison thus initiated proved so successful that it is certain to be continued in modified form, and probably considerably widened in scope, in the future.

Activities of the Postmaster-General's Dept.

The other major Government agency associated with the development and production of telecommunications equipment was the Postmaster General's Department which, in peace-time is charged with the responsibility of maintaining internal civil communications throughout Australia and providing technical facilities for the Australian Broadcasting Commission, in addition to its primary function of conducting the postal services.

For these purposes, extensive laboratories and workshops were established under control of the Chief Engineer's Branch of the Department and, prior to the outbreak of war, the Department was nominated as major Co-ordinating Contractor for the supply of telecommunications equipment to the Armed Forces. This set-up continued until the entry of Japan into the war, when the vastly-increased Service demand for Radar, Radio and Line equipment necessitated the introduction of specialist Production Directorates under control of the Ministry of Munitions — this aspect is dealt with fully elsewhere in this publication and need not be elaborated here.

Even after this time, the Department remained active as a research and development agency, and as a major contractor to the Ministry of Munitions, particularly with respect to telephone and related stores, while it continued to play a basic part in the installation and maintenance of mainland signal services on behalf of the Services. A full account of this work and other Departmental wartime activities would require much more space than we have available, and it is only possible to review the highlights.

Development and Production.

The wartime activities of the PMG's Dept. with respect to Service telecommunications may be broadly subdivided into two major categories, viz., Development and Production, and Works and Services. These are dealt with in that order.

The types of manufacturing work varied from large projects, which involved the creation of special engineering sections in the Department, to smaller contracts carried out by the Department's normal organisation throughout the Commonwealth. Some details of the more important projects are discussed in the following paragraphs.

Radar Equipment: In the early war years, the Department's organisation was utilised in purchasing large quantities of overseas Radar material needed, while its engineering facilities were used in the development of production designs from circuits and experimental models devised in the Radiophysics Laboratory of the CSIR. A special Engineering and Drafting Section was engaged exclusively on this work and manufacture was carried out in the Department's Workshops. Private enterprise was used extensively by sub-contract to obtain component parts of the equipment; much of which required manufacturing technique not previously used in Australia. In 1942, responsibility for supply of equipment to the Services was transferred to the Ministry of Munitions to whom the PMG Department then became a major contractor for the supply of equipment, besides carrying on with design work for the Services.

The Radar equipments with which the Department was mainly concerned included the original Shore Defence installations for use by coastal artillery; Air-to-Surface Vessel equipment for use in aircraft; Ship's Warning and Gunnery equipment for naval fire control; and a fully-tropicalised Searchlight Control system for use with Australian-made 150 cm. searchlights.

Long-Line Telephone and Telegraph Equipment: Items of long-line equipment which were designed by the Department and supplied in quantity for use by the Services were as follows:—

(a) Mobile Communication Units, each a complete line-communication office mounted on a 5-ton Army truck, were provided for the purpose of restoring communications where existing permanent installations had been damaged. Each unit included carrier telephone equipment, V.F. telegraph, V.F. repeater and telegraph repeaters with associated batteries and charging plant, and provided three telephone channels and four high-speed duplex telegraph channels over one physical line.

(b) Four-Channel V.F. Telegraph Terminals which provided four duo-directional high-speed simplex channels over any telephone channel.

(c) Four-Channel Carrier Telegraph Systems designed to utilise the previously unused frequency spectrum of 3.0-5.2 kc/sec. on lines operating with other telephone carrier systems.

(d) Telegraph Repeater Bays which furnish a means of extending 4 high-speed telegraph channels on a duplex basis from a carrier telegraph terminal to four different physical lines.

(e) Telex Units which permit the operation of teleprinters over normal telephone circuits.

Submarine Telephone Cable: A light coaxial submarine telephone cable using polythene insulant was

designed and samples were tested following its manufacture in Australia. This cable was provided for use in shallow waters by Army Signals with carrier systems using frequencies up to 30 kC/s.

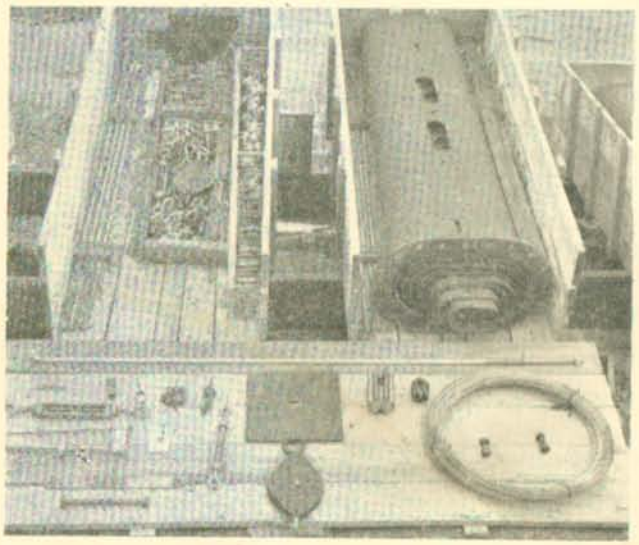
Trunk Test Boards: A standard type Trunk Test Board equipped with the usual Wheatstone Bridge and voltmeter testing facilities and suitable for use in tropical areas was developed for the Army. Eleven boards were subsequently delivered for use in forward carrier offices.

Transmission Measuring Sets: In the building up of long-line services for the Armed Forces, many new carrier offices were unequipped with suitable transmission measuring equipment, because of the general shortage of meters and testing equipment. A transmission measuring set suitable for use at the carrier stations was developed and 50 sets were produced in the Melbourne workshops.

Train Control Facilities: At the request of the Commonwealth Railways, the construction and installation of train control equipment, both on the Port Augusta-Alice Springs and the Port Augusta-Kalgoorlie lines was carried out. A multi-office speech channel, complete with selective signalling, was provided in each case. This equipment considerably speeded up the transportation of troops and freight over two of the most vital railway links in the Commonwealth.

Sectional Steel Telephone Poles and Radio Masts: The requirements of Army Signals for telephone lines in the operational areas north of Australia indicated a need for some special pole which was light and capable of easy transport by air if necessary, or even by hand, and was free from rapid deterioration in tropical countries or attack by termite. As a result of investigations previously commenced by the PMG's Dept., tubular poles constructed in sections pressed from sheet steel were produced in large quantities for the US and Australian Forces.

The telephone line, shown at right, is constructed of sectional steel poles. The illustration below shows how one of the 90 feet steel masts is packed telescopically in a compact casing, complete with all fittings and accessories. This compact packaging greatly facilitates transportation.

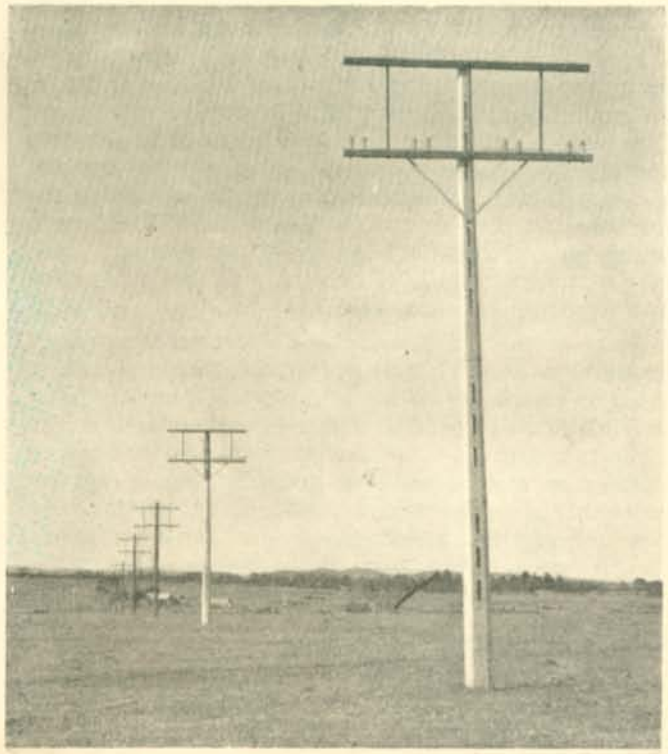


The poles consist of 6′ tapered sections having a special elliptical cross-section. The dimensions of adjacent sections are designed to glove together for assembly, but nest telescopically in one 6′ length for transport. Each section is constructed from two pressed half-sections butt welded throughout their length. The number of sections in one pole depends on the height required, and the most general application for telephone line purposes was for a 22′ pole consisting of four sections tapering from axes of 8″ x 5″ at the base to a 2″ circle at the top.

Radio masts of similar construction were provided by using larger sections in addition to those normally used for telephone poles. A cigar-shaped mast approximately 90′ high is obtained from two tapering sections clamped together at the centre. The mast rests on a steel plate on the ground and is supported by guys. Similar masts were used to construct parachute drying frames.

The 90′ masts pack telescopically in cases together with all fittings and are assembled completely on the ground at the site before being lifted into position by means of a falling derrick constructed from other mast sections. A simple method of carrying out the erection was developed and the information supplied to Defence personnel.

The PMG Dept. was responsible for the design, preliminary field trials and final testing of the production poles which were manufactured by a private contractor (Messrs. K.L. Engines & Tractors, of Springvale, Victoria). The Department also assisted the manufacturer to expedite production of poles by designing machine tools for their construction. Design commenced in March '43 and the first delivery took place in July of that year. By December '44 the delivery was 2,500 poles per week and a total of nearly 200,000 poles had been delivered at the cessation of hostilities.



General Signals Equipment: As mentioned previously, the Department acted as a major contractor for the supply of large quantities of general signals equipment, such as Telephones, Fullerphones, Daylight Signalling Lamps, Heliographs, Switchboards, Microphones, etc.—the total production including over 100 items in quantities including major contracts, besides many others for small contracts. Most of these items had never been manufactured previously in Australia, and it was often necessary to develop new manufacturing technique and arrange its application in Departmental Workshops before the work could be sub-contracted.

VHF D/F Equipment: This equipment provides a means of control of fighter aircraft in which direction-finding stations take accurate bearings of the aircraft and permit their position to be fixed. Used in conjunction with Radar it permits direction of the fighters to their target by Radio. Communication of position to the planes by radio also provides a "homing" service.

The equipment was designed and specifications prepared for its construction by contractors, after which installation at the various sites was also carried out by the Department. Accuracy of calibration of the D/F equipment depends on building symmetry and it was necessary to design special prefabricated buildings which consisted of three-storied, octagonal tower-like structures 30 ft. high.

Radio Sondes: The procurement of meteorological information by means of radio was utilised extensively during the war. A miniature radio-transmitter measuring approx. 9" x 8" x 4" complete with special lightweight batteries and meteorological instruments for measuring temperature, humidity and pressure is carried aloft by a balloon and automatically transmits the information to a ground receiver. A new simplified method of recording the data from the air-borne unit was developed in the Department's Laboratories and embodied in the ground station equipment. When Meteorological Services were taken over by the RAAF, the Department provided assistance in the form of a specification for the air-borne equipment, the designing and building of ground equipments and in connection with initial operational observations.

Low-Pressure Chambers: The RAAF provided Low-Pressure Training Chambers to permit training of Pilots under conditions simulating those experienced at high altitudes. The Department designed and provided Intercommunication Equipment for these chambers. The class in the chamber, consisting of up to 14 pilots, and the Medical Officer in charge, were provided with communication equipment similar to that which they would later use in service and means of communicating with observers outside the chamber. Special amplifiers and switching facilities were required to permit communication between a large group of people using oxygen masks under low-pressure conditions, which also affect the normal efficiency of the voice and electro-acoustic instruments.

Diver's Telephone Equipment: Special telephone equipments were designed and provided for divers carrying out salvage operations on vessels sunk by enemy action. Normal diving helmets were fitted with telephones to permit communication with surface attendants and other divers. A special telephone system was provided in an Observation Chamber which was used to recover £2,000,000 of gold from a ship sunk at a depth of 450 feet. The observer in the chamber wore a breathing mask and directed the operations of grabs, etc., by means of a throat microphone. A loudspeaker was fitted in the chamber to provide communication from the salvage vessel.

Research and Testing Facilities: Investigation of Telecommunication problems was carried out continuously in the Research Laboratories. There were over 400 separate defence investigations, varying in magnitude from those described in the previous paragraphs to investigation of single components or materials. The severe requirements of tropical climates called for a considerable amount of type testing of components and complete items such as radio transmitters and receivers before commencement of bulk manufacture, and the Services were assisted in this connection with many tests requiring special Laboratory facilities.

Other typical investigations were:—The design of radio systems and transmission lines for defence stations; the development of equipment for bomb release control; the design of carbon penetrometers for detection of leaks in respirators; and the measurement of acoustic noise in tanks.

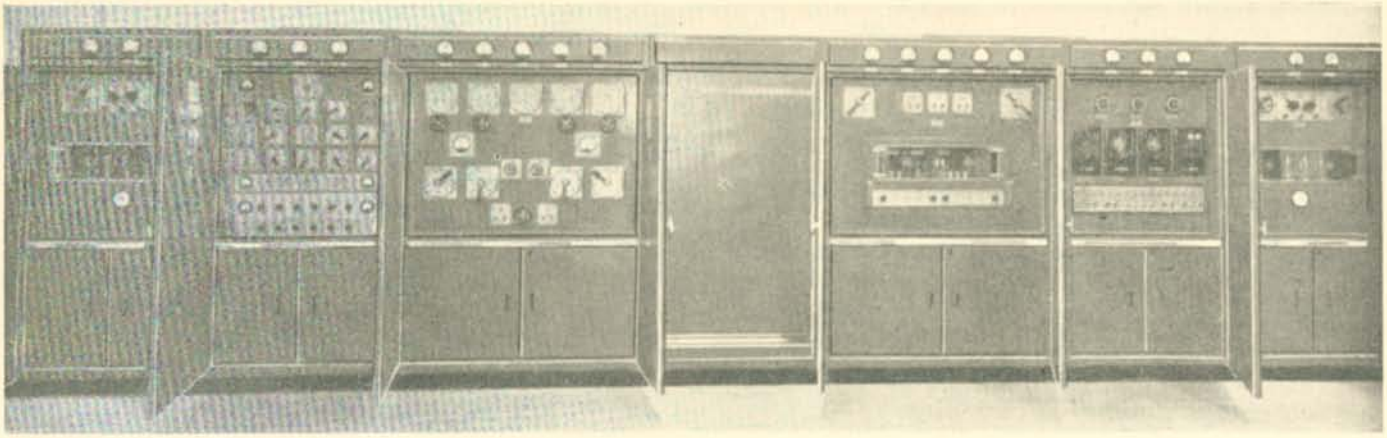
In connection with the Department's early activities on Radar, it is of interest to note that the production of equipment by large numbers of sub-contractors required the establishment of a Radar Material Testing Section for the acceptance testing of material. The services of this Section were made available to the Ministry of Munitions in connection with its later contracts. A considerable amount of investigatory work on manufacturing problems of the Ministry's other Radar Contractors was carried out in the PMG Research Laboratories.

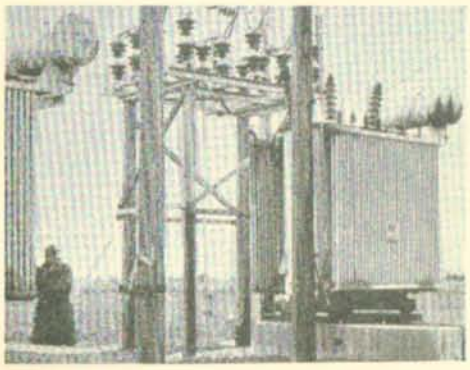
Photographs of items of telecommunications equipment developed and/or produced by the Department are reproduced in the pictorial pages of this publication.

PMG Works and Services

In addition to those sections of the PMG's Department involved in the above projects, other personnel of the Department, normally engaged on civil communications and broadcasting, were diverted from their peacetime works in order to assist the Fighting Services in providing communications within Australia and beyond by means of radio. This involved the establishment of a large number of radio stations, and the works carried out were much more extensive than normally dealt with.

Arrangements made in connection with the establishment of such stations depended on circumstances; in some cases the Department undertook full responsibility, including design, construction of buildings, provision of power, manufacture of radio equipment, etc., but in the majority of cases the projects

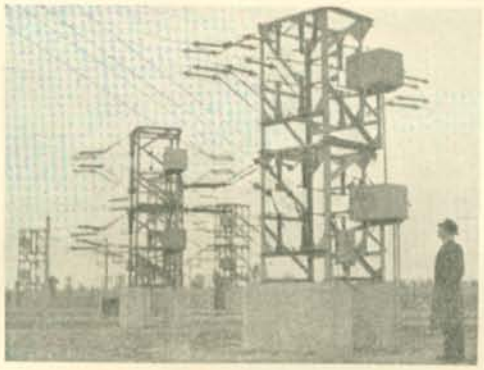


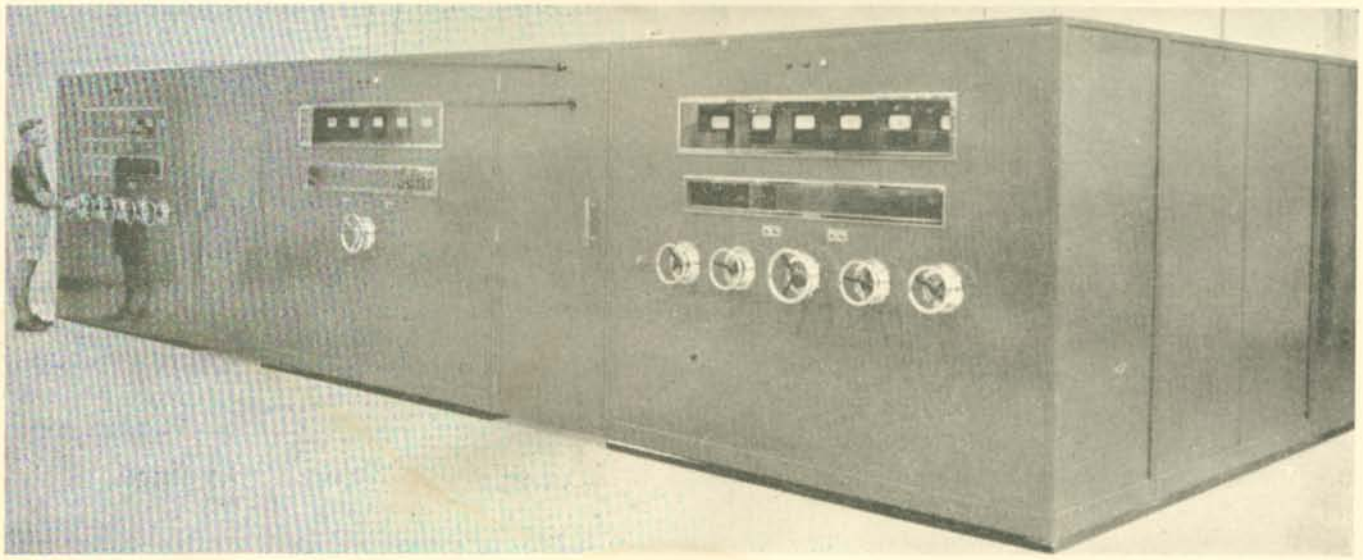


The photographs on this page show some of the equipment at the PMG-operated broadcasting station at Shepparton, Vic., which is now radiating overseas short wave broadcasts under the callsign of "Radio Australia." The picture at the top of the page shows a part of the 100 kw. HF transmitter. The RF drive unit, the main HT rectifiers and the air cooling equipment for this transmitter were produced by AWA. At right is one of the typical radiating systems.

"Radio Australia"

The sizes of one of the transformers produced by the Wilson Electric Co., above, and of a typical remotely controlled radio frequency switch, at right, may be gauged by the figures standing beside the equipment. Below is another section of the 100 KW transmitter produced by STC. The production of this transmitter was handled jointly by Messrs. Amalgamated Wireless (A/sia) Ltd. and Standard Telephones & Cables (A/sia) Pty. Ltd.





were shared with other parties, such as the Fighting Service directly concerned, the Allied Works Council and similar bodies. Under this latter arrangement, the radio equipment proper was, in most cases, manufactured to orders placed by the Fighting Service, but was installed and made ready for service by the Department, which was thus finally responsible for the satisfactory operation of the plant.

Such projects were carried out on behalf of the RAAF, RAN, US Forces, Netherland Forces, and the Department of Civil Aviation, the latter Department being included since its radio and other facilities were planned in conjunction with the RAAF and were used by military as well as civil aircraft.

In all, approximately 250 of these projects were handled by the Department, and they included the installation and maintenance of radio transmitting and receiving stations; radio direction-finding stations for aircraft navigation; radar installations; radio homing beacons; an elaborate short-wave receiving centre at Werribee, Victoria; special radio interception installations; and a number of signal offices, as well as the 100 kW Shepparton World-range Broadcasting Station and several Broadcasting Stations for Army Amenities. The Shepparton and Army stations will be dealt with in further details.

Shepparton World-range Broadcasting Station

The major single radio project undertaken by the PMG's Department during the war years was the establishment of a 100 kW broadcasting station at Shepparton, Victoria. This station is capable of broadcasting to any part of the world, and is understood to be the largest of its kind in the Southern Hemisphere. The initial purpose of the station was to furnish propaganda services to enemy-occupied countries, and information received indicates that the value of such services has been very considerable and contributed in no small part to the maintenance of morale in those countries.

The most striking feature of the project is its extensive size, the site being almost a square mile in area, the whole of this area being practically covered by the aerials, which are carried by fourteen 200ft. steel masts, and the transmission lines which feed these aerials. The building which houses the radio and switching equipment has a floor area of over 25,000 square feet, while the power-house has a floor area of 9000 sq. ft. In addition, seven miles of fencing and three miles of gravel roadways were necessary.

The building for the station was constructed under the direction of the Allied Works Council, and is of blast-proof design because of the possibility of enemy action, and for the same reason, engine-generating plant has been provided to enable the station to operate independently from power from commercial sources. This power supply, in fact, comprises a minor power station at least equal to that found in any moderately-sized country town.

The responsibilities of the PMG's Department in connection with this project included arrangements for the site, buildings, radio equipment, aerial systems, power plants and associated facilities, nearly all of which were designed and manufactured in Australia. The general design and specification of equipment requirements, together with much of the detailed design, was carried out by the Department. Manufacture of the 100 kW transmitters was undertaken in Australia by joint arrangements between Messrs. Amalgamated Wireless and Standard Telephones & Cables. Photographs of the station and equipment are shown on page 56.

Army Broadcasting Stations

Because of the number of troops in the vicinities of Darwin and Port Moresby, the Department established broadcasting stations at these two locations and provided for programs to be supplied from local sources or by re-broadcasting of transmissions from Australia. After completion by the Department of these stations were taken over for operation by the Australian Army Amenities Service.

Equipment for the establishment of seven additional broadcasting stations of the same type was designed and provided by the Department for installation in New Guinea and other areas under military control north of Australia. These equipments were handed over to the Australian Army Amenities Service in Australia, and the latter body arranged for setting up and subsequent operation.

Telephone & Telegraph Facilities

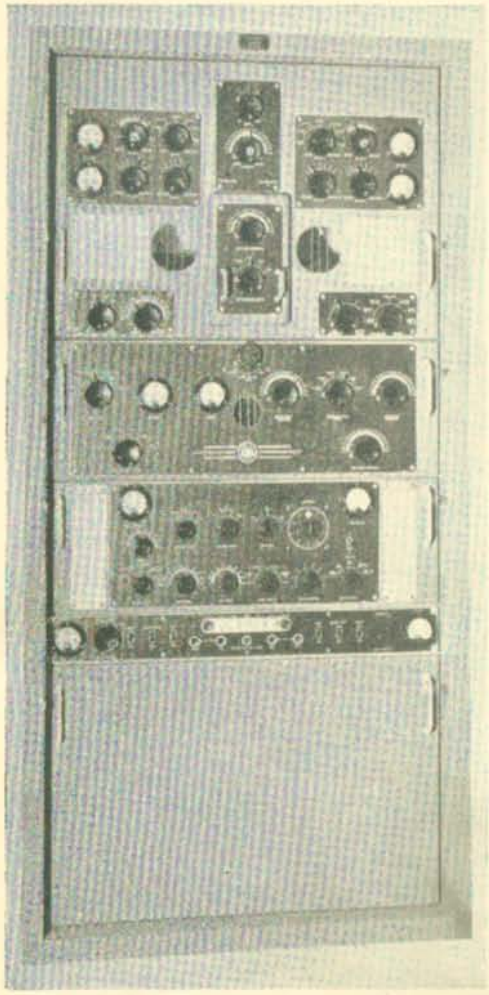
This summary of the work of the PMG's Department during the war years would not be complete unless mention were made of the enormous extension of Australia's long-distance telephone and telegraph facilities, which was effected to meet the urgent strategic and operational demands of the Services, and now remains as a valuable public asset.

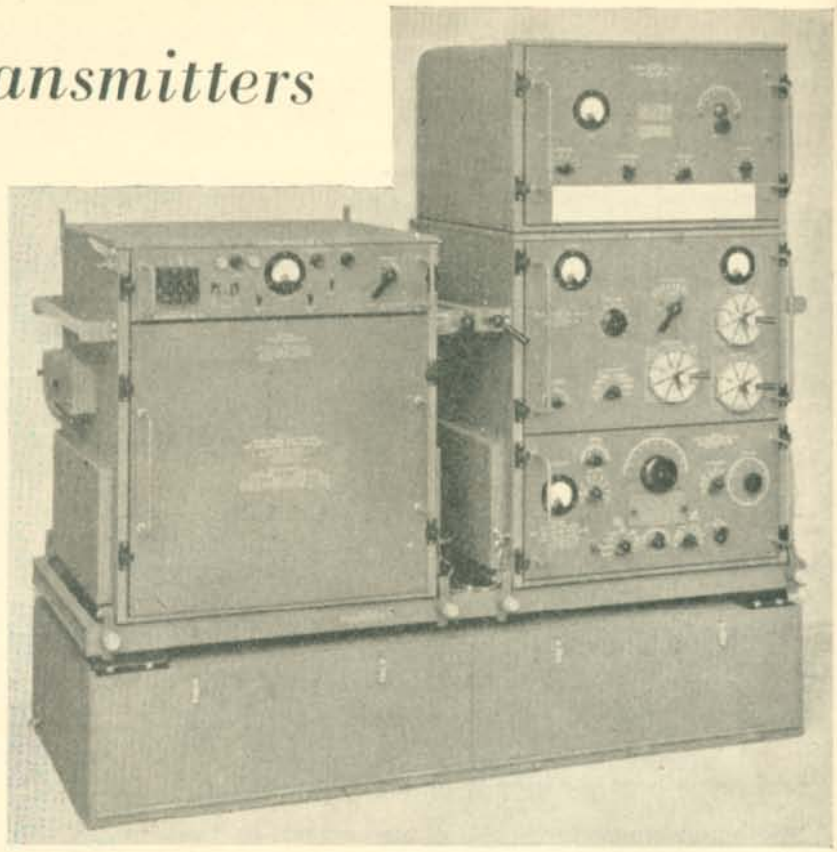
Space will not permit of a detailed examination of the projects successfully completed, and it must suffice to mention that existing facilities over some of the most difficult areas in Australia were multiplied many times—outstanding examples being the provision of new lines and circuits from Adelaide to Darwin, Adelaide to Perth, Brisbane to Hughenden and Darwin, Brisbane to Cairns, and Townsville to Cape York. This last link was extended by means of submarine cable to Thursday and Horn Islands and to New Guinea. Much of this work was carried out in conjunction with the Services and with the aid of Service personnel, but the engineering aspects and provision of carrier terminal facilities were the responsibility of the Department.

Apart from the foregoing special defence works, a considerable amount of construction work was involved in the provision of additional channels on such routes as the Sydney-Melbourne, Sydney-Brisbane, Melbourne-Adelaide, Perth-Geraldton, and Melbourne-Bairnsdale-Gabo Island. In all of these cases, the work was carried out by Departmental labor.

Summarised, the various defence works, either planned and carried out completely by the Department or in conjunction with the USA and AMF Signal Forces, resulted in an increase of about 25,000 miles of wire for telegraph and telephone use in the Commonwealth during the period 1939-1945. The trunk telephone carrier channel mileage was increased two and a half times, and the telegraph carrier channel facilities sevenfold.

Long-Range Transmitters

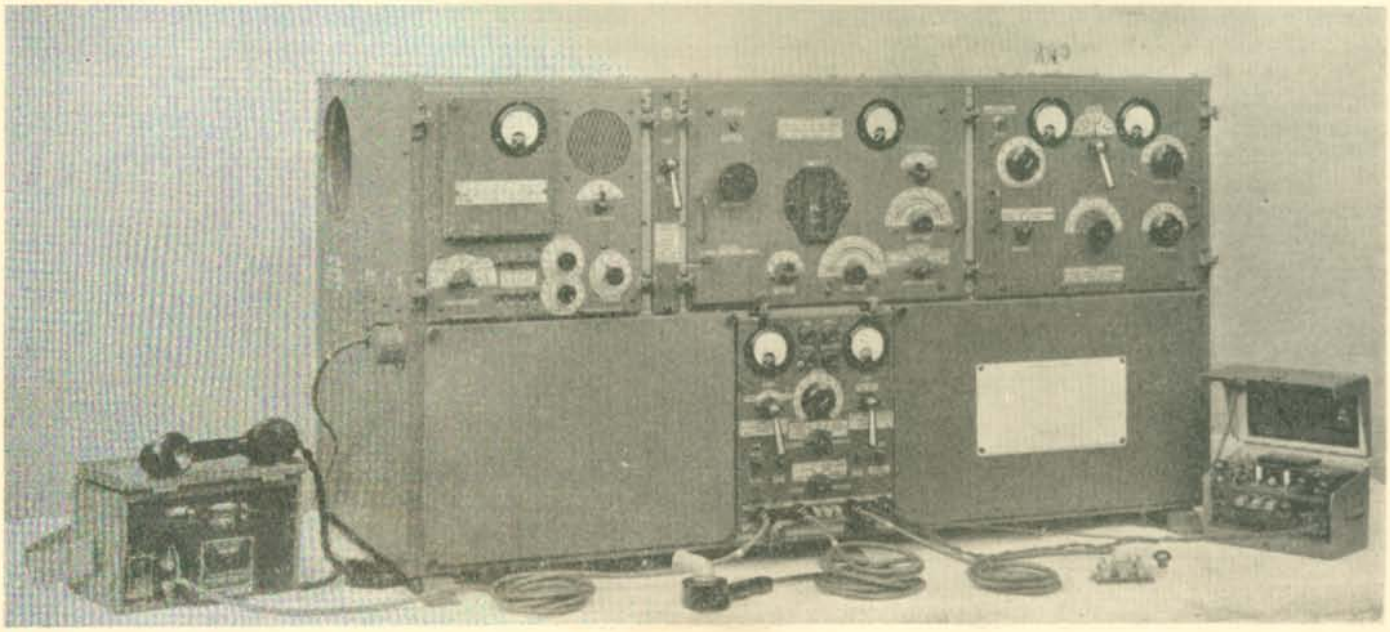


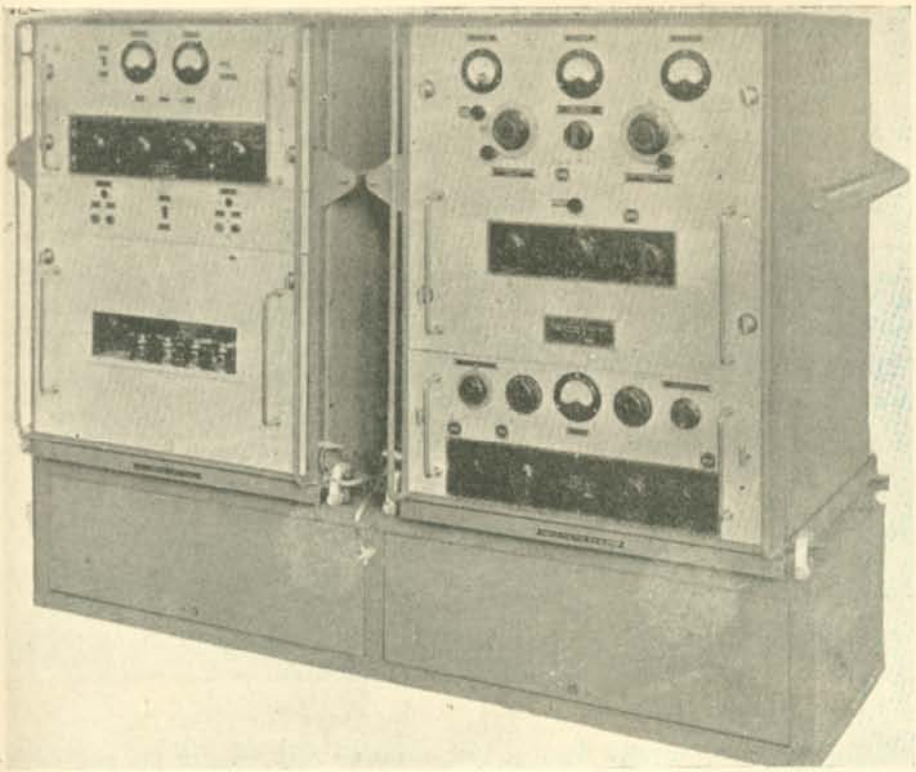


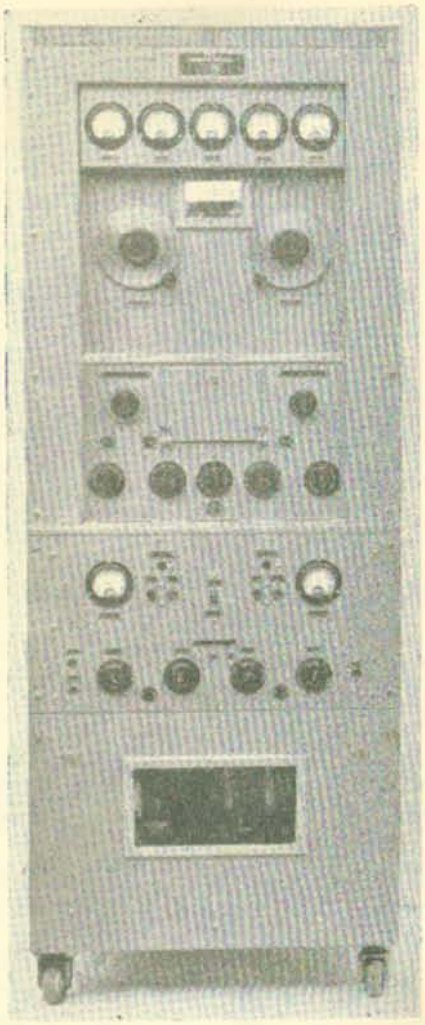
The three transmitters illustrated on this page were all built by Messrs. Amalgamated Wireless (A/sia) Ltd. and supplied to the Services to meet special point-to-point communications requirements. The RAAF was the major user of the AT13C equipment shown above and employed it extensively for mobile and static ground station installations. The equipment has a rated CW power output of 500 watts over the frequency ranges of 150-600 kC/s and 2-20 MC/s. Variants of this transmitter, with slightly modified characteristics were also used as the AT13, AT13A and AT13B.

The equipment shown at the left is the US forces version of the AWA J8922 transmitter and was known as the AMT250—a somewhat similar assembly being used by Aust. Army as the WS No. 105B. This equipment has a CW power output of about 1000 watts and operates over the range 2.5—20 MC/s.

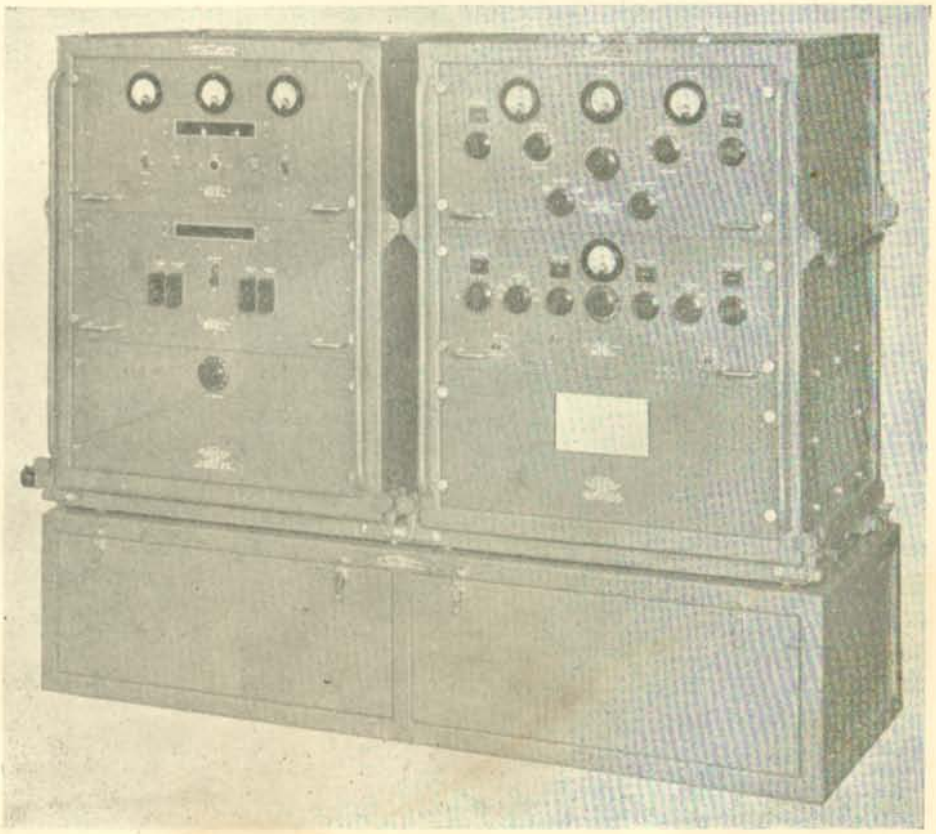
Shown below is the Aust. Army WS No. 133 which played an important part as a mobile general-purpose transmitter throughout the New Guinea and Borneo campaigns. This set provides RT, MCW and CW transmission over the range 2.5—20 MC/c and has a CW power output of 300 watts.





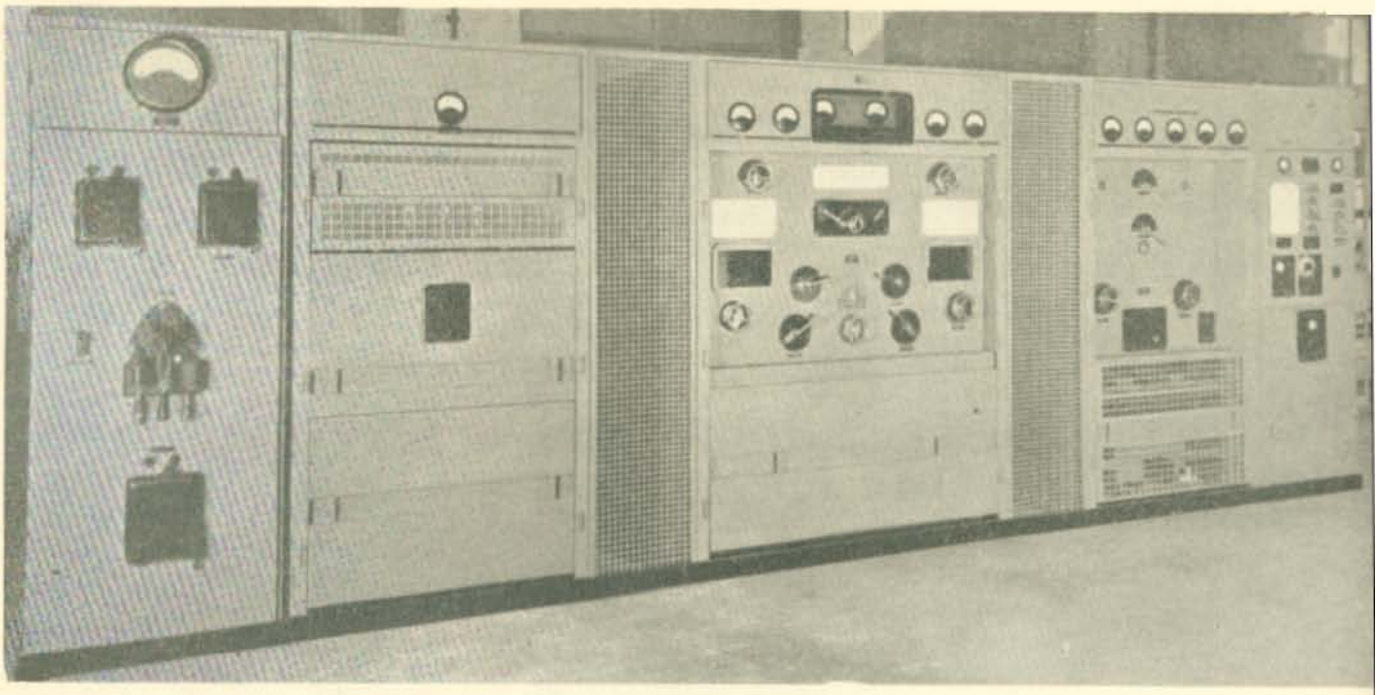


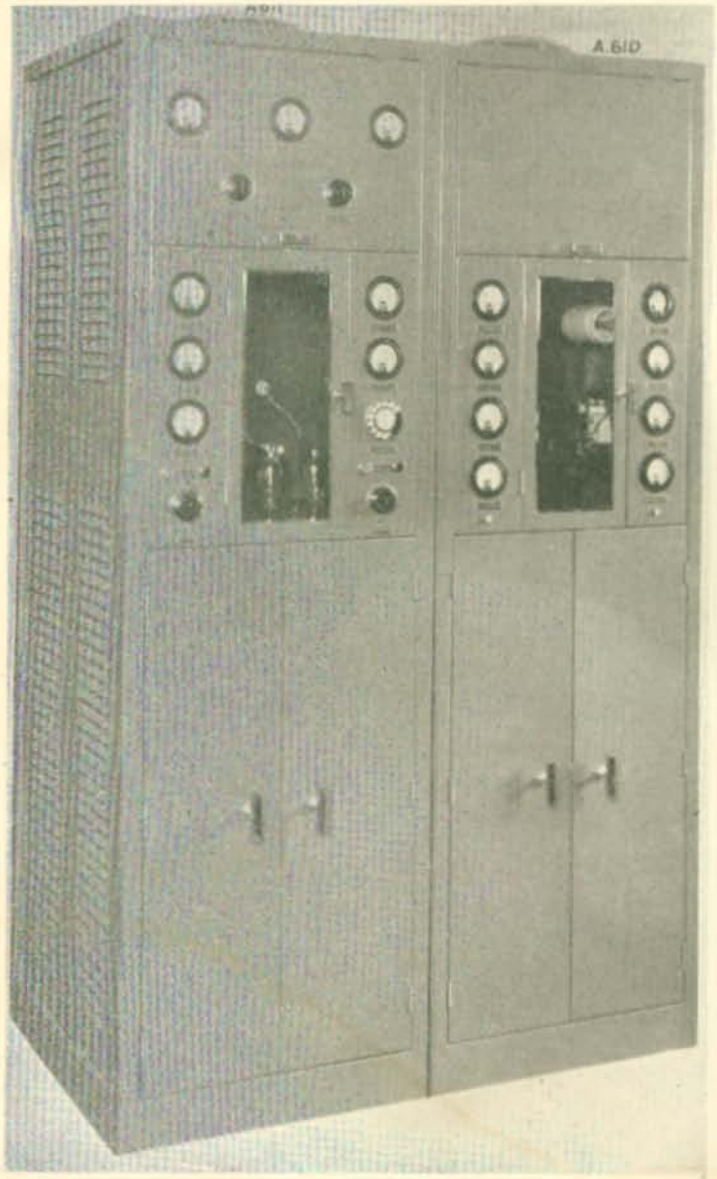
Above is shown the RAAF type AT14A mobile and static ground station equipment, with its predecessor (the AT14) at the right. Both of these transmitter types were developed and built by Messrs. Thom & Smith Pty. Ltd. and provide speech and telegraphy outputs of 100-200 watts over the range from 3-20 MC/s. Voice-operated carrier operation on speech is a feature of both equipments, while the newer sets, besides having reduced weight and extended power input facilities, also includes provision for pre-selection of four operating frequencies.



Illustrated at the right is the 500-watt transmitter variously known as the "4-SU-6A," the "AT20" or the "AMT120," depending on whether the RAN, USN, RAAF or US Army were using it. Developed and built by Standard Telephones & Cables to a RAAF specification, this equipment was a counterpart of the AT13B and provided CW operation, with five pre-selected frequencies, in the range 2-20 MC/s.

Duplicate production of this equipment was established in Melbourne by Eclipse Radio Pty. Ltd. and in addition to the RAAF, supplies went to Aust. Army, which knew it as "WS 173."

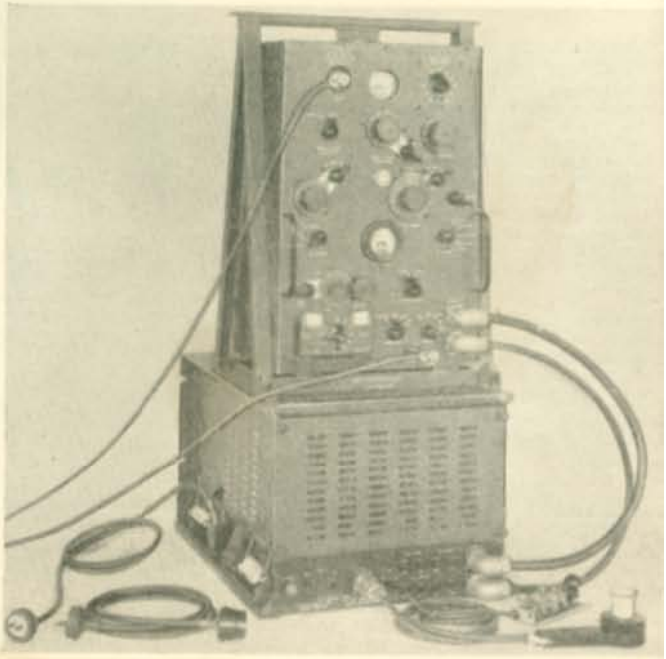




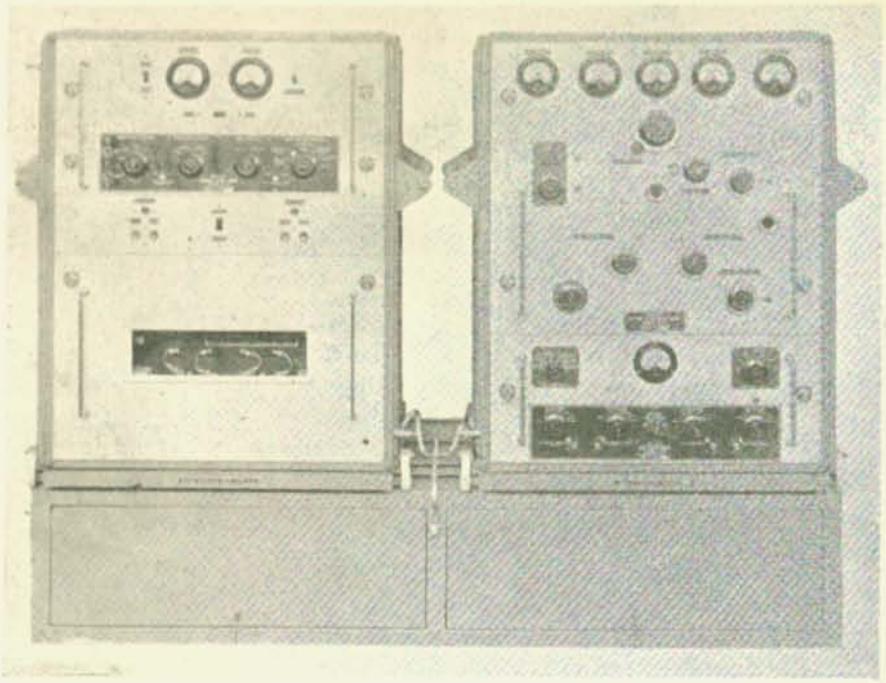
A first-class contribution by Australian Industry to "reverse lend-lease" is shown above in the form of A.W.A. transmitter type J8871. This equipment is a long-range H-F installation rated at 10 KW. and was produced for the U.S. Forces.

One of the "14-S" series of transmitters produced by S.T.C. for the RAAF is shown at left. This is a 400/1000 W. RT/MCW/CW set with VOC operation on speech and has provision for pre-selection of up to 10 "spot" frequencies in the ranges 140-560 kC/s. and 2-20 MC/s. Eight types of transmitters, with varying frequency coverage, were included in this series.

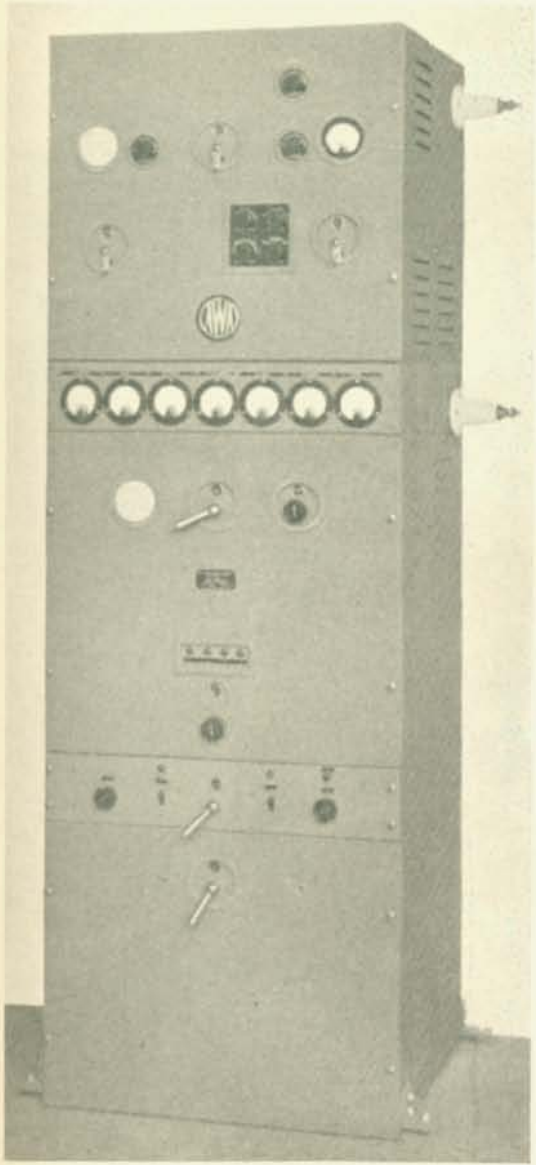
Known variously as the "TW-12" and the "AMT150," the compact assembly shown below was developed by A.W.A. for the U.S. Forces and provided 15-50 watts output on RT, MCW or CW in the range from 1.5 to 16 MC/s., with provision for 6 "spot" frequencies. A similar assembly, rated at 80W., was produced for RAAF as the "AT21."



The unit shown above is A.C. power supply unit, type SRA-34, produced by Transmission Products, of Sydney, for the US Forces. This equipment was fully "tropicalised" and provided all operating voltages for a medium-power radio transmitter.

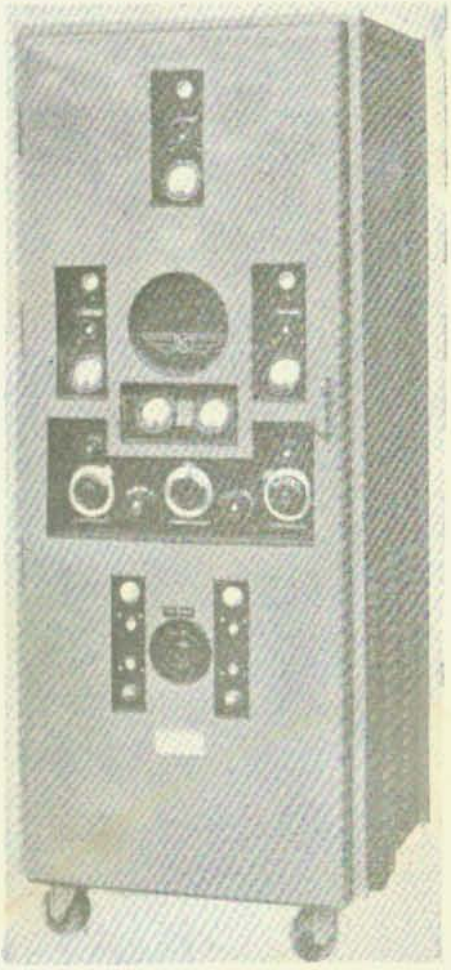


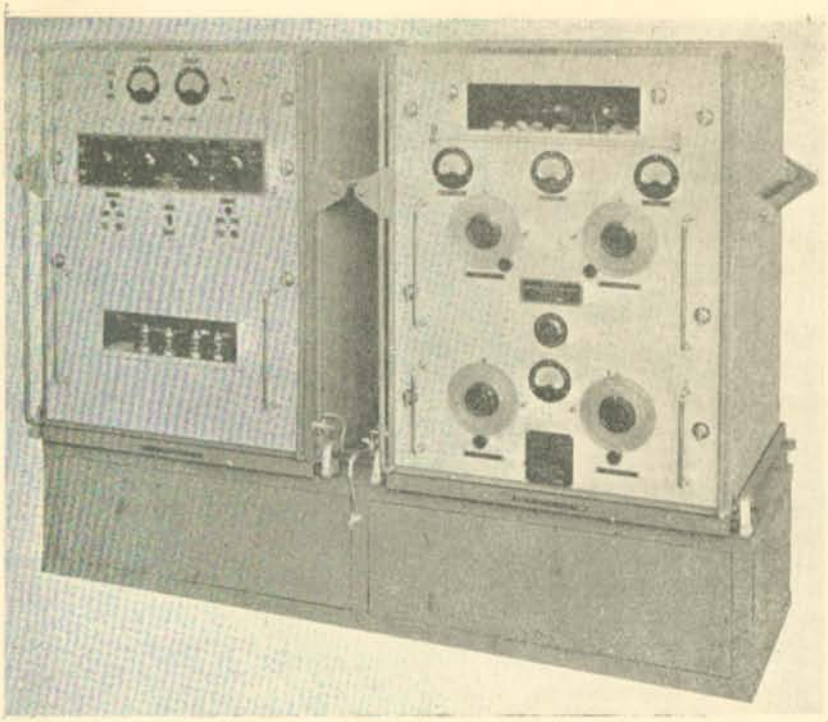
The RAAF transmitter illustrated above operates on 100-150 MC/s., and provides frequency- or amplitude-modulated VOC transmission with a power output of 50-150 watts. Known as the "AT17," this mobile or static equipment was manufactured for the Air Force by Thom & Smith Pty. Ltd.



The neat assembly at the right is the AT19 transmitter produced by Kriesler (A/sia) Pty. Ltd. for the RAAF. This equipment is designed for static ground station service and has an MCW/CW power output of 500/1000 watts in the 2.5-20 MC/s range.

The Merchant Navy as well as the RAN and other Services found extensive application for the AWA series J5385 transmitters, of which one example is shown at the left. This Marine MF/HF set operates in the ranges 365-530 kC/s. and 5-20 MC/s. has 3 pre-selected frequencies and an MCW/CW output of 500-750 watts.

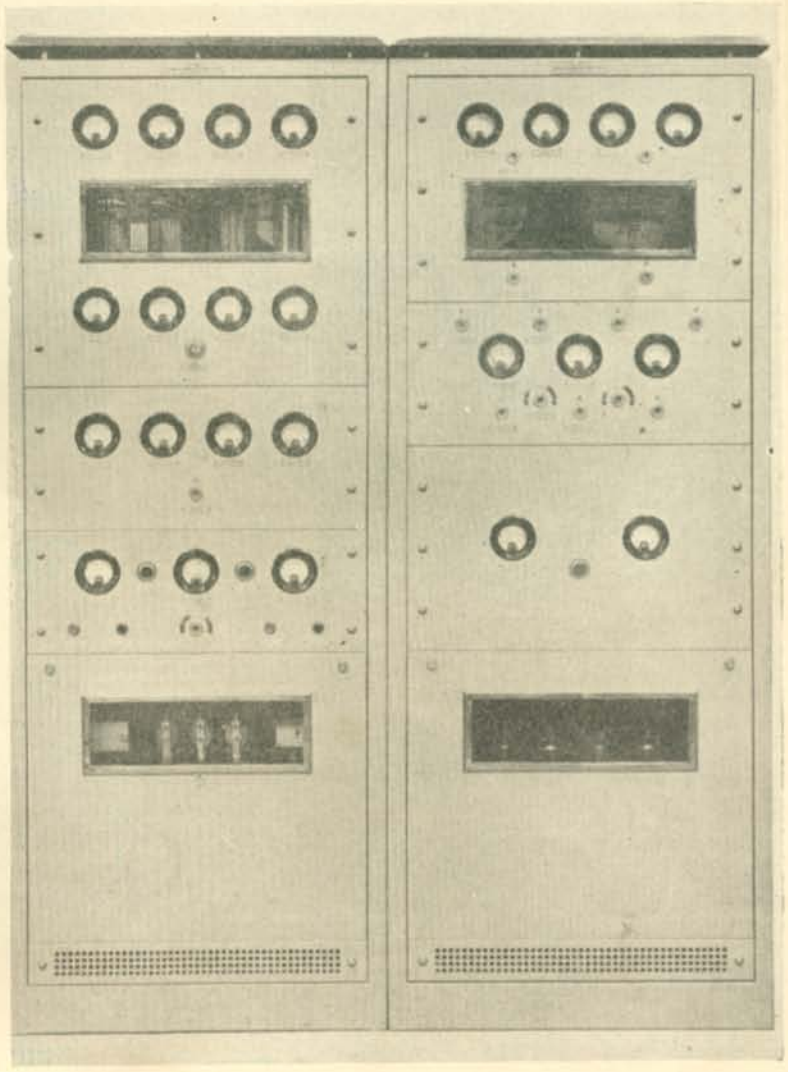




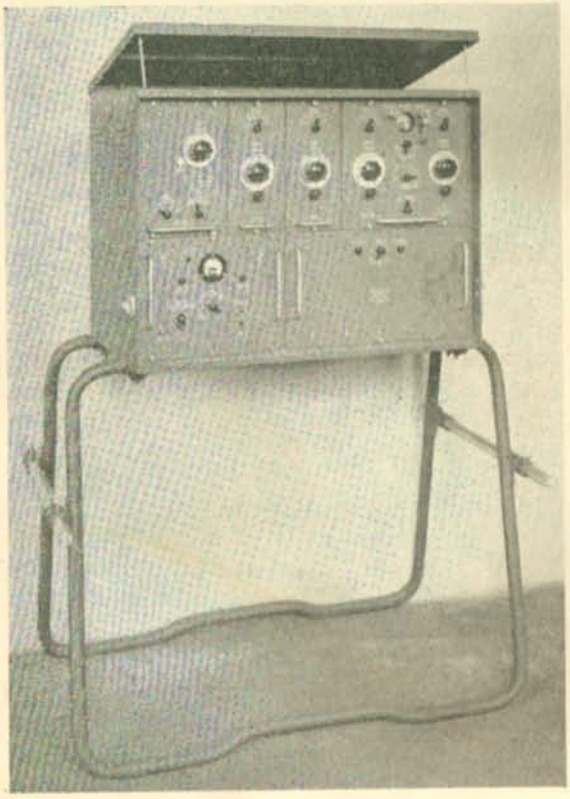
Thom & Smith Pty. Ltd. produced the AT15A shown above, for the RAAF. This transmitter is a 350/500 W. assembly operating on the medium-frequency range of 180-500 kC/s, and was largely employed for "homing" and airport control.

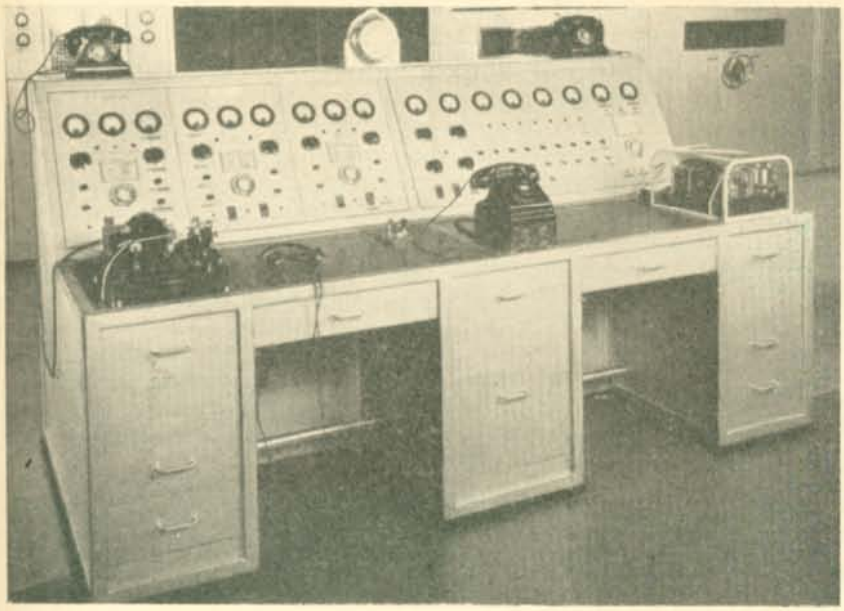
Airzone (1931) Ltd. manufactured the power supply unit shown above to permit AC operation of the SCR-522 by the US Sig. Corps and RAAF. The US identification was AMS-195, while RAAF called it PSU type "V."

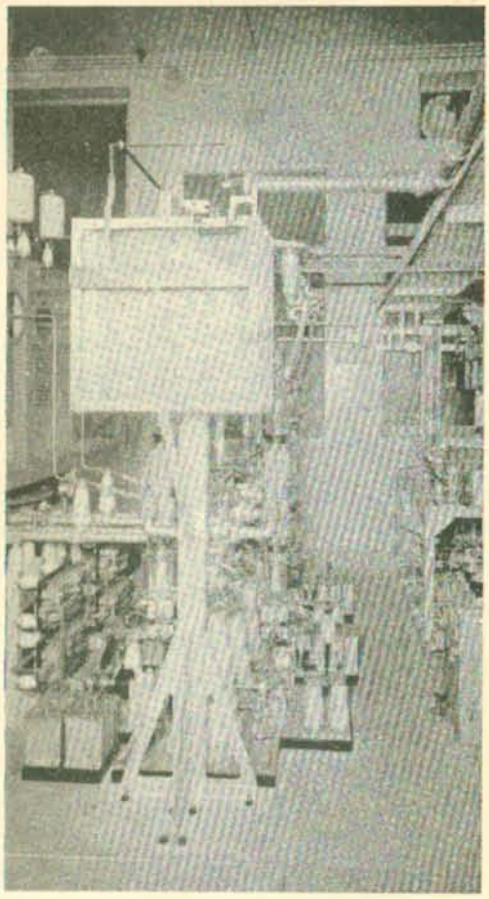
Illustrated below is Standard Telephones' UHF multi-channel radio transmitter type 4-SU-1A. This equipment was built for the Postmaster General's Dept. to provide an extension of the telephone facilities between the Australian mainland and Tasmania.



Both the RAN and USN used the 100-watt transmitter illustrated below, which was produced by Philips Electrical Industries. This equipment covered the range 2-20 MC/s and was readily transportable—the stand forming a carrying frame.

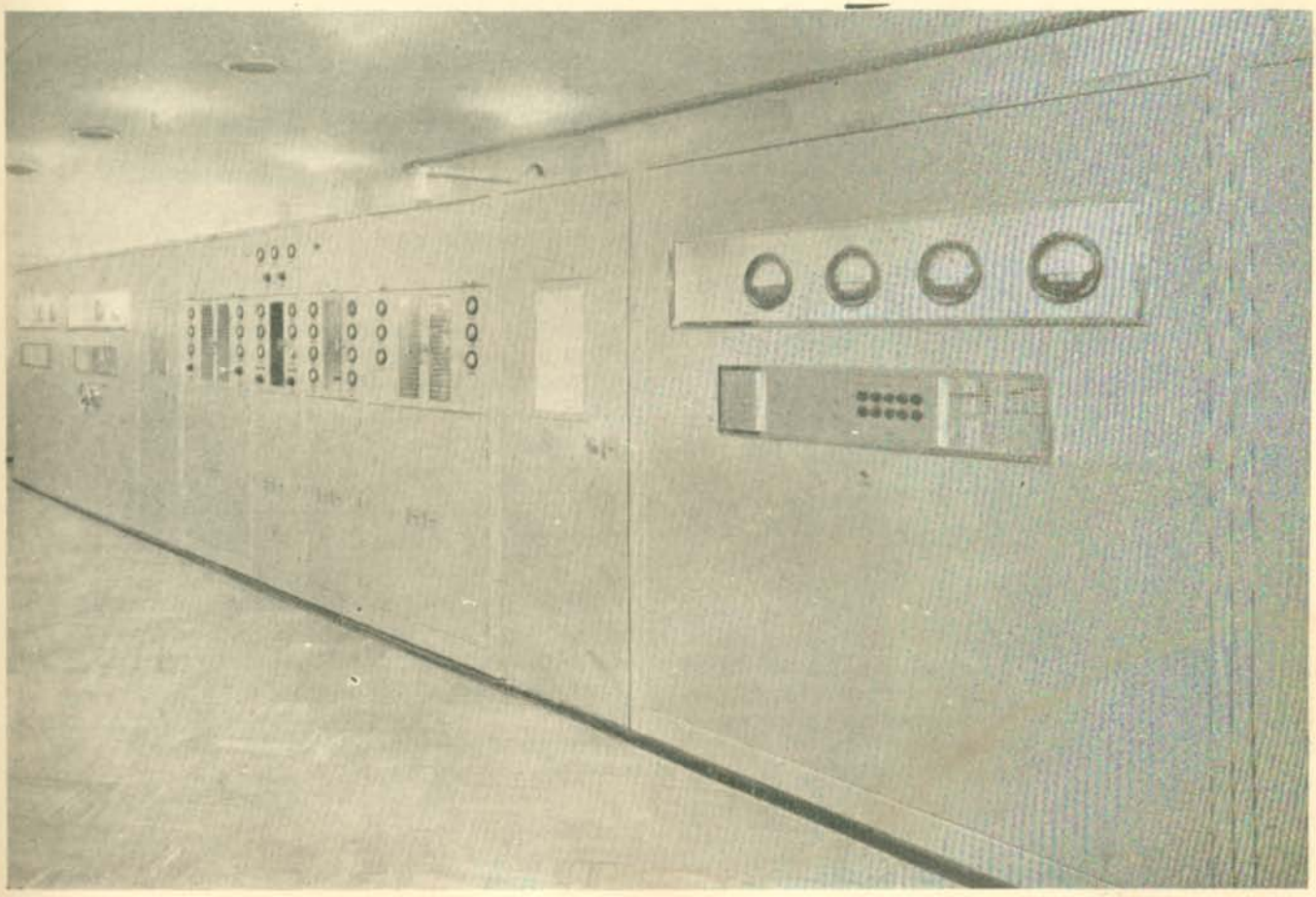






"Bell's Fox"

On this page we show three views of the 200 kilowatt low-frequency Navy installation at Belconnen—source of the "Bell's Fox" transmissions to ships at sea. The main control desk, which centralises the operation of the 200 kW. and other transmitters, is shown above, while at right may be seen the valve change-over unit in the final power amplifier. Below is shown a general view of the complete 200 kW. transmitter. All of this equipment was built for the RAN by STC.



It may fairly be said that one of the worst problems faced by industry in its "home front" battle of production was that imposed by the constant change of Service requirements. Specifications would be laid down as a basis of development and, frequently, before the equipment reached the production stage, modifications would be required. At other times production would commence, only to be interrupted for the purpose of introducing major or minor changes It was rarely that an item of equipment went through all phases of development and production as originally planned.

Apart from the delaying effect on both development and production, this constant change of requirements frequently led to misunderstandings and considerable exasperation of all concerned; but it generally was unavoidable—just one of the penalties of a constantly changing global war—a war in which all established principles of logistics went by the board and in which materiel supply problems were equally confused. It is the purpose of this article to review some of the problems which confronted those responsible for the initiation of Services' equipment requirements and, at the same time, deal with some of the steps taken to meet those problems.

Some Operational Aspects of
Services Equipment Design

IT frequently has been suggested that many of the trials and tribulations of the 1939-45 war could have been avoided by more comprehensive forward planning in pre-war days, but such a suggestion is scarcely tenable as far as equipment matters are concerned. Quite apart from the fact that many of the techniques employed as a matter of course during the later war years were virtually unknown in 1939, it must be borne in mind that few, if any, envisaged an extension of the conflict into the theatres eventually engaged. This factor alone would be sufficient to negative the benefits of any extensive forward planning, particularly with respect to telecommunications equipment production, for, as will shortly be shown, many of the lessons learned, even during the early war years, had to be unlearned after the advent of war in the Pacific theatre.

This is a major example of the causes underlying the changing pattern of Services' equipment requirements. Other examples may readily be found and, in fact, it can be claimed with more than a degree of justification, that every campaign during the war, both before and after Pearl Harbor, provided reasons why Service equipment design must always remain fluid, even, in some instances, to the point of interference with production.

The Changing Face of War

At this juncture it will be of interest to briefly review the course of the war just concluded and examine some of the major influences on the trends of equipment design.

When war broke out in 1939, it appeared that the basic theatres involved would largely be those of World War I, and that equipment problems, apart from those involved in the more extensive mechanisation of armed forces, would follow the same general pattern. This entailed the development of relatively short range point-to-point radio equipment and extensive telephone facilities for the ground forces; fairly conventional radio signalling and DF equipment for the air forces; and somewhat more elaborate shipboard equipment for the naval forces, this last being supplemented by fairly advanced types of acoustic and super-sonic underwater detection systems for anti-submarine operations. "Radio-location" (now radar) was known, but had scarcely progressed beyond the stage of cumbersome static installations for shore-defence and air-warning.

As far as Australia was concerned the war was, and appeared likely to stay, a long way away and, consequently, development and production of Services' equipment was concentrated on those items required for training of forces likely to be engaged in the European theatre, with a long-range possibility of shipping certain items overseas to assist Britain in her supply problems.

The invasion of France and the entry of Italy into hostilities ended the era of "position" warfare, while the Battle of Britain finally demonstrated the value of radar and accelerated work on the development of light-weight equipments for mobile and air-borne use —a trend which proved of considerable value during the Mediterranean operations, where air-borne ASV equipment was responsible for a number of successful "strikes." Such equipment also played its part in the Battle of the Atlantic. Another effect of the evacuation from the mainland of Europe and the advent of war in the Middle East theatre was to focus attention on the communications requirements of highly-mobile armored ground forces.

Here in Australia Dunkirk had its effect on the development of telecommunications, but from the production rather than the design aspects. Development was still concentrated on items which conformed with British requirements, but the changed situation made it evident that Australia would have to become more self-supporting. This view was shared by India and New Zealand, and arrangements were made for considerable expansion of production projects already under way. An important development in Australian Industry at this time was the initiation of a project for the manufacture of field telephone cable, as it was realised that even apart from the possibility of Britain being unable to meet requirements, the greater distances over which war was being waged made inadequate all previous estimates of cable usage. For this purpose the resources of several large Australian manufacturers were mobilised and production got under way with such celerity that it was possible to ship nearly 10,000 miles of "D" class cable to the Middle East before the return of the AIF divisions for service in the SWPA.

by J. R. Edwards, M.IRE (Aust.)

During all of this time, considerable strides forward were being made overseas in the design of all types of communications and radar equipment, particularly because the emphasis was now a mobile, long-range warfare. Special radio equipment, incorporating crew-communication and inter-tank UHF link facilities, was developed for armored vehicles, outmoding apparatus previously considered adequate, while the higher operational ceilings, speed and endurance ranges of aircraft had necessitated a re-design of most airborne equipment. The advent of air-supply dropping during 1940-41 introduced new requirements for mechanical stability and protection of ground forces equipment, but all design was based on requirements for hot and dry or cold and wet climates—the vastly-changed requirements brought about by a combination of these climatic factors had yet to come. Specifications calling for testing under conditions of high temperature and humidity were in existence, but were not enforced, except insofar as clauses calling for tests at elevated temperatures were involved.

In Australia, as well as overseas, war production was commencing to become established by the end of 1941, but on the basis of the lessons learned during the first two years of war. Advantage had been taken of improved techniques to introduce items of equipment which compared more than favorably with "Middle East" standards. Some minor deficiences had been revealed, and corrected, as a result of experience during training operations in Malaya, but even this experience did not provide any indication of what was soon to come. Fungus was still either something you ate or a scientific curiosity, while true amphibious warfare, with its exacting demands for waterproofing, was yet to be experienced.

Unfortunately, this nice, comfortable picture was changed overnight, and war entered a new theatre, with a completely new act for the players to learn. For a time it was not evident how completely new the act was—the hurly-burly of the first few months of the Pacific War left time only for improvisation and attempts at applying the lessons learned in other theatres; while many of those who had learned the hard way, and could have told the score, were not in a position to do so, being guests of Nippon.

As a result, development and production went on unchanged—apart from a sudden acceleration—for a while, and it was not until we commenced to fight back that it was learned how pitifully inadequate were previous standards of equipment design. This situation was not peculiar to Australia. Our American Allies also got some nasty shocks when first their equipment was subjected to what are so inoffensively known as "humid tropical climates."

The remedies for the new-found deficiencies of equipment unfortunately were not so obvious as the deficiencies themselves and, as a result, what might be termed the "trial and error" era of Service design was initiated all over the world. Not only was there little correlated scientific information on the problems involved, but also there was little opportunity for acquiring such information. In addition the lessons of two years of war had largely to be unlearned and the inertia of the development and production machine had to be overcome.

All of this was done under the stress of immediate urgency, and equipment was produced or modified to meet the requirements of the moment. And therein lay another difficulty, which became apparent when sufficient leeway was regained to permit of forward planning. The era of experimentation and temporisation, while it had produced equipment which worked and had established a basic pattern for "tropic design," had also diverted attention from the development and production of equipment to meet the further operational requirements which now could be envisaged.

Here, again, the situation was not peculiar to Australia. The records of the armed forces of all the Allies can show many examples of equipments produced during 1942-43 to meet the need of the moment, which perforce had to be replaced or extensively modified when the overall strategy became clearer. Further complexities were introduced at this time by the intermingling of Commands. Whereas previous equipment planning had largely been determined by individual preferences, the combination of forces necessitated group planning and the utmost possible degree of interchangeability of all items of equipment.

This phase was first manifested in Australia by the formation of an Allied Services' Signals Equipment Standardisation Committee in July, 1943, with the object both of rationalising production and also of ensuring the greatest possible commonality of equipment usage by all Services. Similar bodies functioned in all Allied producing countries, and while the long-term effect undoubtedly was beneficial both to Services and Industry, it cannot be denied that initial impact of standardisation, with accompanying demands for improved standards of overall performance, did impose a severe strain on Industry.

And so, right until the end of the war, particularly in the Pacific theatre of operations, the pattern of Service requirements varied—frequently unpredictably and always with sufficient rapidity to make forward

production planning more a matter of inspiration than anything else. One could elaborate on the theme, citing chapter and verse, but although it might make interesting reading, no other useful purpose could be served. Sufficient already has been said to indicate that the late war imposed terrific problems both on the Services and Industry—problems which tried to the utmost the initiative and ability of all concerned and which make the contribution of Australia's Telecommunications Industry, with its relatively-limited technological resources, all the more remarkable.

Some of the Problems

Apart from the problems of "tropic design," which will be dealt with separately, the initiation and development of Services' equipment in Australia presented numerous problems which in some respects were almost peculiar to this country.

In the early war years, these problems were brought about largely by the relatively minor part played by Australian forces overseas. In almost every case Australian forces functioned as part of formations under British control, and so there developed upon the local authorities the necessity for equipment standardisation along British lines. This was not always the case, but, generally speaking, it was essential that forces raised for oversea service with British formations should be trained with equipment similar to that in use by those formations.

Consequently, although a few items of British-made signalling equipment of various types were available in this country, and it was anticipated that the forces overseas would largely be equipped from British resources, it was decided that local production should follow British designs as closely as possible. Actually this policy had been determined prior to the outbreak of war, but although some equipment had reached the prototype or pilot model stage, little had been done towards actual production.

The initial objective in this local manufacture of Services' signalling equipment was to produce "Chinese copies" of the overseas items, but, in doing this, considerable difficulties immediately arose, mainly due to the fact that little or no **manufacturing** information was held on the British equipments. As mentioned previously, a few items of the equipment itself were held, but these were either old "marks" or in a fairly worn condition, while in other cases only photographs and brief performance details were available.

As a result of this, local manufacture at first was largely a matter of local interpretation, and it is not surprising that the equipment as produced frequently had to undergo considerable modification before it finally conformed with the operational requirements it was expected to meet. However, it is to the credit of Industry that, even in those early days, with so little prior experience and so little guidance, it was able to produce a considerable quantity of apparatus that not only met Australia's training requirements, but also was suitable for shipment overseas for use by Empire forces engaged in the Middle East. This apparatus included radio sets, telephone equipment, visual signalling devices, and the field cable previously mentioned.

The necessity for local interpretation of overseas designs was but one of the problems faced by both the Services and Industry. Even in those days material supplies were a real problem. Industry in this country had always been dependent on overseas sources for certain materials, such as moulding powders, light-weight alloys, etc., and it was far from encouraging to learn at times that the successful interpretation of an overseas design depended on the availability of materials either not known in Australia or in very short supply.

These two problems alone—lack of basic design data and materials shortage—made it difficult for the Services to establish equipment specifications capable of easy interpretation by Industry. But there was a third stumbling-block that, for a time, looked like being a barrier to production of any but the simplest items. This was the Services' desire for complete interchangeability, not only of complete equipments, but also of accessories and components.

This requirement was perfectly natural for equipments which were expected to operate alongside overseas counterparts. It is difficult enough to keep operational forces supplied with equipment components and accessories when everything is standardised, but it becomes almost an impossible proposition if there are a multiplicity of different equipments performing similar functions. As a result electrical and mechanical interchangeability were regarded as primary considerations to be satisfied.

Little difficulty was experienced in satisfying the requirement for mechanical interchangeability—the interpretation here being that a locally-produced assembly should be capable of physical substitution for its overseas counterpart without alteration to mounting arrangements, etc., although minor variations sometimes became necessary because of design limitations, but the electrical interchangeability factor was a real problem.

The reason for this was that pre-war production of telecommunication equipment in Australia had tended toward American, rather than British, lines and existing components and accessories bore little similarity to those required for replacement of British items. This difficulty was not insuperable as far as the general run of components were concerned, but it was with respect to radio valves—there were few, if any, facilities for the production of British-type valves.

At that time, it was impracticable to initiate the production of British-type valves—although certain types were produced in quantity later—and compromise became necessary. The requirements for complete electrical interchangeability were modified to include only such basic considerations as power supply voltage, terminal connections and control functions, and on this basis, plus the requirement for physical interchangeability and an agreement that components should conform as closely as possibly to the British pattern, production was able to proceed.

The above factors have been dealt with in some detail, not only to show the difficulties confronting both the Services and industry when initiating Australian production of Service-type telecommunication equipment, but also because they applied in some

Service Reception Sets

Illustrated at left is one of the earliest aircraft receivers placed in operational serv.ce by the RAAF during the recent war. This TRF set was known as the "AR14" and was built by Radio Corporation on the basis of Air Ministry receiver type R.1082.

Slightly out of place on this page, but none the less interesting is the radio tuner/amplifier system, developed by Velco Sound Systems of Melbourne for Service Amenities' use, and shown at right.

At right is shown Reception Set No. 4 which was developed and manufactured by Philips Electrical Industries, Sydney, to meet Army requirements for a general-purpose communications receiver. Capable of AC or battery operation, this set was suitable for mobile or static use and saw extensive service throughout the SWPA.

The canvas-covered receiver shown at right is RAAF type AR10—a simplified portable communications set which was developed by Radio Corporation early during the war and was used extensively for artillery co-operation in the Middle East.

Philips Electrical Industries developed and produced the communications receiver illustrated below for the US Forces. Known as the "R163," this set provided coverage over the range from 540 KC/s. to 22 MC/s.

degree right throughout the war period, whenever local production of overseas equipment was attempted. It is some consolation to know that although the particular problems dealt with were more-or-less peculiar to Australia, similar difficulties were experienced in Canada and the USA when production of British-designed items were attempted. Nor were such problems confined to British designs — American equipment was just as difficult for others to copy—the root reason in all cases being the fundamental differences between the industrial techniques of the various countries.

"Australian-Pattern" Equipment

Although the above problems were largely overcome and reasonably successful production achieved, the Services realised very early in the war that the real answer to the production problem was the introduction of "Australian-Pattern" equipment—apparatus that had the general performance characteristics of overseas items, but was designed to conform as closely as possible with Australian technology.

In this respect, the initiative was largely taken by the RAAF and it will be of interest to quote from an official RAAF statement on the subject:—

"At the outbreak of war with Germany in September 1939, the RAAF was almost entirely dependent upon overseas supplies for the provision of its radio equipment. It had a few Australian ground transmitters of commercial designs and a few communication receivers, but the manufacture of radio equipment for use in RAAF aircraft had not been established. However, it may reasonably be claimed that the RAAF became more independent of overseas design and material, and that at an earlier date, than either of the other Services. Moreover, the work of the RAAF in this direction contributed very materially to the needs of the other Australian Services, as well as to those of British and Allied forces in this and adjacent theatres of war. In this connection it is of interest to note that radio equipment, developed to RAAF specifications, was employed by the RAN, the AMF, the RAF in the Middle East and Far East, the US Navy and Army, the NEI Army and the Free French Forces in the Pacific.

"This achievement is one for which the RAAF signals staff may justly be praised without detracting from credit due to the industry whose wholehearted co-operation, initiative and energy was complementary to the Air Force effort. It resulted from a combination of factors; first, a longsighted appreciation of the fact that, in the event of isolation from overseas supplies, Australian self-sufficiency in radio resources would be a national necessity; and, second, a realistic approach to the practical problems of achieving this self-sufficiency in the quickest possible time using the industrial facilities and techniques already developed for commercial and domestic purposes.

"As to the first of these factors, it is sufficient to say that before the war, early in 1939 in fact, the RAAF had prepared specifications calling for four main items of radio equipment, viz., a communications receiver, a communications transmitter, a complete aircraft transmitting and receiving installation, and a radio compass. The last named was abandoned, but orders were placed for prototype equipments based on the first three specifications and a great deal of work had been done on these equipments before the outbreak of war in September, 1939.

"The second factor, however, was probably the most important in securing quantity production of satisfactory equipment with the minimum of delay. At the outset the RAAF adopted a policy of issuing specifications which were essentially functional, and of assisting the industry to meet these functional requirements by the use of established methods and standard components, rather than the alternative of departmental technical development followed by specification of manufacture to detailed design, or the compromise method of adapting existing Service designs to commercial methods and components. As time went on, the specifications became more exacting; requirements became more specialised; new methods and more rigid standards for components were rendered necessary; entirely new departures such as tropic-proofing were demanded; but the process was a gradual one effected smoothly and without interrupting the steady and increasing flow of essential equipment.

"The RAAF Signals and Radar staffs, now combined under the Director of Telecommunications and Radar, legitimately take pride in the wartime achievements of the Australian radio industry which they did so much to stimulate, and in the harmonious relationships which were maintained through a long period of intense stress and vigorous effort."

Some of the material quoted above is irrelevant to the present discussion, but the statement has been reproduced in its entirety as an indication of the Services' attitude with respect to Australian production of telecommunications equipment. This statement deals primarily with radio apparatus, but it was with radio that the major production troubles were experienced—Radar involved entirely new techniques and it was necessary in any case to make a fresh start, while the production of line and visual signalling equipment, with few exceptions, did not introduce any particular difficulties until much later, when the need for tropic-design and waterproofing became evident.

It should be noted that the term "Australia-Pattern" as used above is not employed in the strict Service sense, where Australian versions of overseas equipments were designated as "A-P" types, but rather is it used to indicate Australian-made and *designed* equipments built to perform similar functions to equipments of overseas origin. An example might assist in clarifying this point.

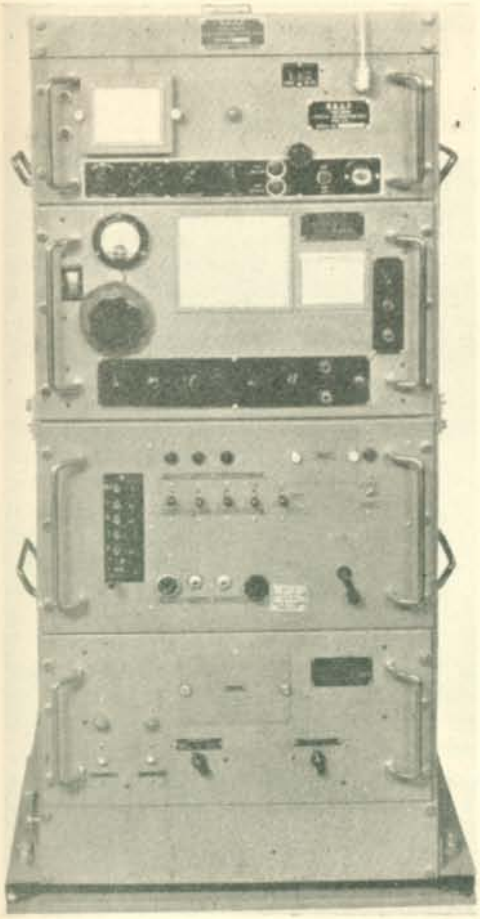
Quite early during the war, Army required a long-range radio transmitter having similar operational functions to those of the British Army WS No. 33. However, insufficient information regarding WS No. 33 was available to permit fabrication of a reasonable facsimile, so a GS Specification was drawn up on the basis of the known performance of the British equipment. This equipment was designated "Wireless Set No. 133", indicating the similarity of its operational significance to that of the "33", but had it been developed on the basis of British design data, it would have been designated "WS No. 33 A.P." or "WS No. 33 (Aust.)".

Both types of equipment—overseas "copies" and wholly-Australian designs—were manufactured in Australia throughout the war years, but after the entry of Japan the tendency was in favour of "Australian pattern" equipment. The reasons for this are not hard to seek—before Pearl Harbour our forces were serving overseas and equipment was produced to meet requirements primarily laid down by the authorities and conditions under which they were serving, whereas after that time, the Australian authorities were probably in a better position than anyone to determine the conditions which had to be satisfied.

The Advent of Tropical Warfare

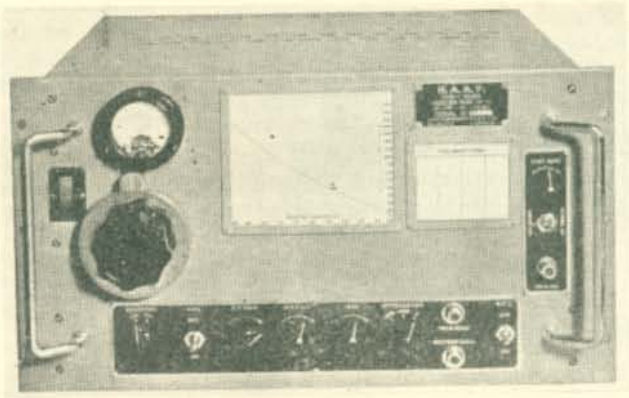
This brings us back to the "trial and error" era of Service design—an era which, in spite of the RAAF's under-statement (see para. 4 of the remarks quoted previously) probably was fraught with more problems, both for the Services and Industry, than any other period during the whole of the war.

Air Force Receivers and D/F



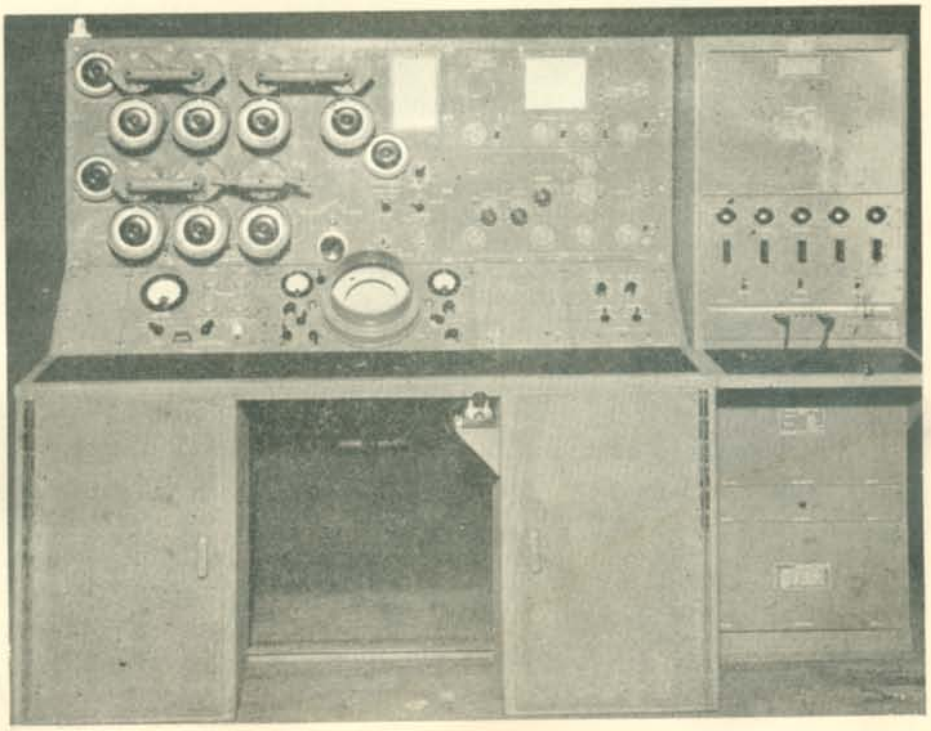
The RAAF type A.12-S assembly shown above is a precision unit developed by Radio Corporation for VHF D/F service. This equipment uses a special crystal calibrator assembly and makes use of the AR17 FM/AM receiver. This equipment was also known as the RC73D.

At right is shown a RAAF type AR7 receiver undergoing its acceptance tests at the factory of Kingsley Radio, Melbourne, where these sets were built. This equipment was the standard RAAF general-purpose and communications receiver and, in a slightly modified form, was used also by Army as Reception Set. No. 1.



The receiver shown at left is the RAAF FM/AM UHF type AR17 which was developed and built by Radio Corporation Pty. Ltd. for operation with the AT17 transmitter on 100-150 MC/s.

Another direction-finding equipment is shown at right—this installation being the cathode-ray indicating equipment type C5352 developed by Amalgamated Wireless for static D/F service with the RAAF.



The automatic distress signalling equipment shown below was produced by AWA for use in lifeboats and rafts. The assembly is sealed and can be thrown into the sea without damage, where it floats until picked up.

During this period, which saw the commencement of fighting in the islands of the SWPA, the whole of the Services' provisioning—equipment, food, clothing—was affected and for a period of many months, it was almost literally a case of "the blind leading the blind". Nobody knew anything—or if they did, they kept very quiet about it—and knowledge based on pre-war experience in the areas was frequently misleading, due to the obvious fundamental differences between peacetime living and fighting what virtually was a guerilla war. Overseas advice was sought but the information forthcoming was meagre and of little value, and for those critical months of 1942, Australia was thrown very much on her own resources.

Although all items of Service equipment and supplies were affected by the conditions, it is doubtful if any were affected more severely than telecommunications apparatus—particularly Radar and radio—due to the critical nature and high standards of insulation resistance of much of this equipment. And of all the Services, it is probable that Army struck the worst of the trouble—the relatively-static and protected nature of most Navy and Air ground stations provided their equipments with conditions far more favourable than those experienced by Army with is foot-slogging jungle patrols and exposed observation posts and artillery installations.

This view is confirmed by the fact that the first known instances of breakdown directly traceable to humid tropical conditions were experienced by Army—the first failure being a Radar installation near Port Moresby, followed by a series of failures of radio transmitters at Milne Bay—while it is a matter of record that the Army authorities were the first to insist on the rigid application of equipment acceptance tests calling for exposure to hot, moist cycles.

In passing, it may be mentioned that this action caused considerable confusion with respect to equipments under development and manufacture and it is a regrettable fact that a degree of adverse criticism was levelled at the responsible Army authorities for their action—the apparent reasoning being that as the other Services had not stated a similar requirement, it was unnecessary! This experience demonstrates once again that the operational commitments of a Service are the ruling factor with respect to its requirements—in this case, Army's commitment introduced factors yet to be experienced by the other Services. They were, later!

In due course, all of the Services fell into line and called for rigid application of an Inter-Service "tropic-testing" specification (CL1001), but this was not until the end of 1943—in the meantime, there was the confused period referred to above, followed by an intervening period during which each of the Services applied its own particular Specification (Navy- K110; Army—RS/PROV/3341; Air—DCD WT/1000). Each of these Specifications, while similar in intent, differed in detail from the others and again led to considerable confusion, both in the Services and with Industry.

By the end of 1942, the picture was becoming a little clearer and correlation of results and observations began to establish a basic pattern for 'tropicalisation"—a term which applies to the treatment of existing equipment rather than to the development of new equipment, which is usually referred to as "tropic design"—and it was possible to ensure a reasonable degree of reliability of equipment in the field, besides being able to nominate interim preventative measures for equipment in store and in advanced stages of manufacture.

The Problems of Tropic Design

The problem of permanent "tropic design" had yet to be solved as it was not fully realised at that time that moisture absorption was the prime cause of many of the troubles experienced, but it is of interest to note that the first step in this direction was taken by Army during December, 1942, when it laid down a specification for WS No. 22 (Aust.) calling for hermetic sealing of the sender/receiver and power supply cases.

Early in 1943, it became evident that a concerted attack must be made on the problem of "tropic design" and, as reported elsewhere in this publication, a Conference of Service and Government representatives was convened by the Council for Scintific & Industrial Research with the object of formulating a plan of action. As a result of this Conference, a Scientific Mission was despatched to New Guinea for the purpose of observing the behaviour of Service equipment (of all types) under operational conditions.

The Report of the Mission was published in October, 1943, and in addition to confirming the necessity for improved design and packaging of all Service equipment, set out some basic facts regarding tropical deterioration which finally established the pattern for further work on "tropic design". The relevant remarks are worthy of quotation:—

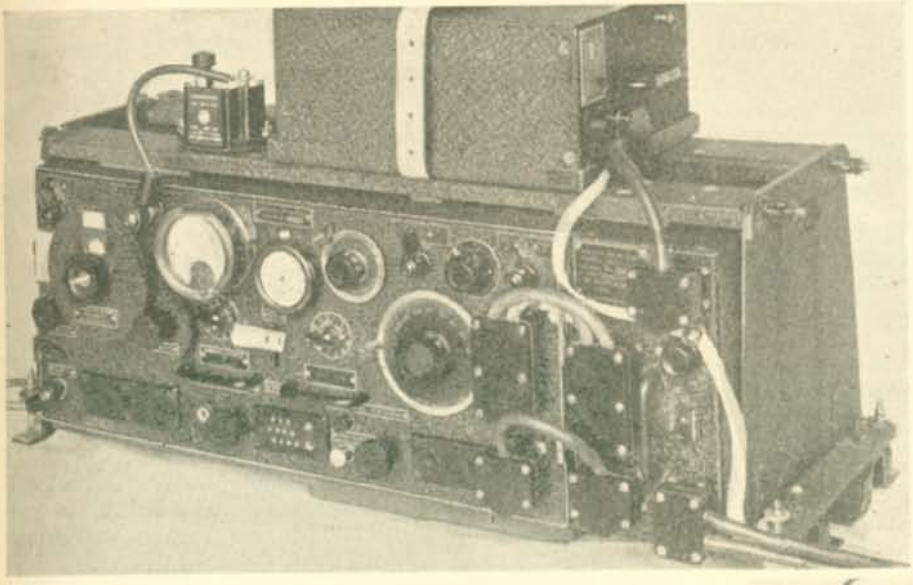
> "The main cause of deterioration of electrical and radio equipment in New Guinea is the effect on moisture on electrical insulation (the word "radio" being used to include both Radar and wireless equipment). The effect of temperature alone is negligible—much higher sun and shade temperatures and more sudden changes of temperature are encountered under desert conditions.
>
> "The deterioration of electrical insulation is manifested in three ways:—
>
> (a) Absorption of moisture on the surface of the insulator, causing insulation leakage, warping or deformation of the insulating material, or change in the electrical constants of circuits using the insulation as a dielectric.
>
> (b) Adsorption of moisture on the surface of the insulator, causing surface leakage.
>
> (c) Penetration of the moisture through crevices or pinholes in the insulation, causing internal leakage or change in the electrical constants of circuits, due to the admixture of moisture with the dielectric."

The Report went on to elaborate these points and also dealt with the matter of fungus growth, which had been regarded by many investigators as almost "No. 1 enemy". While not belittling the importance of fungus as an agent of deterioration, the Report pointed out that as long as materials were carefully selected, fungus would not grow on clean, dry surfaces, so that its prevention was largely a matter of preventing the ingress of moisture.

With this Report as a basis, work on "tropic-design" went on apace as, in addition to securing better co-operation on the part of all concerned, the work of the Mission was carried on by a number of Inter-Service Committees and other agencies. This work was co-ordinated by the Council for Scientific & Industrial Research, largely through its Scientific Liaison Bureau, and we are indebted to the Council for a summary of its activities, which follows:—

> "In 1943, CSIR undertook responsibility for laboratory investigations of the deterioration and preservation of

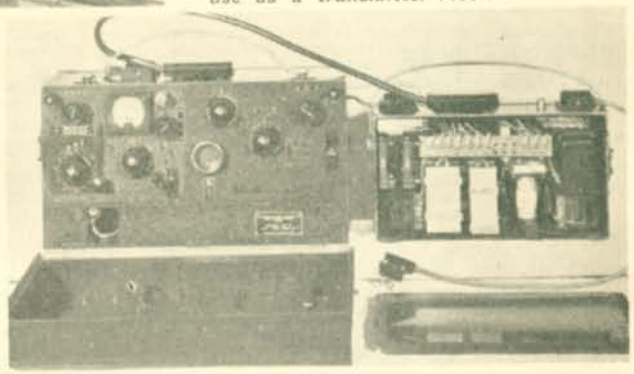
Field Equipment for the A.I.F.



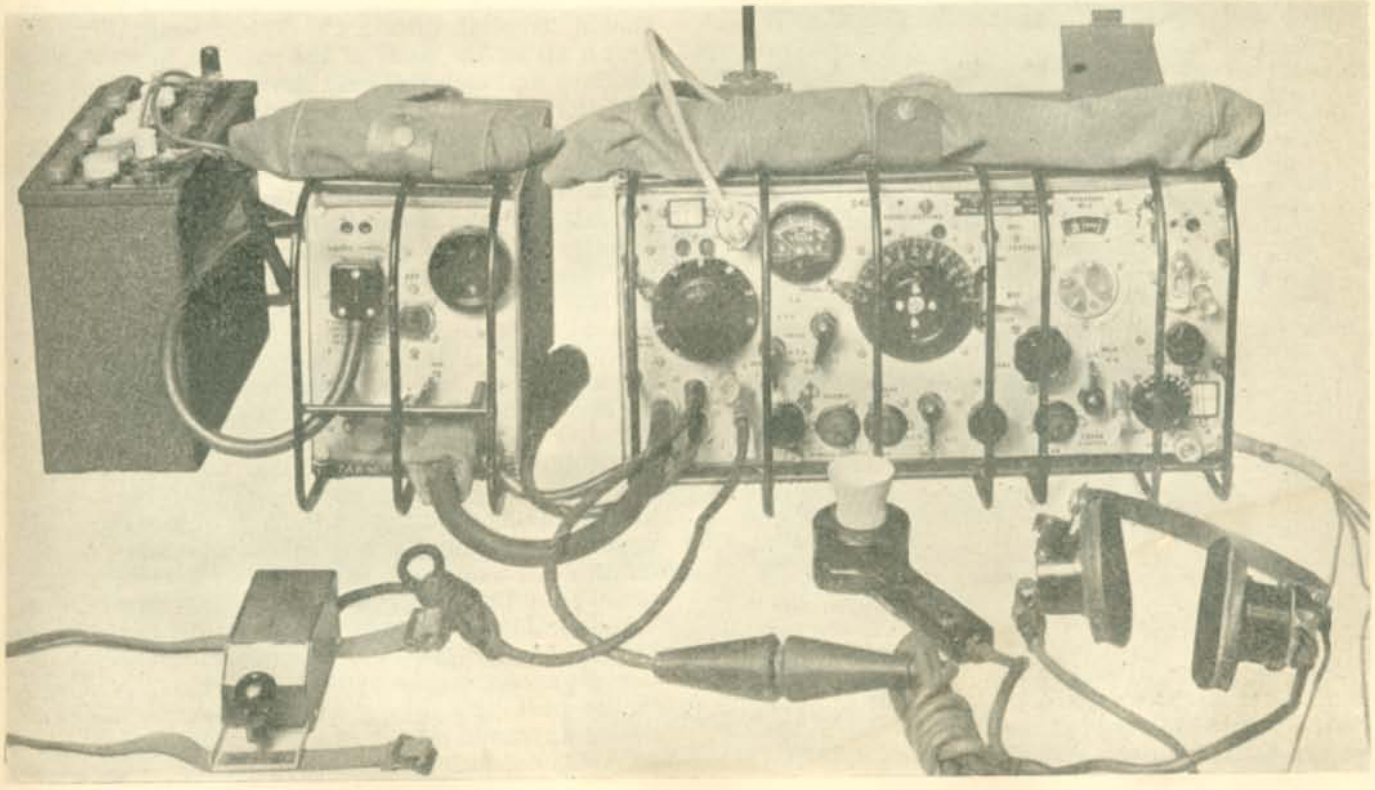
Although not of Australian origin, the American SCR536 "handy-talky" shown above was so widely used by Australian forces that it merits a place in this publication. This set was a complete transmitter-receiver and weighed barely 5lbs.

Illustrated below is the "original" Australian-made Army wireless set — the "101." This set was developed and built by AWA and was exported in quantity to the AIF in the Middle East for field use as a transmitter-receiver.

Superseding the "101" was the No. 11 set illustrated above. This was developed by AWA on the basis of the British Army No. 11 set and was manufactured in large quantities during the first half of the war. Excellent performance was achieved, but the set was not of "tropical" design.



Army's latest solution of its requirement for a general-purpose field wireless set is shown below in the form of the Astor-built Wireless Set No. 22 (Aust.). This equipment is fully "tropic-designed" and waterproofed to permit its use in amphibious operations. An important feature of the assembly is its light weight—the complete station as illustrated weighs less than 90lbs. and is designed to split into three "man-pack" loads.



telecommunication and electrical equipment intended for service under humid tropical conditions. The Division of Electrotechnology in the Council's National Standards Laboratory was chosen to undertake the main investigations and to co-ordinate the work of the other laboratories of the Commonwealth and the industry which assisted in the program. The Materials Testing Laboratory of Amalgamated Wireless (Australasia) Limited had commenced its own program many months before this, and freely provided very great assistance in those critical times to the Services and to the Commonwealth.

"Throughout the remainder of the war, the laboratories engaged in "tropic design" or "tropicalisation" investigations concentrated upon the problem of moisture in relation to materials and components used in telecommunication equipment. Attention was also given to the effects of exposure to extremes of temperature and thermal shock. A considerable part of the program was devoted to the development of testing methods of testing equipment. This was necessary for research into the behavior of materials and for the qualification and production testing of components and complete equipments. The results of these investigations may now be briefly summarised.

"It is found that measures which provide adequate protection from moisture (by the choice of suitable materials and moisture-resistant finishes) also provide automatically satisfactory protection from mould attack. The application of moisture-resistant finishes (varnishes, wax and bituminous compounds) to materials subject to deterioration, delays but cannot prevent the progressive reduction of performance due to the ingress of moisture. It is therefore essential that, as far as possible, materials which are inherently resistant to deterioration on exposure to moisture should be chosen.

"For complete protection, in general, the only satisfactory solution is hermetic sealing in metal, glass or ceramic cases. Joints between the metal and metallised glass or ceramic parts may be soldered. Otherwise, and particularly for parts which must be opened periodically for maintenance, joints may be effectively sealed by gaskets or glands of synthetic rubber. There are considerable practical difficulties in the general application of hermetic sealing, such as provision for the dissipation of heat and the prevention of leakages of moisture through gaskets and glands. However, this type of construction, with the enclosure of a capsule of a dessicant such as silica gel, is undoubtedly one of the best methods of design for tropical service.

"The deterioration of performance in humid atmospheres of glass and higher-grade ceramics is due mainly to the formation of surface films of moisture, which are relatively highly conductive compared with the base material. A considerable amount of research has been undertaken in the "anti-wetting" treatment of the surfaces of these non-absorbent materials with surface active amines, which has resulted in an improvement of one hundred to one thousand-fold in the insulation resistance. Organosilicon compounds, developed in USA and Great Britain, may provide even better results.

"Research in testing methods and testing equipment for examining the effects upon materials of atmospheres of high relative humidity led to the conclusion that the relative humidity in the test chamber must be maintained within close limits, such as 96% $\pm$ 2% R.H. This is necessary throughout periods of heating, cooling and fixed temperature, and during electrical measurements when the conditions maintained should be similar to those encountered under operating conditions in the field (such as 90% to 95%). A sensitive automatic means of maintaining this control by electronic apparatus has been developed and is regarded as a major advance in humidity testing technique.

"The results of the accumulated information and experience in this field will now be applicable to the peacetime requirements of equipment not only for the Services but for civilian use in humid climates, or in places such as Sydney and Melbourne, where high relative humidities are encountered during some periods of the year."

This summary of work done in the "tropic-design" field is somewhat out of chronological order in that it covers activities right through the period from 1943 on, and before concluding this article it is desirable to make further brief reference to the purely Service aspects of the 1943-45 period.

Services' Standardisation Activities

Following on what we termed the "trial and error" era of Service design which concluded with the organisation of Inter-Service investigations of tropic-design matters, Service production settled down on a fairly even keel—the major difficulty being the ability of Industry to produce the quantities of equipment required. This position was complicated by the now-universal demands, both by our Services and the Americans, for either tropicalisation or tropic-design of all equipment.

The Production Directorates of the Ministry of Munitions were now well in their stride and were giving material assistance in many respects, particularly with respect to the assessment of industrial capacity and ensuring a flow of raw materials, but the demands for equipment kept growing. Considerable confusion again was introduced, and the establishment of priorities became an almost-impossible task.

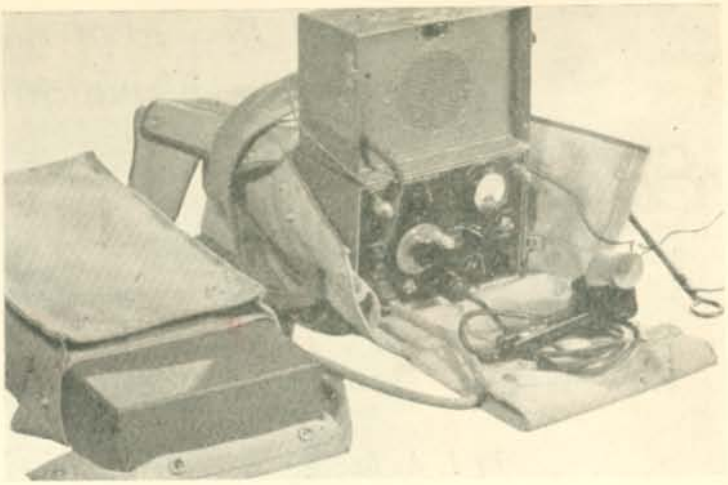
A survey of Services' equipment in production at this time indicated a considerable amount of near-duplication and, in July, 1943, before the Scientific Mission had completed its work, General Headquarters, SWPA, convened the Equipment Standardisation Committee which has been referred to elsewhere in this publication, with the primary object of eliminating near-duplicate production either at that time, or in the future. A secondary object, which later became one of the major functions of the Committee, was to standardise Services' equipment acceptance tests.

This second phase of the Committee's activities commenced as soon as the simplification of equipment schedules had been initiated, and in December, 1943, the Committee published its first testing Specification—the previously-mentioned "CL1001", entitled "The General Requirements Applicable to Telecommunications and Associated Apparatus for Use in Humid Tropical Climates." This Specification was drawn up on the basis of the existing Service specifications and took full cognisance of local technology and the latest information from overseas. It would be idle to pretend that, in spite of all this, no objections were raised to CL1001—there were, but at least it was a combined Services specification (instead of several), and was a step in the right direction.

Following on the publication of CL1001, the Committee went right ahead with its standardisation activities, working closely in liaison with the Standards Assocation of Australia, and produced or adopted for Service use a number of Specifications covering materials and components—as at the cessation of hostilities, no less than 27 major specifications had been published or were in an advanced stage of preparation.

The effect of this work, together with that of CSIR and the ever-growing appreciation of Service requirements by Industry made for a very efficient set-up during the closing year of the war and relations on all sides were most harmonious. A carping critic might raise the point that it took a long time to reach this desirable state of affairs, but against that it must be realised that the "home-front" battle of production did not commence until 1942 and that it was early in the next year before conditions were such as to permit anyone to take stock of the situation—so, maybe it was *not* such a long time, after all.

Portable Transmitter-Receivers



The compact assembly shown above is the Astor ATR4, developed from a Forestry Commission set for use by RAAF air-liaison parties. This equipment was slightly modified and adopted by Army as Wireless Set No. 113A, in which version it performed sovereign service during the Timor operations.

Developed for jungle warfare as a result of experience with the 108 Mk II and the 208, the Army 108 Mk III shown below was built by Radio Corporation and saw extensive service throughout the SWPA. This equipment, like the others on this page, was completely battery-operated and designed for "man-pack" operation.

On this page are shown four patrol sets built by Radio Corporation Pty. Ltd. ("Astor") for infantry, "commando" and air liaison service. Above is shown the Army 108 Mark II which was developed from the British No. 18 set and saw service in the Middle East, while below we see the lightweight No. 208 set which was extensively used by Army "commando" troops in the New Guinea campaign — both sets are transmitter-receivers.

A Review of the Operational Use of Australian Telecommunication's Equipment in the SWPA

Equipment At Action Stations

*by J. A. Angus**

To recount the multitude of individual uses to which Australian made tele-communications equipment was put and the job it did in the field for the Australian Navy, Army and Air Force in the Pacific Area, would be to tell, piece by piece and action by action, every campaign in which Australian Forces—and in many instances the U.S. Forces—were engaged.

The story of the uses of Australian Military equipment illustrates the vital nature and the magnitude of the task of the Australian telecommunications industry in producing that equipment, and it tells to some degree of the signals job that our Navy, Army and Air Force personnel accomplished, but no attempt is made here to describe the full structure of the signals organisation of the individual services or every campaign they conducted—that is a task too immense for a publication of this nature.

This article tells directly of what could be seen and learned of the uses, operation and requirements of Australian telecommunications equipment under operational conditions during a ten weeks' tour of the SWPA—living with the men who operated the equipment and seeing at first hand the functions it performed.

RAAF Northern Command

The first place visited after leaving Australia was Madang on the north coast of New Guinea. It was a typical New Guinea coast setting with plenty of coral, palm trees, blazing heat and rain. At Madang was located the headquarters of the RAAF Northern Command—a headquarters operating and controlling one of those areas into which RAAF operations in the South West Pacific was divided.

Other task units were; North-Eastern Area with headquarters at Townsville; North Western Area at Darwin; 11 Group at Morotai and 1st Tactical Air Force at Labuan. The headquarters in each area operated independently, under RAAF Command for operational control and under RAAF HQ. for administration and supply.

Northern Command (Norcom) was formed in April, 1944, with its administration section at Nadzab and the operations section at Milne Bay, which moved to Madang in August, 1944. Later in September the administration section also moved to Madang which then became the main centre of communications in the Norcom area.

The Chief Signals Officer of RAAF Northern Command, Wing Commander Charles Beurle, had a HQ Staff of about 12 officers and three other ranks including his assistant C.S.O. Signals, S/Ldr. Bill Roby, and assistant C.S.O. Radar, S/Ldr. George Rann, and was responsible for the positioning and efficient working of all RAAF telecommunication facilities within the area. This included point-to-point communications, wireless aids to navigation and radar facilities. In effect, the C.S.O. controlled all signals units or signals sections of units, squadrons, etc., within Norcom.

The Norcom Telecommunications Unit under Commanding Officer S/Ldr. Dick Walker, operated the

* This article is written by RETAILER'S editor, J. A. Angus, as a result of his experiences as an Accredited War Correspondent in the Pacific area.

During the early part of 1945 it was decided by this business publishing company that some serious effort should be made to record the achievements of Australia's Telecommunication Industry during the war and to what effect the products of industry were used. Approaches were made to the Navy, Army and Air Force seeking their co-operation in obtaining details of the use of Australian-made equipment in the field, and subsequently a War Correspondent's accreditation was issued to Jack Angus under sponsorship of the RAAF and with the co-operation of the Navy. It was under this arrangement that he commenced his tour of the SWPA, and it was not until shortly before he was scheduled to return to Australia that Army co-operation was forthcoming and access to Army equipments permitted.

Consequently, because of the limited amount of time he was able to spend with the Army, the activities of that Service are not mentioned in all places. This does not necessarily detract from the effectiveness of the story because the Army does not require the diversity of types of telecommunications equipment for forward operational use such as used by the RAAF. The signals equipment of each Army Division is virtually duplicated and in covering, at Borneo, the 9th Div. and at Morotai the Adv. LHQ signals set-ups, it is felt that from an equipment point of view a fairly complete picture has been obtained.

Our thanks are extended to the Services for their co-operation and assistance given our War Correspondent, particularly to the RAAF who provided all transport facilities and whose initial action made the visit to the operational areas possible.

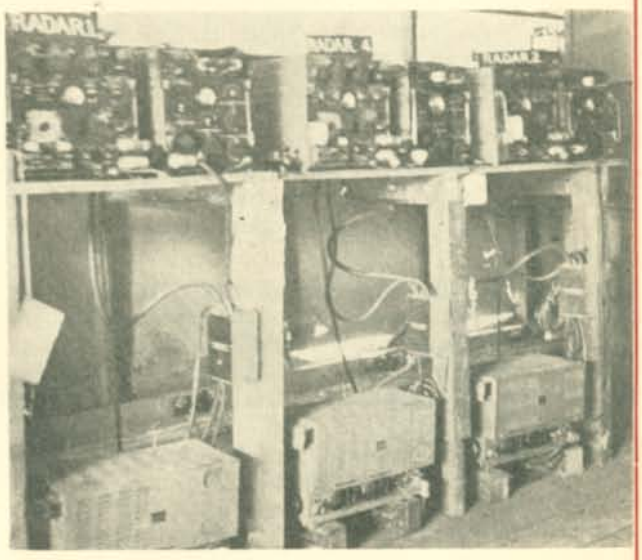
O. F. MINGAY, Managing Editor.

A bank of AR7 receivers, made by Kingsley Radio, at the Telecom Unit receiving station at Madang can be seen at left. Call-signs and locations of some of the stations being worked can be identified on the picture. There were about 27 of these receivers in use in this signals office.

Madang signals office, transmitting station and power plant. The signals office which was located among the HQ administrative buildings was the nerve centre of communications housing the receivers and telegraphists, the teleprinters, telephone switchboard, and the cypher staff, as well as providing message distribution facilities.

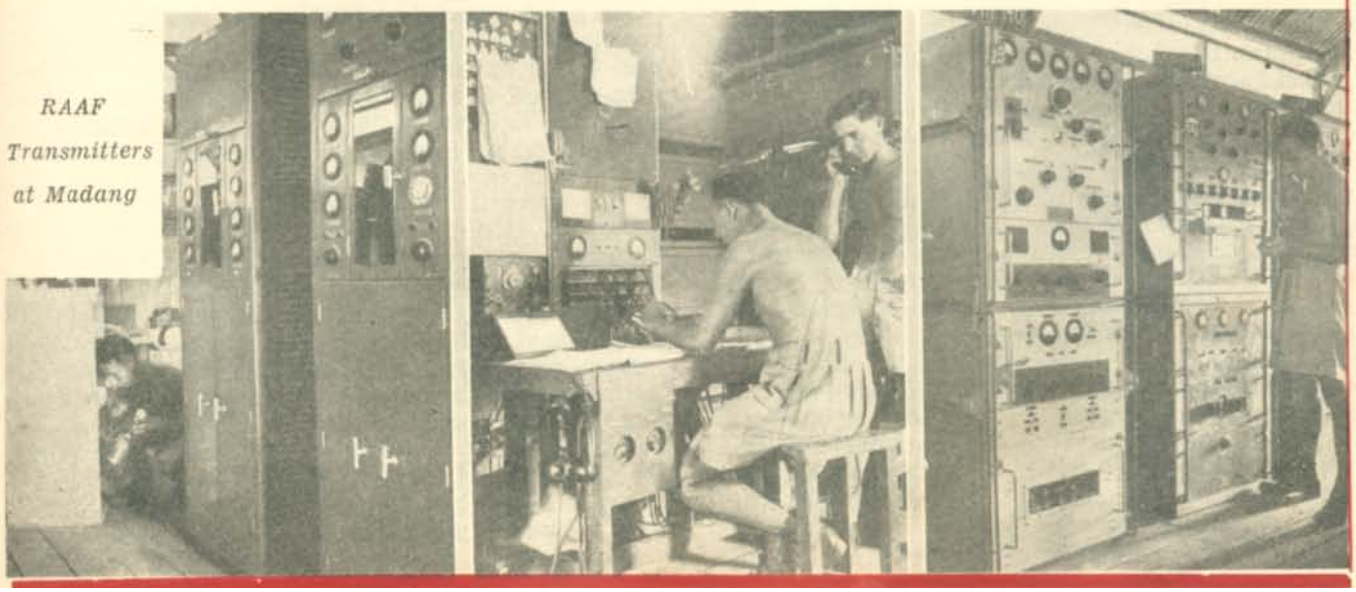
The receivers used were all Kingsley AR7's—about 27 in all which, in maintaining a 24-hours service, required a staff of 76 telegraphists, and 24 signals clerks. In addition there were four telephone operators and three teleprinter operators. The teleprinter circuit was linked between the Sig. office, the airstrip and the Air Defence Headquarters (ADHQ). This sig. office handled an average of three million groups per month received, which of course does not include the messages sent out. All "out" messages were keyed by the telegraphists at the Signals Office, where remote control facilities were provided for the transmitters located in a central transmitting station some mile or so away.

The keying lines between the sig. office and the transmitter were usually type D8 cable and required fairly constant maintenance. In addition to the fact that the cable had often to be tied around trees, the moisture and heat ruined the insulation so that in wet



The photograph above and those below show various equipments at the RAAF Telecom Unit transmitting station at Madang. Above are three AT5 transmitters, made by AWA, with line relays for each mounted on the floor beneath each transmitter. Below, from left to right, are: 1. Two AT14S HF transmitters (made by AWA). At the left of the picture one of the station personnel is removing an STC transmitting valve from its packing case. 2. The 50 line patch panel through which all lines feeding into the transmitters are controlled; and 3. An AT17 VHF transmitter, made by Thom & Smith (left) and an AT20 (STC).

RAAF Transmitters at Madang



weather dead shorts often occurred. The cable had a maximum useable life, under these conditions, of about eight months. Under more permanent conditions, it was possible to overcome most of these troubles by the use of properly erected HDC lines and, in some cases, armoured underground cables.

The transmitting station surrounded by its aerial arrays stood on its own in a clearing in the jungle about a half a mile off the road which lead from the air strip to the main R.A.A.F. and Army camp areas. It was a building of some 30 feet by 70 feet made of bush timber with an iron roof and with Sisalkraft waterproof paper for walls, but it contained almost 40 modern radio transmitters including 20 AT20's (STC and Eclipse), three AT14's, one AT14A (Tasma), eight AT5's (AWA), two AT17's one AT15 (Tasma), and three AT21's (AWA). These transmitters provided a total frequency coverage over the ranges 150-500 kC/s., 2-20 Mc/s. and 100-150 Mc/s.

Keying lines came in to these transmitters from the sig. office carrying all general signals for as far north as Morotai and direct to Melbourne; from ADHO carrying traffic for operational sorties and communications to all radar stations; from 42 OBU (the local Operational Base Unit) for Aeradio, a term which is applied to the system for ground-to-air and air-to-ground communications operating on either CW or voice.

For the Aeradio circuit either an AT14 or AT14A was used; AT20's were used for the direct Melbourne circuit; AT21's or AT5's were used to radar stations, while for an air-sea rescue watch operating from the sig. office to water craft and Catalina flying boats an AT20 was also used. The system of Aeradio communications conformed with civil practice although all stations in New Guinea were operated by the RAAF. The Aeradio stations were divided into two nets: 1. Moresby, Milne Bay, Dobadura, Torokina, Jaquinot Bay and Lae; 2. Lae (as connecting station), Madang, Momote, Tadji, Hollandia, Biak, Middleburg, Morotai, Labuan, Tarakan and Balikpapan.

Fl./Sgt. Jim Crowe, who in pre-war days was engaged in free-lance radio and electrical work and associated with an amateur station at Gladstone, Queensland, was in charge of the transmitting station staff of 12 wireless mechanics and three electrical mechanics. This staff, in addition to standing watch in the transmitting station carried out the task of maintaining the transmiters, all of which were pulled down and completely overhauled at least once a month when all components, valves, wiring, etc., were checked and tested.

In order to keep the equipments as dry as possible and inhibit fungus growth the valve filaments of the transmitters were kept heated at all times. If a transmitter was left idle for more than a few days moisture absorption would provide an excellent breeding ground for fungus, resulting in serious deterioration—the safety margin for an idle equipment being under a week. This was by no means the only effect of local tropical conditions. The transmitters had to be cleaned of spider webs anything up to ten times a day and particularly during the rainy season, myriad insects invaded every possible corner of the transmitters, made contact across terminals and caused arching. The aerial feeder lines from the transmitting hut to the aerials were strung about six feet from the ground but the area around them had to be frequently cleared—it would take only six weeks for the undergrowth and kunai to envelope the lines at that height. In addition, difficulty was experienced with the aerial arrays—they were mainly Delta matched systems designed for use on one frequency. The difficulty arose due to the necessity for much frequency changing, on most occasions without time to pull down and re-cut the aerials, with the result that the aerials had to be juggled and used as best as possible—regarding 30 per cent. as maximum tolerance.

The fact that most of the transmitting station personnel had never seen a radio transmitter before enlisting and had been sent straight from Air Force training schools to Madang, yet were able to keep the station on the air and functioning efficiently under those conditions, speaks well for the thoroughness of the R.A.A.F. system of training.

The power supply for the transmitting station, signals office and the Norcom HQ camp was provided by four Ford V8-driven 25 kVA generators supplying a standard three phase 415 volt supply. The power plant equipment with the exception of Ford motors was made by Hodson & Gault of Melbourne and by Westinghouse. The average drain was 15 kVA day-time and 65-70 kVA at night.

Madang ADHQ

One of the most interesting RAAF units at Madang, from a general point of view, was the Air Defence Headquarters. The ADHQ was linked with all radar stations and Fighter Director Posts (FDP) in its area and with other ADHQ's. It was the point of identification of all aircraft in the air, and was kept advised of all aircraft movements and provided a cross check on friendly aircraft if their IFF was not operating.

IFF is an abbreviation for Identification Friend or Foe. All Allied aircraft were fitted with IFF equipment—a small continuously-operated transmitter which sent out a coded signal when "triggered" by a search pulse from the corresponding ground equipment. By this means, all aircraft with this equipment could be readily identified when they came within the field of radar search. By changing the code and frequency of the IFF transmitters it was possible throughout the war to avoid confusion in the identification of friendly or enemy aircraft.

The nerve centre of an ADHQ set-up was the plotting room. Usually a large room containing a table in the centre and on which was a large scale map of the area marked off in sections. All radar stations in the area were in direct radio communication with ADHQ for advising aircraft plots, and all aircraft operating in the area reported their movements to ADHQ and as this information was received a team of "plotters," always in attendance at the plotting table, placed markers representing the aircraft, in position on the map. The markers were indexed to show the number, size, direction, speed and identity of all individual or groups of aircraft in the air.

The markers were continuously moved over the map, tracing the movements of the aircraft, so that at all times the "controller" (the officer in charge) who was usually seated at a desk elevated above the level of the plotting table could see a complete and accurate picture of the position, etc., of all aircraft in his area. The "controller" was also in direct telephone communication with the Fighter Squadron based on the

The receiving installation comprising 16 AR7 Kingsley receivers at the ADHQ, Madang. Signals from the receivers are fed through the rack in the centre, to the headphone positions.

The hut at right was used by the RIMU for re-equipping of Radar stations.

local airstrip and in radio contact with other Fighter Director Posts within his area of defence (in the case of Madang there were three), and aircraft also with ADHQ's in adjoining areas.

From his desk the "controller" could direct movements of all aircraft in his area, set courses for fighter aircraft to intercept enemy planes that had been located, and divert bombers from danger areas.

The radio receiving room at Madang ADHQ. used up to 16 Kingsley AR7 receivers, receiving information from radar stations, FDP's (Fighter Director Posts) and ADHQ's. In addition, BC624A VHF receivers were located in the plotting room receiving R/T communications from aircraft.

The transmitters were all located in the Telecom transmitting station and the keying lines all fed to there from ADHQ. For contact with radar stations AWA AT5 transmitters were used while 500-watt transmitters (either AT20's or AT136) were utilised for contact with FDP's and ADHQ's.

Within the Norcom area there were 17 radar stations, eight of which reported into ADHQ Madang, five to another ADHQ establishment at Moresby and four to the 112 MFCU at Torikina—a Mobile Fighter Control Unit which is virtually a small edition of an ADHQ with a mobile, rather than a permanent structure.

A Typical Setup

The set-up and the equipments used by the ADHQ at Madang can, in general terms be taken as typical of all RAAF ADHQ's in the Pacific—some were larger, some smaller—and in a number of cases the transmitters occupied a separate ADHQ transmitting station, but their functions were the same.

Aerodrome Control

The control tower on the Madang airstrip housed MF, HF, VHF equipment for aerodrome control. This equipment comprised an AT5/AR8 AWA transmitter-receiver, a Radio Corp. ATR2B transmitter-receiver used for contact with crash boats, Sunderlands, Catalinas and Mariners and a U.S. made VHF transmitter type SCR522/TR5043.

An MF homing beacon utilising an AT15A (Tasma) transmitter operating on 525 kc/s. was also located at the strip. The function of a "homer" is to send out continuous signals which, when received by aircraft in the air, can be used to indicate whether the aircraft is headed on course to the aerodrome. The transmitter was controlled from the strip operations room and half-hourly weather reports were also transmitted on the homing beacon.

3RIMU

Located on a small island in Madang Harbour was RAAF No. 3 Radio Installation and Maintenance Unit, generally referred to as 3 RIMU. As its name implies, this unit was responsible for the installation and repair of all signals and radar equipment in the Norcom area. In addition to a machine shop and separate workshops for radar and signals equipment the Unit carried a large stock of parts and complete equipments and, in fact, was equipped to carry out all types of repairs to any signals or radar gear.

In addition to the workshop the radar section utilised a palm-roofed "boong" (native) hut as a separate unit for refitting complete radar stations. Such refitting included not only the radar gear, but tents, transport, etc., so that it could be delivered and installed as a complete station ready for operation with accommodation and facilities for the radar station crew. This was a very necessary factor, as radar stations were mostly located miles—or even hundreds of miles—away from other units and perforce had to be self-contained in every respect.

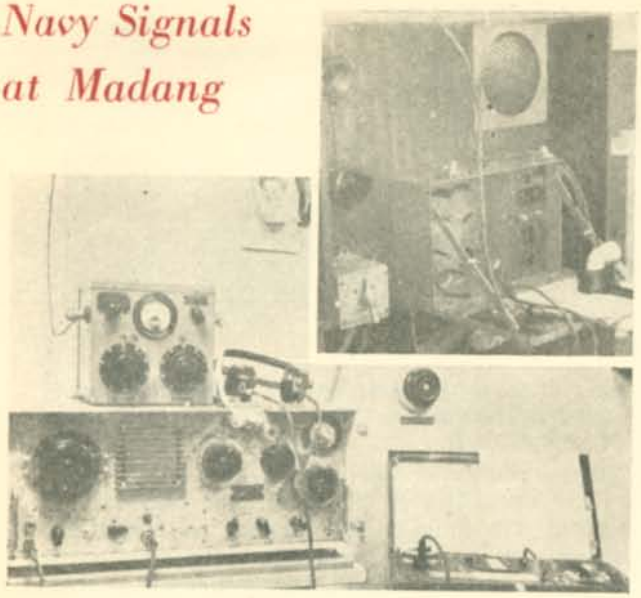
The technical personnel required to handle the work at the RIMU totalled, in addition to officers, 24 mechanics in the radar section and 40 mechanics in the signals section. There were also three complete installation parties working in the field.

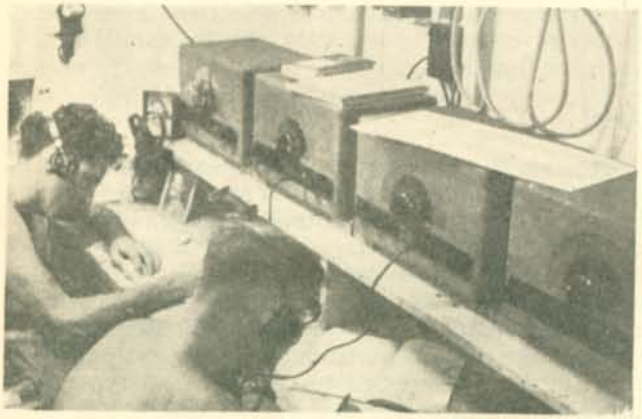
The functions and equipment, etc., of an RIMU will be treated more fully in a later section of this article but before leaving the Madang RIMU it is interesting to note, as an example of the resourcefulness and enterprise apparent throughout the Services, that in the machine shop, a Japanese lathe which had been found and repaired was working alongside an Australian made "Mars" Junior, and the rest of the machine shop equipment.

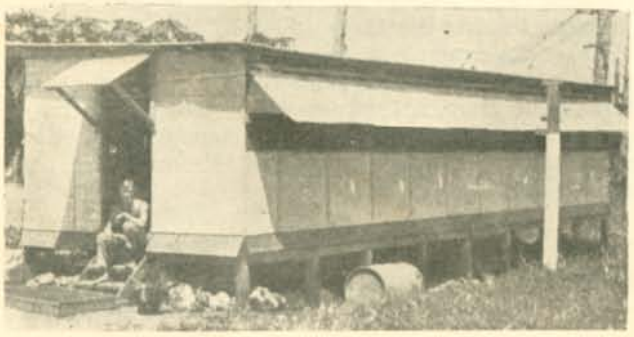
Navy at Madang

At Madang was also located the headquarters of the Naval Officer in Charge of the area. The signals

Navy Signals at Madang







section of the NOIC establishment handled all signals traffic from the area to Canberra and to NOIC Moluccas at Morotai. It also acted as an alternative route for traffic from Morotai to Canberra which normally went via Darwin, and in addition operated the "New Guinea Intercept" which was the term applied to the method of communicating with ships at sea.

Messages for ships broadcast from Madang were picked up and re-broadcast by the NOIC Station at Morotai. This re-broadcasting was additional to the normal Naval service from the high-power Navy station at Belconnen, near Canberra, and was done to ensure that all ships had every opportunity of receiving the messages sent, because during the greater part of the time that ships were at sea it was necessary for them to maintain radio silence and therefore were not able to acknowledge messages.

Communications were also maintained with all Port Directorates (PD's) in the NOIC Madang area. These PD's were located at Wewak, Hollandia, Biak, Finschafen, Lae, Oro Bay, Milne Bay, Jacquinot Bay, and Torokina. The functions of the PD's which operated as staging points for shipping were based mainly on communications. They gave instructions to all ships regarding routes to be followed, minefields to be avoided, etc., and advised arrival and departure times to NOIC.

The NOIC headquarters occupied the pre-war Madang hospital on Bode point. The building had been fairly extensively holed by straffing and was presumed to have previously been used as headquarters by the Japanese. The transmitting and receiving stations, however, were set up on Beliau Island in Madang harbour.

The NOIC W/T station had been originally established at Milne Bay but was transferred to Madang in July, 1944. Beliau Island at that time was covered with seven feet kunai and littered with coconut fronds that had been felled by gunfire. Out of this, clearings were hewn for the transmitting station, and about a quarter of a mile away for the 20′ x 60′ receiving hut. The island, too, had to be cleared of foxholes, Jap bodies, and unexploded 12-pounder and mortar shells before it became properly habitable.

Lieut. John Tucker was the Navy Staff Officer Communications and his Assistant SOC, Lieut. Jack Dunn, was in charge of codes and cyphers with a staff of about 65 coders and signalmen.

The receiving station staff under Warrant Telegraphist "Duff" Herman totalled about 60 and handled an average of about 18 thousand messages per month, each message averaging about 50 groups. This traffic reached a peak of 43 thousand groups per day. The receiving equipment comprised ten A679H (STC) receivers which terminated two circuits from Belconnon (Canberra); two from all PD's, which were divided into two nets; one from NOIC Moluccas; one for Port Wave (Harbour communications); one for the Admiralty Ship to Shore channel; one for Hollandia; one

Reading from top to bottom the pictures on this page show:—The remote control equipment on the bridge of the HMAS Diamantina controlling an RC8 transmitter-receiver, made by Radio Corporation, which was located in the ship's wireless room. This RC8 can be seen in the next picture alongside an AWA-made type R7647 wavemeter. The third picture shows the line of receivers on the "Diamantina." They are, from left to right, the 1C6940, 2C6940, C6940 and 2C6940 receivers made by AWA. The next picture shows one of a bank of STC type A679J receivers at the N.O.I.C. Madang receiving station, whilst the last photograph gives a general view of the Navy transmitting station at Madang.

for New Guinea Intercept which also covered Morotai to Darwin traffic, and one on Bells Fox, the Navy designation for Belconnon transmissions to all ships.

The transmitting station had a staff of four watchkeepers and five mechanics under the control of PO Wireless Mechanic George Ryan and was equipped with five AT13, one AT13B, (AWA), three AT20's (STC), one SVC100/101 (Philips) and a Teleradio 3B which was used for monitoring their own transmissions. All transmitters were interchangeable on to any circuit with the exception of the SVC100/101 which was always kept on the Port Wave and Ship to Shore frequencies. A triangular aerial array on 50 ft. masts was used. The station had its own power supply of three 13 kVA Diesel generators and two Ford-driven 5 kVA's and also its own workshop with five wireless mechanics under PO Ted Barnes.

HMAS Diamantina

Whilst at Madang I was also able to spend a day aboard the Australian frigate HMAS Diamantina. The ship's signals personnel, under the Signals (and Navigation) Officer, Lieut. Bill Reid and PO Crawford Young, totalled four telegraphists and two coders. Crawford Young, an electrician by trade, operated amateur station VK6CY before the war.

The main bank of receivers in the radio room were made by AWA and comprised two 2C6940's for HF reception, one 1C6940 for the MF Port Wave and the international distress wave and one C6940 for LF reception.

The ship's main transmitter was an AWA 21/22J 5385 and there was also an RC8 (Astor) transmitter-receiver which was used for Port Wave and also for working with aircraft spotters and Army observation posts. The RC8 transmitter-receiver could be operated by remote control from the Bridge. An AT5/AR8 (AWA) was kept as an emergency outfit, completely self-contained with its own battery power supply, and was installed aft away from the wireless room. A Philips' PA equipment was also installed to provide sound reproduction to all parts of the ship.

RAAF Radar-Momote

From Madang a visit was paid to Momote in the Admiralty Islands. There the RAAF had an FDP (114 Fighter Control Unit), two AW (air warning) radar stations, one GCI (Ground Control Intercept) radar station and a J28 (CSIR) ionospheric recording station. The purpose of the ionospheric recording station was to measure fluctuations and conditions of the ionospheric layer so that this information together with that supplied from other recording stations could be used by the RAAF in predicting ionospheric activity enabling a proper choice of frequencies for various times, to be made.

The two AW Radar stations (337 and 347) arrived at Momote on March 9, 1944 with the first convoy of US Forces and landed in Seeadler Harbour. Both were fully operational within a week of landing. Fl./Lieut. Jim Hatty, who landed with the stations, was still in charge of 347 but was expecting to be relieved when I met him.

Radar 337 was first installed on top of a Jap foxhole but after a time the foxhole collapsed and the station was reinstalled alongside. It was about 14 feet above sea level and close to the shore. The radar equipment of this station was the HMV made AWJ23A receiver and the AWJ23B transmitter with modulator together with a US made BL4 interrogator for identification of IFF. This equipment gave an average range of 70 to 80 miles, depending of course, on the height of the aircraft.

The station had a direct telephone line to the FDP at Momote and maintained communication direct with ADHQ Madang with an AT5/AR8 (AWA). Two Airzone-made homing beacons were also installed which operated alternate 24-hour shifts. Power was supplied by two Ford 10 driven 5 kVA generators. OC of the station was P/O Bruce Burgess who had eight radar operators, four telegraphists and two radar mechanics, together with guards, driver, cook, medical orderly, etc. The crew lived in a "boong" hut and tent camp about 300 yards away from the station.

At 153 Radar, the mobile GCI station, F/O Bill Wellstead was in charge of his crew of about 30. The station used British equipment (transmitter type T3079 and receiver type R3202/A) which was mounted on trucks—one for the transmitter, one for the receiver and one orderly room truck, whilst three trailers carried the aerial array and two diesel-driven 25 kVA generators.

After returning to Madang the next stopping place was Biak in Dutch New Guinea. The route from Madang to Biak took me over Wewak and Aitape to Hollandia, where a stop was made before proceeding to Biak.

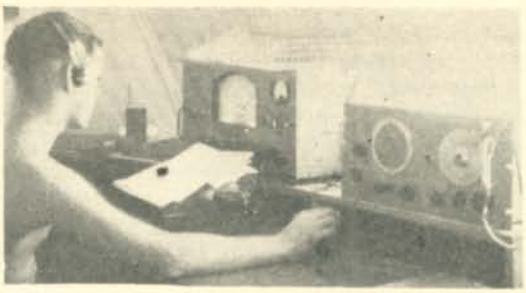
Navy Port Directorate—Biak

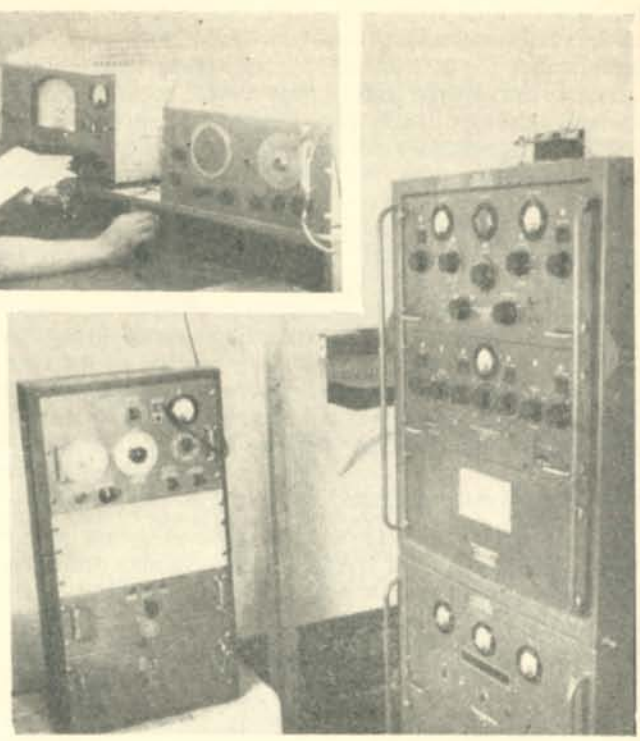
The principal functions of a Navy Port Directorate are to give instructions to all shipping, including Merchant Marine, as to their routes, advise departure and arrival times to the NOIC (in this case to Madang) and act as a staging point for shipping.

The signals officer at Biak PD, S/Lieut. Keith McGowan, had a staff of six telegraphists and three coders who, with their equipment of two DR101's (Philips), one A679H and one AT20 (STC) handled an average traffic of 4,000 groups per day. The two DR101 transmitter-receivers were used for a point-to-point circuit with Mios Wondi and for Port Wave, whilst the AT20

A general view of Radar station 337 at Momote, Admiralty Is. This station used HMV made AW equipment and had a range of between 70-80 miles depending on height of aircraft being plotted.

Navy equipment at the Port Directorate station at Biak is shown at right. The telegraphist is working with an STC A679J receiver (left) and the receiver of the Philips DR101 transmitter-receiver. The DR101 transmitter can be seen alongside an STC AT20 in the station's transmitting room.





and A679H operated the Madang circuit. A staff of 11 signalmen also manned a visual signals tower controlling all V/S for ships in in the harbor and challenging all craft on their arrival.

RAAF 89 OBU

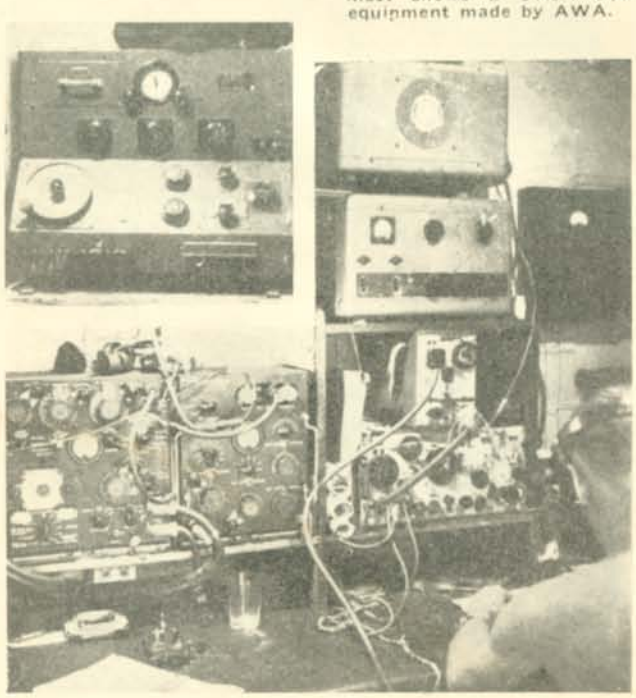
At the time of my visit to Biak, the signals section of the RAAF Operational Base Unit (89 OBU) was in the process of being changed into new and larger transmitting and receiving stations.

The original radio facilities were operating, providing one circuit to Madang (Biak was in the Norcom area), one to Middleburg and two for aeradio. The equipment used was five Kingsley AR7 receivers, an AT13B and an AT13 (both AWA transmitters) and one AT5/AR8 (AWA) and was operated by a staff of 14.

The new station under construction was intended to carry all RAF as well as RAAF traffic. It was being erected by an installation party from 3 RIMU Madang, under F/O Dick Miatt. The equipment planned for the new transmitting station included two AWA AT13C's (one to be used as a homer), two AT13's (AWA), two AT14's, two AT17's (Tasma), and two AT20's (STC) with the addition of aerodrome control equipment.

A new power plant had been installed at one end of the new transmitting station building housing two Ford V8 driven 25 kVA generators.

Equipment in the receiving room of the HMAS "Platypus" is shown below. At left is an AT5/AR8, beside which is an Army No. 22 set. Mounted above the 22 is a 3BZ (Teleradio). The inset shows a C143A D/F equipment made by AWA.



NOIC Moluccas

The next stopping place was Morotai where the NOIC Moluccas was located. Unlike NOIC Madang, the Navy headquarters at Morotai were not based on shore, but was aboard HMAS Platypus, anchored in the harbour.

The Navy signals job at Morotai was not as large as that required at Madang. There were no PD's in the area, and signal traffic to Borneo was carried by Army and US signals, although when guardships were present at Balikpapan, Tarakan and Labuan they tuned in on the New Guinea Intercept circuit. The signals personnel aboard Platypus, in addition to the SOC Lieut. Jim Kershaw and Warrant Telegraphist Alex Brydie, totalled two PO's, six telegraphists, two mechanics and five coders.

Equipment aboard Platypus was a 21/22J 5385 (AWA) transmitter, two AT5/AR8's (AWA transmitter-receivers, one of which was kept as emergency equipment), and RC8 (Astor) transmitter-receiver and a 3BZ (AWA) teleradio which was used for air raid warnings. An Army 22 set (Astor) was also installed in the radio room with an Army operator and was used for direct communication with Army Adv. LHQ which was based on Morotai Island.

HMAS Whang Pu, which was also anchored in the harbour, was used as the control ship for the harbour control circuit using a 1C6940 and an AT5/AR8 (AWA).

Plans were being made at that time for the NOIC Moluccas to take over the US Navy operated station Radio Morotai, transferring their signals set-up to the existing shore-based installation and opening up their own direct circuits to Labuan, Balikpapan, Tarakan and Biak so taking over the complete job of harbour control. From the shore-based station they would also have direct telephone and teleprinter communications with all Army and RAAF Units on Morotai.

The corvette HMAS Bowen was also in Morotai Harbour. It carried radio equipment typical of that class of ship comprising an 18J5385 (AWA transmitter); a 1C6940 and a 2C6940 (AWA receivers); an RC8 transmitter-receiver (Astor); an SCR522/TR5043 (US) and a C143A (AWA) MF D/F.

Army at Morotai

Attached to the Army General Staff at Morotai as technical advisers on all signals matters and in technical control of units within the area was Col. Jim McKinlay, of West Australia, Assistant Signals Officer in Chief and his staff of six officers.

The Advanced Land Headquarters Signals Unit which supplied the bulk of the Army signals facilities on the island of Morotai was under the command of Lt.-Col. "Sam" Hall who had taken over from the previous CO, Lt.-Col. Bill Galley. The Unit had been formed as 23 L of C (Lines of Communication) Signals in Victoria in June, 1944 and moved to Hollandia in November of that year, where they operated until a detachment was sent to Morotai on February 3, 1945. By June, the complete unit was on Morotai and became Adv. LHQ Sigs.

The first detachment to arrive at Morotai under Capt. Joe Wells was equipped with Fullerphones, "L" telephones, and ten-line magneto switch boards, and provided telephone circuits for intra-island facilities. They also opened radio links with Hollandia and Manila using 133's (AWA).

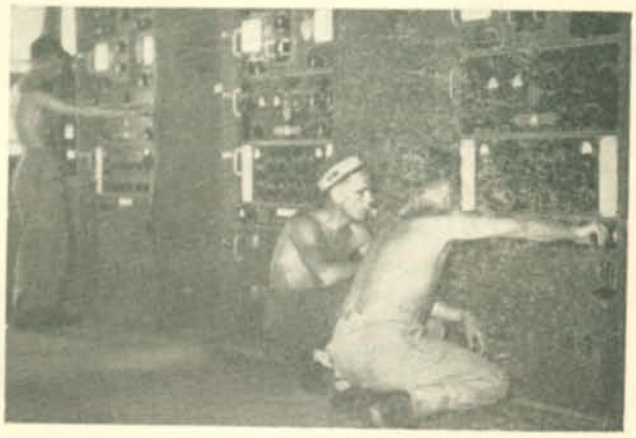
The second detachment, which was part of a line section, arrived a week later and laid their own lines as far as Sabatai, which was slightly beyond the perimeter. On this job the men, most of whom had been on the Kokoda Trail, worked 16 hours a day for the first three weeks in getting the lines through.

The main body of the Unit reached Morotai in March, leaving only a small rear detachment at Hollandia for communications with Melbourne, Lae, Manila (Philippines) and Morotai. The main signals office was established and a second link with Manila and circuits to Darwin, Atherton Tablelands, Lae and two to Melbourne were established using 133 (AWA) transmitters and No. 4 (Philips) receivers. Telephone facilities were consolidated and extended, using mainly type "L" telephone sets (STC).

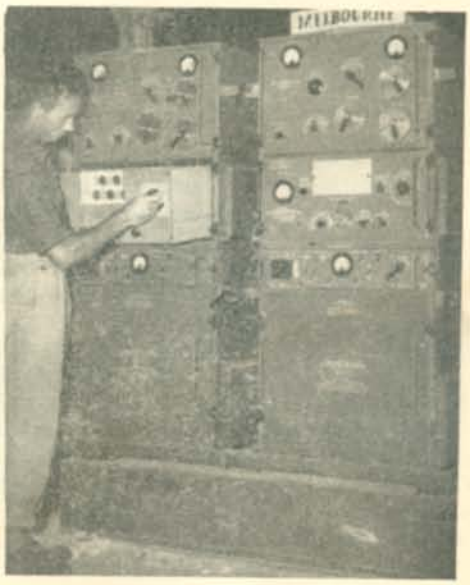
A few weeks later a section of 3 Coy. LHQ Heavy Wireless Group arrived and were attached temporarily to Adv. LHQ Sigs. 3 Coy. operated two high- speed channels direct to Melbourne and one monitoring transmitters and type C95028 and C95031 receivers (AWA).

Later a third channel to Manila was opened with another 133 transmitter. Copper airlines for telephone communications were installed as far as the 7th Div. and 9th Div. concentration areas where they were camped at Morotai prior to their invasion of Borneo. These lines were considered to be an improvement on the existing US circuits.

The pictures below show Army transmitter installations at Morotai. At top is a line of 133's at Adv. LHQ station and below are three 105B transmitters used by No. 3 Coy. Wireless for high speed work. Both types of transmitters were made by AWA.



The photograph below shows a British-made Creed High Speed recorder in use at Adv. LHQ sig. office, Morotai. At right is view of two of the 90 ft. masts which support a Rhombic aerial at the SW tip of Morotai Island. These masts are set in coral in 2 to 4 ft. of water. At extreme right is an AT13C AWA-made transmitter in the Adv. LHQ transmitter hut.



Signals were faced at that time with an ever increasing demand for telephone facilities to service Corps troops and Base troops on their arrival and all line signals on the island were pooled to cope with the job. Expansion of line facilities was made continuously, taking over US lines as the Americans moved out and providing communications for remaining US units. Teleprinter circuits were established to Naval Command US Navy Base, 13th US Air Force Bomber Command, RAAF Headquarters and to Corps. During 7th and 9th Divisions' operations on Borneo, Adv. LHQ Sigs. at Morotai provided their rear communications, working to the invasion forces' command ships.

"Golden Arrow"

The remainder of 3 Coy. Heavy Wireless arrived during July 1945 with a further two sets of 105 and C95028 high-speed transmitters and receivers. They also brought a 5kW (SWB8E) Marconi transmitter for use on high-speed transmission.. This transmitter was mounted on a complete English truck assembly known as the "Golden Arrow." It was these "Golden Arrow" assemblies which were used by British invasion forces in Normandy. 3 Coy. took over command of its own troops and established a separate camp about a half mile away and was in the process of establishing its own transmitting station and withdrawing the equipment of its advanced section from the Adv. LHQ station.

Adv. LHQ Sigs. handled an average of between 80,000 to 100,000 groups per day. After the cessation of hostilities they established communication with Japanese forces in the Celebes, Halmaheras and at Ambon. 133's were used for this and also for maintaining contact with Australian forces relieving POW's in those areas and in Timor and Macassar.

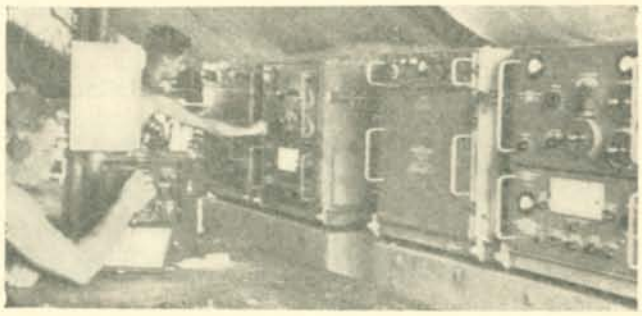
Advanced HQ RAAF Command

An advanced headquarters of RAAF Command was located at Morotai and had been established there in March 1945 to handle RAAF planning and execution for the Borneo operations. RAAF Command located at Brisbane was the organisation responsible for directing all operational activities of the RAAF.

When an advanced HQ was sent to Morotai to plan the Borneo invasion their signals staff was the first to arrive, so that their own communications channels could be established. The Chief Signals Officer of RAAF Command who was in Morotai to handle the RAAF signals planning for the Tarakan invasion was Group Capt. J. Thompson (RAF). He returned to the RAF after the Tarakan show, and W/C Alex Slight took over with W/C Stan Rose as his deputy CSO.

The Adv. RAAF Command W/T station was equipped with eight AR7's (Kingsley) receivers and seven AT13B (AWA) transmitters, plus an AT5/AR8 (AWA) transmitter-receiver and an ATR2B (Astor) transmitter-receiver which were kept as spares. Communications were maintained with RAAF Command Brisbane, North Western Area, Norcom, Manilla and with Tarakan but this latter circuit was changed to Labuan when the RAAF 1st Tactical Air Force HQ was established there. Eight Ford 10 driven 5kvA generators supplied power for the transmitters and the signals office.

The signals office and equipment were originally set up in tents where they operated through three weeks of continual rain. The signals personnel, however, got on the job, mainly in their off-duty hours, and built a tin-roofed hut over the tents which were subsequently taken down. This changeover from tents to the hut was accomplished with only a half-hour break in signals traffic.



The tent mounted on 44-gallon drums served as a transmitting station for the Advanced HQ RAAF Command at Morotai. The lower photograph taken inside the tent shows two AT13B transmitters on mobile mountings. The transmitters were produced by AWA. A Bendix wavemeter can be seen on the table in the left foreground.

Although the Adv. RAAF Command set-up was purely one for planning and direction of the Borneo operations, its signal traffic reached a total of 55,000 groups per day. Even with this volume of traffic, speed in handling messages was maintained — the average time from originator to addressee being about 70 minutes per 100 groups. During the time of my visit to Morotai the Adv. HQ of RAAF Command commenced its withdrawal from that area, returning to RAAF Command Brisbane.

11 Group Morotai

The RAAF 11 Group Headquarters was formed at Morotai to take over control of the area when the 1st Tactical Air Force, which had been based there, moved forward with the Borneo invasion forces.

The 11 Group Telecommunications Unit and 6RIMU were also formed but the ADHQ (previously 110 MFCU) and the 60 Operational Base Unit already existed although they came under the control of 11 Group.

The CSO of 11 Group was W/C Ron Austin OBE, who with his assistant CSO, S/Ldr. Dick Purdie and staff of four headquarters' officers took over the task of organising signals facilities with what equipment was available in units that had remained on Morotai, pending the arrival of 11 Group equipment. Temporary point-to-point and ground-to-air communications were first established with equipment at the OBU comprising five or six transmitters (AT20's and AT14's) and seven AR7 receivers.

The 11 Group Telecommunications Unit was formed under S/Ldr. Gavin Douglas, a prewar amateur (VK3YK) and occupied the site vacated by 1st TAF. The Telecom sig. office was equipped with Kingsley AR7 receivers and operated three aeradio circuits, one air reconnaisance circuit, two to Melbourne, two to Labuan and one to Balikpapan. Four teleprinter circuits were also established, one to Group HQ, and RAAF Command, one to ADHQ and Pitoe airstrip, one to 82 Wing and one to two U.S. units.

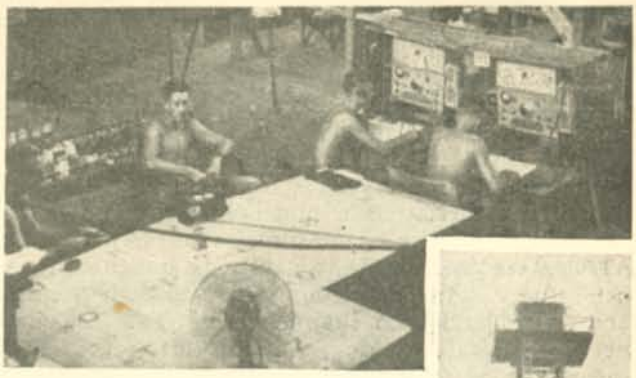
The transmitting station equipment comprised five AT20's (STC and Eclipse), three AT14A's, one AT14 (Tasma) and one AT13 (AWA). The AT20's were used to Melbourne and Balikpapan and for the aeradio circuit. The station was staffed by Sgt. Ken Dunlop and three WMM's (wireless maintenance mechanics). Further equipment for the Telecom Unit was beginning to arrive whilst I was there and it was planned for the unit to move into the site about to be vacated by Adv. RAAF Command.

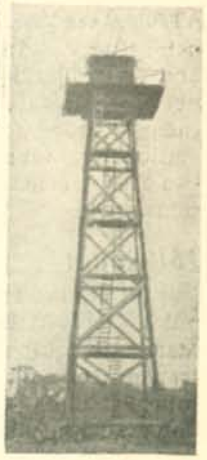
6RIMU

6RIMU was formed with W/C Alex McBride, MBE as the CO under the 11 Group structure to replace 4 RIMU which moved with 1st TAF to Borneo, and was to have consisted of detachments from 2, 3, 4, and 5 RIMU's. The transfer of personnel and equipment had not been completed and hence 6 RIMU was not functioning fully.

It had a complete line section, a mobile signals installation section and a radar servicing and calibration section, and had completed the tasks of installing telephone and power facilities in the 11 Group camp, in addition to the screening and noise elimination on the RAAF crash boat and air-sea rescue craft and the rebuilding of a batch of unserviceable AT5/AR8's.

The photograph at foot of page shows the interior of the RAAF Telecom receiving station at Morotai, with operators working with a bank of AR7 receivers. At the right of the photo immediately below is one of the standard 48 ft. masts at the Telecom transmitting station. In the background is a USAAF Douglas plane which crashed shortly after taking off from Wama strip, about 5 miles away. It passed between the transmitting station masts beneath the aerial without causing any damage, but believe it or not the wingspan of the aircraft is greater than the distance between the masts!





Above is a view of the plotting room at the ADHQ at Morotai. In the foreground is the plotting table and at rear two of the AR7 receivers. At right is the 70ft. tower overlooking the perimeter, which housed the ADHQ, VHF D/F equipment.

ADHQ Morotai

The Air Defence Headquarters, previously 110 MFCU, was renamed as an ADHQ when 11 Group was formed and this alteration of title indicated a change from mobile to static operation. The ADHQ set-up was located on the perimeter about four or five miles from the sea and alongside a 70 feet tower, from the top of which the perimeter was visible. A fabricated hut on the top of the tower housed the VHF D/F equipment.

The operation of this ADHQ was the same as that of ADHQ Madang, described earlier, but was on a slightly larger scale. The signals officer was F/O Ron Pilgrim who was in the process of handing over to F/Lt. Basil Dale (an Associate Member of the IRE) who had operated VK2XX and VK9XX before the war The sig. office personnel totalled 46 telegraphists, 11 wireless maintenance mechanics, one wireless operator mechanic, three cypher assistants, three clerks five telephone operators, 30 R/T operators and one teleprinter operator.

AR7 (Kingsley) receivers were used for all HF channels—two to US fighter control centres in the Philippines, one to North Western Area and Norcom ADHQ's, two to MFCU's in Borneo and Biak, three to radar stations, one for air-sea emergency watch, one for general air warning channel (R/T to all units and ships), one controller liaison channel for direct communications with neighbouring MFCU's, one to PT boats and base for co-ordinating air cover on strikes and one as backing for the teletype circuit to the 11 Telecom Unit.

In addition, four VHF channels were kept for fighter aircraft control using R5019's—a US and Canadian aircraft equipment adapted for use from the SCR522/TR5043 using AR7 power supply units. Other equipment held included ten ATR2B's (Astor) for the use of Wireless Observer Posts, which are ground spotters consisting of a party of three R/T operators with a self-contained camp, while four AT5/AR8's (AWA) were also kept as emergency equipment units.

Three radar stations operated direct with ADHQ Morotai—310 and 161 on Morotai and 352 on Kokoja, a small adjoining island. In addition, there were four stations in the Balikpapan area but these supplied their plots in the first instance to the FDP (Fighter Director Post) at Balikpapan.

The ADHQ Morotai transmitting station was located several hundred yards from the signals office and housed five AT20's (STC and Eclipse), four AT14A's five AT17's (Tasma) and three AT5's (AWA). The AT20's were used on the two US nets and three RAAF nets; the AT14's on the air-sea rescue, air warning and controller liaison channels; the AT17's on channels for aircraft working, and the AT5's operated to radar stations. The power supply for the transmitting station was supplied by two 25 kVA generators whilst two 5 kVA generators fed the signals office and operations room.

161 Radar

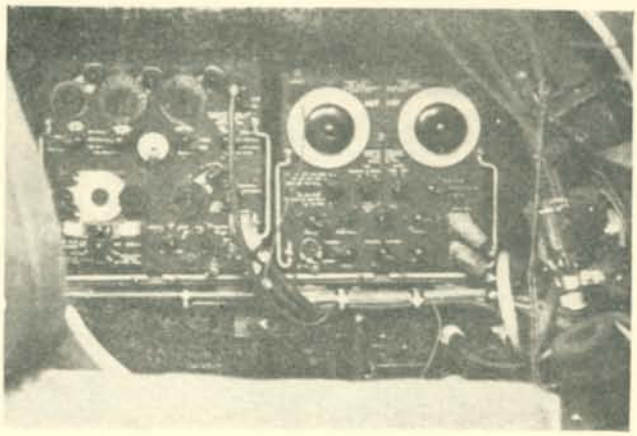
161 Radar station, which was located about eight miles from ADHQ on Morotai Island, used LW/GCI Mark II equipment comprising an SCR602A radar transmitter and receiver made by Research Laboratories, Canada, and modified by the RAAF to Australian Radiophysics Lab's specifications, while the aerial array, masts and rotating hut were made by the N.S.W. Government Railways Workshops, which had established a special Radar fabrication section under the guidance of Mr. Woldridge.

F/Lt. John Sands was in charge of the station and his crew comprised six radar operators, four radar mechanics and four telegraphists plus guards, cook, medical orderly, etc. One of the mechanics, Sgt. Rolie Thomas, had previously conducted his own radio business at Hawthorn, Brisbane, where he concentrated on service work. He also operated amateur station VK4LR. Although 161 Radar station had direct telephone communication with ADHQ, two AT5/AR8's were kept as backing for the telephone in case of line failure.

60 OBU

Morotai, because of its position and aerodrome facilities was a staging point for aircraft from all points north and from Borneo. As an Operational Base Unit, the function of 60 OBU at Morotai was to provide all flying control facilities, refuelling, servicing, weather, etc., and control for base operations.

There were two airstrips on Morotai. 60 OBU took over the control of Wama strip from the Americans in April, 1945, and in the first month handled 13,000 aircraft movements on and off the strip. Shortly after, OBU also took over control of Pitoe strip.



The picture at top of page shows a general view of the control and orderly room at RAAF Radar station 161 at Morotai. From left to right is, plotting board with a 10 line switch above and an AT5/AR8. The lower picture also shows a "58" as mounted for airborne use in a Beaufighter. The outline of the observer's seat can be seen at bottom and left of picture.

60 OBU was linked by teleprinters to 11 Group Telecom, to ADHQ and to AACS (American Army Communication System). The control tower on Pitoe strip handled traffic on Wama as well. The two control towers were connected by telephone and Wama relayed a running commentary to Pitoe. The signals equipment in Pitoe tower comprised a SCR522/TR5043 —US made aircraft type transmitter-receiver, two AR7's and an AR8 as HF receivers. An American

At right is equipment on RAAF crash launch O22. From bottom to top is an AT5/AR8, a Bendix transceiver, the aerial unit, and at left above operator's head a US-made 5043. Below is a waterline view of the air sea rescue craft 920.

transmitter had been used as a homing beacon but was being replaced by an AT 13C (AWA).

Aircraft based at Morotai included Spitfires, Liberators, Lightnings, Mitchells, three squadrons of Beaufighters, one squadron of Douglas transports and part of the US 13th Air Force, and to give some impression of the size of the Morotai airfield, it may be stated that there were over 700 aircraft on the ground at Pitoe strip alone, and every five days there was an average of 1,000 aircraft taking off and 1,000 landing on the strip. Pitoe had a runway of 8,000 feet with a 500 feet overlap at each end.

RAAF Marine Section

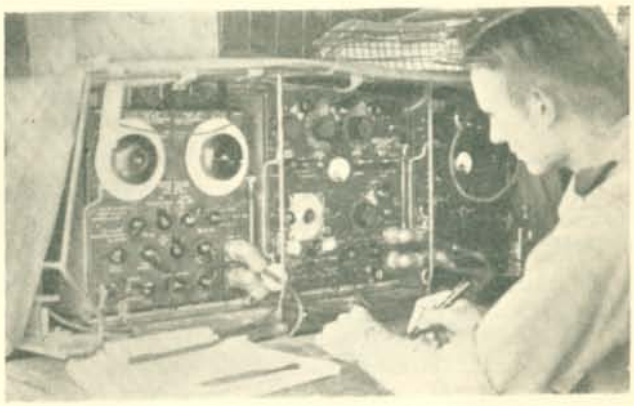
The RAAF also had a Marine Section at Morôtai which operated under 60 OBU for administration and maintenance and under ADHQ for operational control. The marine section functioned with a 48 ft. crash launch and a "900" class 63-ft. air-sea rescue craft. Normally there are two "900" class air-sea rescue craft at each base. The second for Morotai was on its way there.

The crash launch, designated 022, was powered by three 8-cylinder Chrysler marine engines. It was commissioned in Sydney about the middle of 1942 and had been at Milne Bay, Goodenough, Kiriwina, Biak, Noemfor and the Admiralty's prior to its arrival at Morotai. All travelling had been done under its own power. The launch carried a RAAF crew of four, made up of a coxswain, a radio operator, an engineer and one crew member, and was used to guard take-offs and landings of all water-based aircraft and was equipped with an AT5/AR8 (AWA) transmitter-receiver for communication with ADHQ, the airstrip, with Catalinas and for aeradio. It was also fitted with IFF and carried a US made SCR522/TR5043 transmitter-receiver for contact with Mariner aircraft and ships.

All the "900" class air-sea rescue craft had been built in America at a cost of £30,000 each. They weighed 32 tons, were driven by two V12, 650 h.p. engines and with a range of 500 miles, had a top speed of 33½ knots and a cruising speed of 25 knots. These boats were owned and largely manned by RAN and were attached to RAAF for rescue work, picking up crews of aircraft forced into the sea. The crew of eight under a Navy lieutenant usually included two RAAF personnel (WAG's) as radio operators.

The craft based at Morotai was "920" and like the crash launch, had been brought from Sydney under its own power. It was commanded by Lieut. Alex McLean and carried three radio operators, one Navy telegraphist "Hub" Davis (who also acted as cook) and two RAAF Sgt. WAG's, Des Fennell and Bill McDonald. The radio equipment comprised a US made TCS5 HF transmitter-receiver, a US made aircraft type SCR522/TR5043 transmitter-receiver providing VHF channels to aircraft, a radio compass and IFF. Normally, however, the HF equipment used by this class of vessel was an AWA made AT5/AR8.

This detail of the RAAF marine section completes a review of the major signals activities of the Navy, Army and Air Forces at Morotai. Although my visit to Army Signals at Morotai was not made until during the return trip from Borneo it has been dealt with above for the sake of convenient grouping.



These photographs of 9 Div. Sigs. activities at Labuan show, from top to bottom: Operators of 13 Heavy Wireless Section working with a line of No. 4 reception sets; a 9 Div. Sigs. operator with a 22 set, and at bottom, a 112 set (Army version of the AT5/AR8) at one of the Light Wireless Sections. The 112 is made by AWA, the 22 by Radio Corporation and the No. 4 by Philips.

9th Division Signals

From Morotai my next course headed west to Borneo. I landed at Labuan where the Aust. Army 9th Div. HQ. and the 1st Tactical Air Force HQ were located.

The H.Q. 9th Div. Signals was at Labuan under Lt.-Col. "Ted" Lambert of South Australia. The Divisional Signals consisted of the Unit HQ. with the CO (Lt.-Col. Lambert), his adjutant and a staff of five; the HQ Coy., No. 1 Coy., and No. 2 Coy.

The HQ Coy. consisted of an administrative section and a technical maintenance section. The administration section was staffed by three officers and 31 other ranks, and the maintenance (M) section by one officer and 25 other ranks. The equipment of the M section included large battery charging outfits, Supertesters (Radio Equipment); Crystal Calibrator, and Wavemeters (AWA); AC/DC/Bty. Signal Generator and an AC Signal Generator TA101B (Philips); US made SCR211E frequency meter and IE17 handie-

talkie test equipment; a British made Bridge Megger and a captured Japanese cathode-ray oscillograph.

The No. 1 Coy. was divided into three sections; "A" (wireless) section, "B" (cable) section and "D" (operating) section. 'A" section with two officers and 42 other ranks was responsible for the Divisional end of the channels to Brigade HQ., Field Regts. HQ., Cav. Regts. HQ., and RAE HQ. In addition it was responsible for providing both terminals of communication with Divisional troops such as the Machine Gun Battalion, Pioneer Bn. etc., and also for providing rear links to Corps at Morotai. During the Borneo operations, however, the 13 Heavy Wireless Section was attached for this latter purpose using four 112's (AWA) while the 2 Light Wireless Section, also using four 112's, was attached to assist with intra-Divisional communications. "B" section had the task of laying lines around Div. HQ including elements of Division, whilst "D" section provided the operating personnel for switchboards, line communications and the DR service. Both "B" and "D" sections were also supplemented in Borneo by attached sections.

The equipment used by "A" section included nine 22's (Radio Corp.), two 112's (AWA) and a ten-line switchboard with "L" type telephones. "B" section carried 150 miles of D3 cable, 25 miles of D3 twisted cable, a No. 3 mechanical cable layer and two No. 4 cable layers. "D" section had two 20-line switchboards, 4 ten-line boards, ten miles of D3 cable, line test sets, 15 Fullerphones with long-range units and associated sig. office equipment.

The job of the No. 2 Coy. of 9 Div. Sigs. was to coordinate the activities of detached sections of Div. Signals personnel with brigades, regiments, etc.

The 9th Div. Sigs. Unit, however, did not cover all signals personnel and equipment that functioned with the 9th Aust. Division in Borneo, as in addition, there were Brigade, Battalion and Regimental Signals sections, and numerous signals sections, either independent units or detachments from L of C or A Corps sigs., which had been attached to 9th Div at Labuan and operated within the 9th Div. in Borneo. The personnel in these attached sections totalled close on 1,000 men.

The various types of signal equipment used in the 9th Div. Borneo operations were:—133's and 112's (AWA); 22's and 22YB's (Astor); SCR536's (US made Handie-talkies); 108's and 208's (Astor); 11's and 19's (AWA); 109's (STC); No. 4's (Philips); 10-line magneto switchboards; TC12 and TC4 central office switchboards (US made); PBX switchboards (PMG); Cable Layers, both hand and mechanical of various types (PMG and Kelly and Lewis); "L" and "F" 'phones (STC), and Fullerphones (Stromberg).

In its original New Guinea campaign, 9 Div's signals equipment comprised mainly 11's, 109's, AT5/AR8's, 108 Mk. II's, SCR536's, a few British 22s', "D" and "F" 'phones and Fullerphones, and it was during this campaign that the Division first experienced the difficulties of keeping equipment dry under humid tropical conditions. Wherever possible, 240-volt globes were hung in the larger items of equipment—otherwise it was a case of drying it in the sun. For smaller items such as telephones, telephone cords and plugs and the chassis of the SCR536's, ovens, heated by primus stoves or kerosene lamps, were built to dry out the gear and retard deterioration and fungus growth.

12 pair of D8 twisted cable running to 9 Div. HQ at Labuan is shown at right on sectional steel poles erected in paddy fields.

Magneto switchboard converted from U-C 10-line for use with Tele. Sets "L" (STC) in use at 9 Div. HQ.

The two photos immediately above show 9 Div. personnel with, top, a US-made 45-line switchboard, and the lower picture two AWA-made 133 sets each mounted on a jeep and a jeep trailer.

The Division was re-equipped during 1944 after it had returned to Australia, and after intensive training was concentrated on Morotai during March and April, 1945, in preparation for the Borneo invasion, which commenced at the end of April.

The 9th Div's first Borneo operation was the invasion of Tarakan on May 1st and was carried out by 26 Bde. Signals for the operation were provided by 26 Bde. Sig. Section, 2/7 Field Regt. Sigs. Section and detachments of eight other signals sections. 49 Heavy Wireless Section provided communications from Tarakan to Morotai using two 133's which were mounted in jeeps and trailers. During the landing, one of these sets fell into the water and was completely "drowned". The waterproofing of the equipment was successful but the P.A. Unit and some valves had been damaged by the drop. Repairs were effected and the equipment was on the air within three hours. In the meantime, the other 133 had established communication with Morotai within 25 minutes of landing. Signals commitments for the operation were all met

At top are 9 Div. Sigs. personnel at Labuan with a 108 set (made by Radio Corporation). The lower picture taken in the Maintenance Section workshop shows, a Weston output meter, a Supertester, a Philips wavemeter, a US Philco frequency meter and a 22 set under repair.

and because of the hard work of signals personnel, all facilities functioned smoothly and efficiently.

The 9th Div's second invasion of Borneo commenced on June 10, 1945, and was designed as an amphibious assault on Brunei Bay area, to take Labuan Island, Muara Island, Brunei Peninsula, Brunei, Miri, Lutong and Seria, to permit of the establishment of an advanced fleet base in Brunei Bay. Simultaneous assaults were made by 20 Bde. on the Muara-Brunei area and by 24 Bde. on Labuan Island. Rapid advances were made once the landing operations commenced at Labuan and lines had to be laid at top speed. Communications for the first phase of the assault were handled by the 24 Bde. Sigs. Section and a Beach Sigs. Section.

The Beach Sigs. Section established two Advanced Beach Signal Stations (ABSS's) each equipped with a 46 (British made walkie-takies), a 22 (Astor) and telephones. The functions of the ABSS's were to provide communication for the Assault Battalions to Bde. HQ. aboard ship and forward to Assault Bn. HQ. The Regt. Sig. Platoon of each Bn. provided the communications from Bn. HQ. forward to Companies, etc., using up to nine 108's and thirty SCR536's in addition to telephones. Lines were laid by a No. 6 pack layer using either D3 single cable or W130 assault wire.

One of the ABSS's was built up to a Main Beach Signals Office (MBSO) with two 22's and four 46's which provided communications for brigade during landing, carrying Bde. traffic back to Div. HQ. on the ship. As soon as Bde. HQ. was established on shore, Bde. took over its own communication channels to Div. and of course provided its own communication forward to Bns. Brigade Sigs. Section equipment comprised five 22's, five 208's, 20 miles of cable, cable layers No. 6 and 3, "L" 'phones, 10-line magneto switchboards and Fullerphones.

The MBSO also served Div. HQ during landing operations, providing communications to Corps. Bdes., Navy and RAAF until the Div. HQ. was established.

The first troops landed at Labuan at 0915 and by 1730 that day Div. HQ was ashore. The following day a decision was made to establish permanent Div. HQ on the site first occupied and consolidation of communications commenced immediately.

Rapid advances were also made by 20 Bde. in landings on Brunei and Muara Island and ABSS's were quickly established in both instances. Because of the speed of the advances, a heavy strain was placed on signals, particularly at Brunei where it was necessary for battalions to operate individually and seize key points as quickly as possible. Supplies of cable, including an extra quota of 40 miles, were soon exhausted.

Throughout the operations it was found that the radio communications had worked well, having been quickly and efficiently established once parties landed and called forward to their respective sites.

1st Tactical Air Force

The RAAF 1st Tactical Air Force had taken part in a long list of operations prior to its participation in the Borneo campaign. It had been originally formed in November, 1943, as 10 Operational Group (10 OG) and saw action at Cape Gloucester, Tadji, Noemfoor and then went to Morotai in September, 1944. It was at Morotai in December, 1944 that the unit was renamed 1st TAF.

From Morotai, 1st TAF Command Posts were sent with the Borneo invasion forces to Tarakan on April 30, to Labuan on June 10 and to Balikpapan on July 1. During the early part of July the rear party from Morotai joined the Command Post at Labuan and established TAF HQ there.

W/C Maurice Myers, who had been Chief Signals Officer of 1st TAF ever since its initial formation as 10 OG, operated the amateur station VK2VN before the war and was on the RAAF Wireless Reserve since 1936. During the time of my visit to TAF he handed over to a new CSO, W/C George Prosser who had been in the RAAF since 1938 and served as Signals Officer of No. 10 Squadron of Sunderlands in England.

In addition to the CSO, the TAF HQ signals staff comprised the deputy CSO S/Ldr. Roger Choate, the Assistant CSO Radar F/Lt. Norm Campbell, five other officers and three office personnel.

1st TAF Telecommunications Unit

The 1st TAF Telecommunications Unit functioned under the control of its CO S/Ldr. John Curtin with a total strength of 14 officers and about 170 other personnel. In addition to the HQ set-up at Labuan, detachments from the unit supplied communications for the RAAF at Tarakan, Singapore and Kuching.

The first party of Telecom personnel to land at Labuan set up an advanced signal station with one

AT14 (Tasma), three AT13 (AWA) transmitters and four AR7 (Kingsley) receivers. Other personnel arrived two days after the initial landing, and temporary receiving station was set up in the old Eastern Extension Telegraph & Cables building, while the transmitting station was installed in a house near the swamp. One night when a Jap party had broken through our lines, one of the transmitting station personnel who was on duty was shot and later a bomb was found under one of the beds in the sleeping quarters. Both the transmitting and receiving stations were later moved in to properly constructed sites.

The Telecom signals office was located among the HQ administrative buildings and with 18 AR7 receivers operated two circuits to Melbourne, two to Darwin, two to Balikpapan, two to Tarakan, one to RAAF Command Brisbane, one to Singapore, one to Kuching and two to Morotai. Teleprinter circuits were operated to other RAAF units on the island. Two Kleinschmidt Perforators were used on high-speed work which was used exclusively on the Melbourne circuits. The traffic through this Telecom Unit averaged as much as 72,000 groups per day, and had shown only 0.06% error over one million cypher groups, meaning that W/T error was virtually non-existent.

The transmitting station housed six AT20 (STC and Eclipse) transmitters, three AT14A's (Tasma), one AT13C and four AT13B's (AWA) and one AT15 (Tasma). The AT15 was used as a homing beacon, the AT20's were used for circuits to Melbourne, Singapore, Tarakan and for aeradio, whilst the AT13C and the AT13B were used on Brisbane, Morotai and Darwin.

Radar Organisation

The detail of placing and controlling radar stations came under the direct control of the Assistant CSO Radar, F/Lt. Norm Campbell. There were 13 radar stations under the control of 1st TAF. Of these, ten were AW (air warning) stations and the remaining three were GCI (ground contact intercept) stations.

All the AW stations were equipped with HMV made J23A Mark 1A equipment and the GCI stations carried American equipment which had been revised to Australian Radiophysics Laboratories specifications. The personnel of an AW station generally comprised a Fl/Lt. as CO, four mechanics, nine radar operators, four telegraphists, two cooks, a medical orderly, a driver-fitter, a clerk and a number of guards ranging from five to twenty, depending upon requirements.

316 Radar

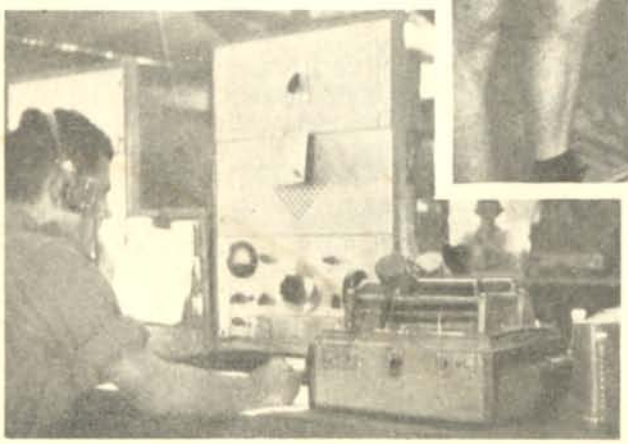
One of the AW type radar stations, known as 316 Radar was located on Cole Point at the northern tip of Labuan Island and used the HMV Mark 1A radar equipment with a Mark II tower made by the N.S.W. Government Railways. Two AT5/AR8's (AWA) were used for maintaining communications with the Mobile Fighter Control Unit.

CO of the station, F/Lt. John O'Sullivan, took over when the station was operating at Kombies in Dutch New Guinea in October, 1944, where the station was using a Mark I tower. The station later returned to the mainland for refitting with the new tower and then moved to Labuan with the invasion forces.

A GCI station (166 Radar) under F/Lt. Warren Mann was also located on Labuan Island, and was equipped with SCR602 transmitter-receiver and Indicating Units made by Research Enterprises Ltd., Canada. The height-finding equipment was made by the N.S.W. Government Railways in conjunction with Radiophysics Laboratories and the cabin and aerial were also made by the N.S.W.G.R.

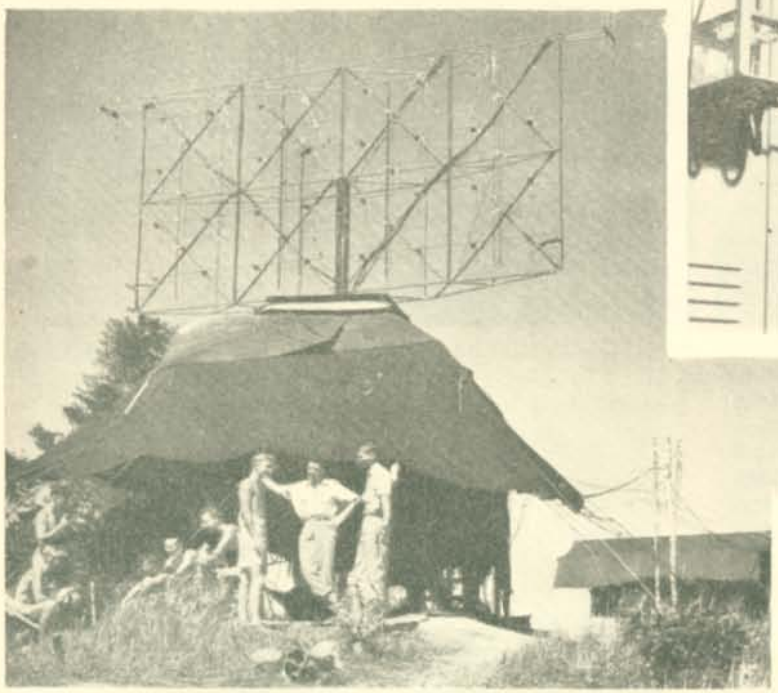
Since this station commenced operating on Labuan on June 13, it had two aircraft to its credit, one which had been brought down by gunfire and one which had been intercepted and shot down.

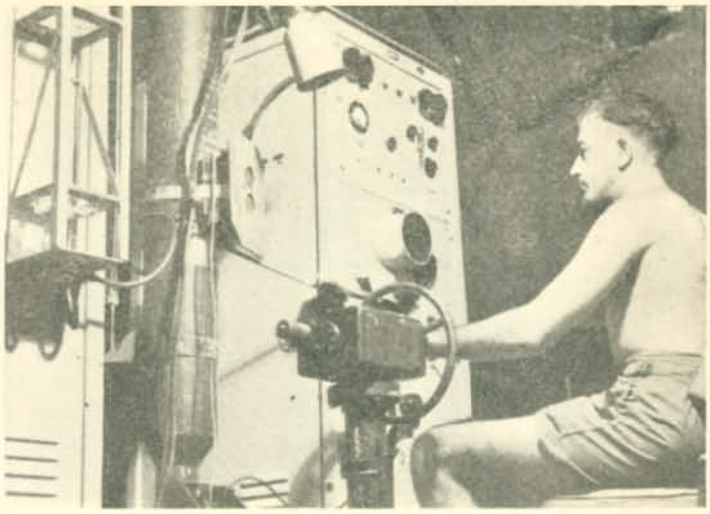
At right is an AT13B, a product of AWA, in the RAAF 1st TAF Telecom transmitting station at Labuan, while below, at the receiving station of the unit is a Kingsley AR7 and a British-made high speed recorder.



Below is a line-up of generators, which provide power for the RAAF Telecom transmitters at Labuan. There are two 5KVA's at left and four 10KVA's. One of these generators and the transmitter at left are both scarred by bullet holes.

RAAF Radar Stations

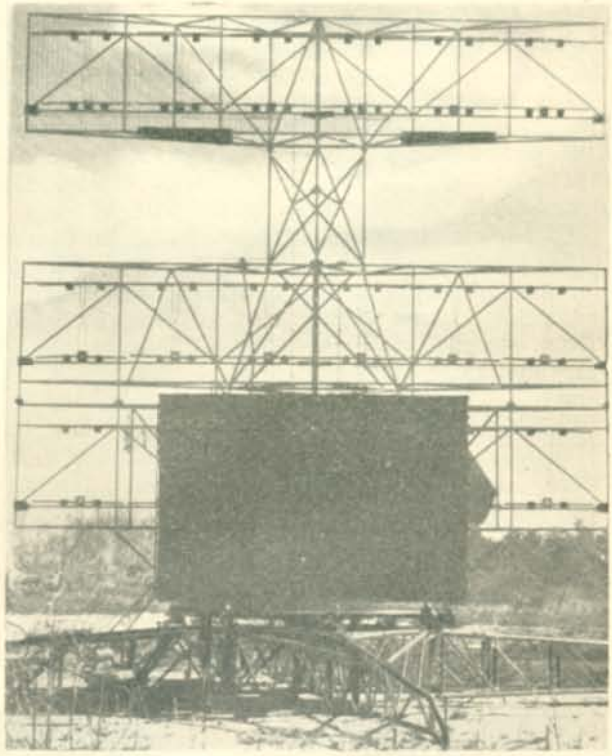


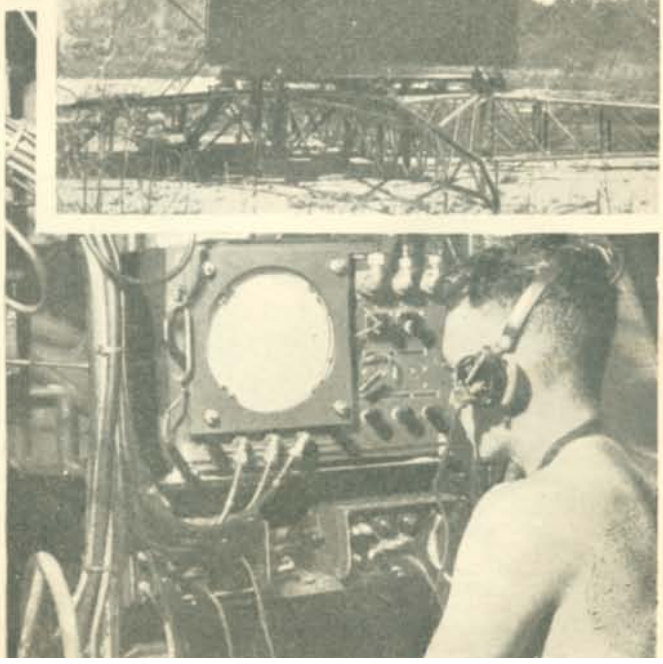


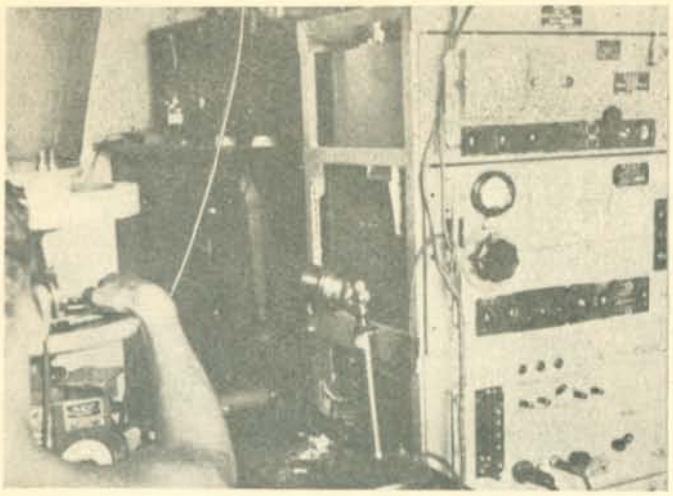
at Labuan

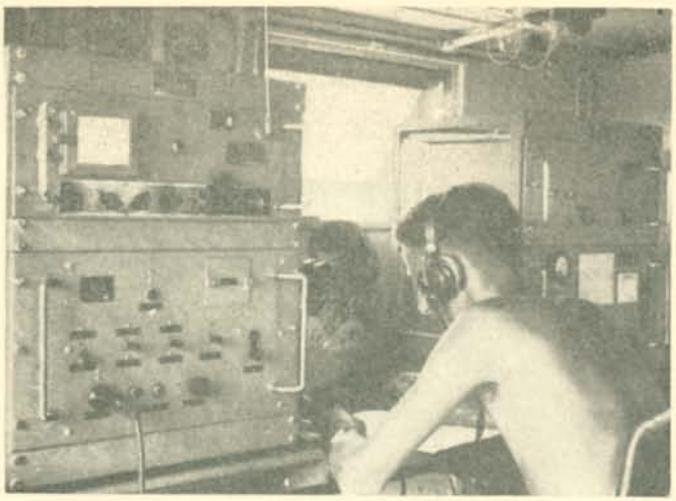
On this page is a photographic display of two typical RAAF Radar installations of the 1st Tactical Air Force at Labuan. The two pictures at the top of the page are of 316 Radar, which was located on Cole Point at the northern tip of the island. It was an AW (air warning) station using HMV-made LW AW Mark IA equipment (see top right) and a Mark II tower or aerial array made by the NSW Government Railways.

The picture at right shows the set-up of 116 Radar, a GCI (ground control intercept) station, the stand, cabin, aerial array and height-finding equipment of which was made by the NSW Government Railways, who worked in conjunction with the Radiophysics Laboratories on the height-finding equipment. The SCR602 transmitter-receiver and indicating units, part of which are shown at the foot of the page, were made in Canada by Research Enterprises Ltd. and modified locally to suit RAAF requirements. Below, left is the "A" scope (height range), transmitter and table and at right the PPI (plan position indicator).







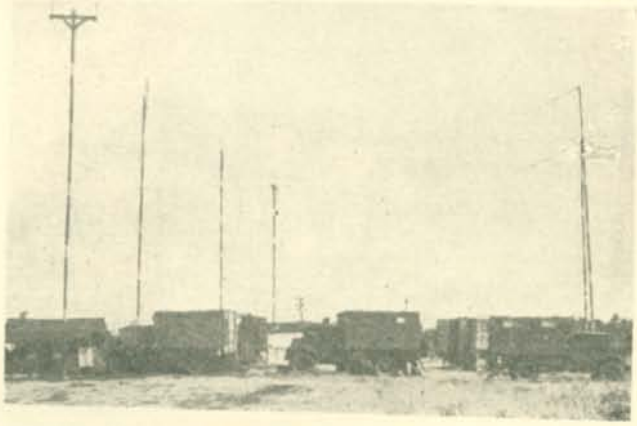


111 MFCU

Radar stations in the Labuan area worked in conjunction with the 111 Mobile Fighter Control Unit—a mobile version of an ADHQ. The unit was formed as 111 FCU in Western Australia early in January 1943 and operated at Madang, Cape Gloucester and Aitape before it was withdrawn in January 1945 for reforming and re-equipping as a mobile unit. It was then sent to Morotai in May and arrived at Labuan on D day.

The MFCU signals equipment comprising 21 AR7's (Kingsley) 20 AT21's, (AWA) two AT14's (Tasma) for HF coverage, six AT17's (Tasma) and six AR17's (Astor) plus four US aircraft typs SCR522/TR5043 transmitter-receivers used for the VHF band.

HF equipment was used for point-to-point communications with radar stations for tellings of radar plots, for administrative traffic and for communication to adjoining Fighter Sectors and to US Fighter Sectors. These channels used the AT21-AR7 combination and provided radio links as follows:— one to 323 Radar; one to 324 Radar; one to 325 Radar; one to 163 Radar; one Ship-to-Shore for Fighter control; one to 114 MFCU, Tarakan, and 110 MFCU Morotai; one to Balikpapan (a sector of 110 MFCU); one for air-sea rescue; one to Tactical Bomber Command (a US frequency); and one to all US Fighter Sectors in the Philippines; as well as two land-line backings to 324 Radar and 316 Radar. The rest were kept as spares and against other possible commitments whilst the AT14's were kept to provide higher power if required.

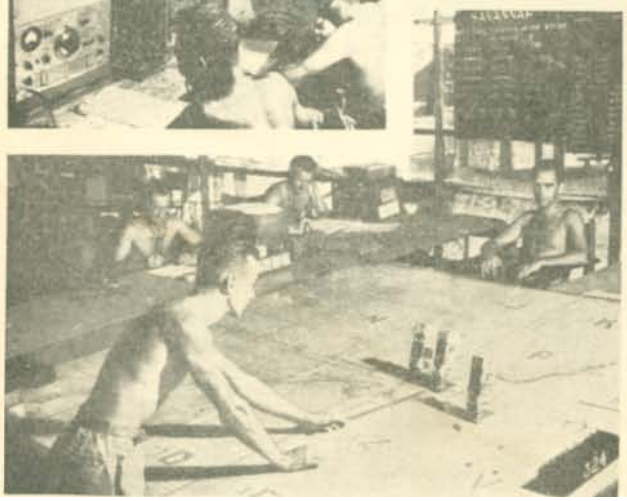


The photo immediately above shows the line-up of vehicles used for mobile mounting of signals equipment by the 111 MFCU at Labuan, known as "Radio City." Interior of two of these vehicles is shown above. At left the VHF D/F equipment comprising type A5 directional aerial, crystal calibrator and an AR17 receiver (made by "Astor"). At right, crystal calibrator control unit and another AR17.

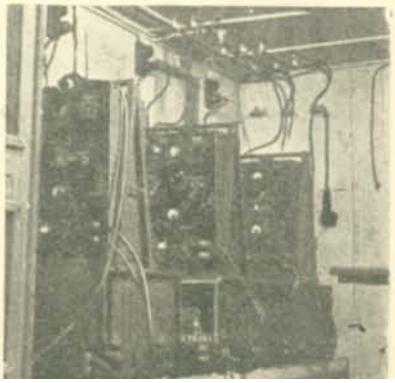
Four VHF ground-to-air circuits were normally worked. Initially the SCR522/TR5043's were used for this aircraft control work but were replaced by higher powered AT17's and AR17's, which were more suitable for ground service.

The AR7 receivers on telling circuits were located in the plotting room near the plotting table whilst the other receivers were in an adjoining signals room. All the transmitters were mobile-mounted in transmitter trucks which were located about 300 yards away from the building occupied by the MFCU. The

MFCU Plotting Room



At left, the plotting room at 111 MFCU. Inset are three of the Kingsley AR7's used. The vehicular mounting of AT21's (made by AWA) is shown at right. Five AT21's are housed in one vehicle.



AT17's and AR17's were mounted as separate truck assemblies, remote controlled from the sig. office. Within the first ten days of its operation at Labaun, three Japanese aircraft were shot down as a result of the workings of 111 MFCU.

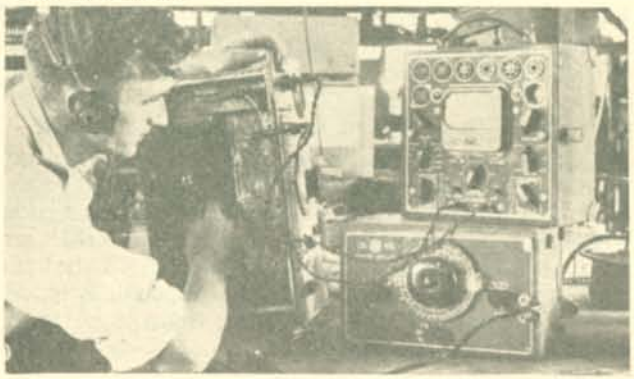
4 RIMU Labuan

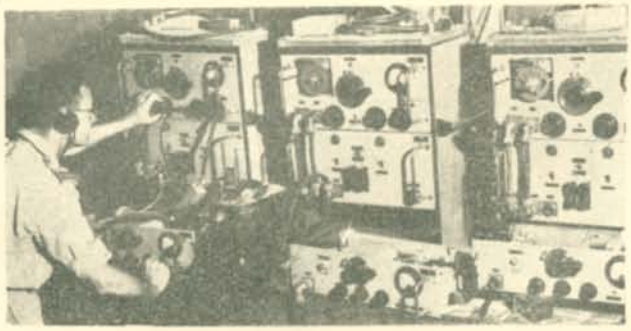
The normal strength of this Radio Installation and Maintenance Unit was in the region of 220 personnel and the Unit's equipment comprised 12 Palec VCT's and 12 Palec MCA's for use in the field, plus AW Radar Test set type A18, Peak Diode Voltmeter type A8, AWB1 Wavemeter, Test Cathode-ray Oscilloscopt A9/1, Field Intensity Receiver type D32 (all HMV), Signal Generator type A6, Calibrator Wavemeter type M/D (both AWA), multimeter type 7, (English), wavemeter type BC906, IFF testing receiver BC 1066, signal generator I196A (all American), IFF test set type 74 (Air Ministry) three VCT-V (Transmission Products), a Philips Signal Generator and Oscillograph, and an AWA oscillograph 2J6726.

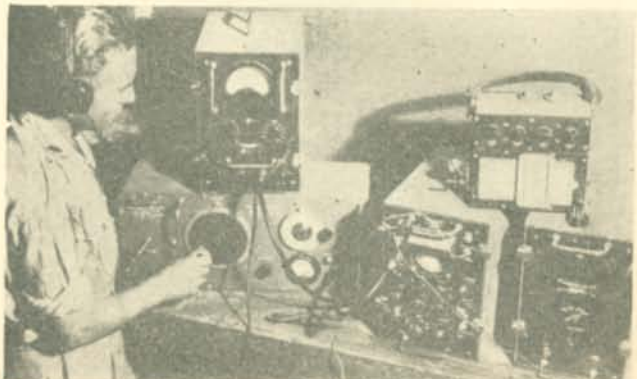
4 RIMU supplied assault parties who did the initial RAAF signals installation work at Tarakan, Labuan and Balikpapan. The equipment installed at Labuan within three days of landing was 15 AR7's, four teletypes, two type X (cypher) machines, one 50-line switchboard and 12 transmitters. The normal quantity of equipment carried by such an assault party totals 30 tons, which is carried in six vehicles.

S/Ldr. Tom Stanfield was the CO of 4RIMU, S/Ldr. Ian Greenham was the senior Radar Officer and there were about eight other officers. As with other RIMU's the Unit was divided into signals workshops, radar workshops, and a number of installation parties, normally specialising in either signals, radar, or line work.

These pictures of 4.RIMU at Labuan show: 1. Test work on an AR7, with AWA oscillator and a VCT V made by Transmission Products. 2. A bank of Airzone-made BTR1's and 3. Radar test equipment including AWA signal generator, and HMV-made oscillograph, power supply unit and field strength receiver.







47 OBU

The Operational Base Unit (47 OBU) which arrived at Labuan with the invasion forces erected its own control tower whilst under fire and were controlling aircraft landings on the Labuan strip six days after the landing began.

An AR7 receiver and an AT5 transmitter were used in the control tower for HF ground-to-air communication. Other control tower equipment included a US-made SCR522/TR5043 transmitter-receiver for VHF ground-to-air communication and an Airzone BTR1 interrogator which was also used as a homing beacon. From a signals office under the control tower and adjoining the main control office, three watches were kept—one on weather, one for aeradio and one with the AACS (American Army Communications System) for which AR7 receivers were used.

86 Wing

86 Wing—a RAAF attack wing comprising one squadron of British built Mosquitoes and one squadron of Australian Beaufighters, based at Labuan. A squadron of Australian built Mosquitoes, which had not at that time arrived at Labuan, was also attached to the Wing.

This Wing had been equipped as a completely self-contained unit able to provide all its own operational base facilities and had within its own structure a complete OBU. When the Wing arrived at Labuan the existing homing beacon and VHF D/F operated by 111 MFCU, removed the necessity of the wing OBU opening these facilities. 47 OBU was also in existence and would normally have provided control facilities for the Wing aircraft but as the Wing preferred to use its own equipment it set up a separate 84 OBU which maintained three ground-to-air watches for all operational aircraft and in addition provided AR7 facilities for monitoring TAF Telecom Unit transmissions.

The signals facilities, under control of the Wing Signals Officer, F/Lt. Des Allison, were all completely mobile with equipment mounted in a series of truck assemblies comprising:—two receiving vehicles type R2 with five AR7's (Kingsley) in each; three transmitting vehicles, of which two each housed a Tasma AT14A and an STC AT20, with two AWA AT21's as standbys, while the other carried an AT14A and an AT15A (Tasma) and also two AT21's as standbys; two power supply trucks each carrying a 25 kVA generator; one vehicle housing two teletypes and a switchboard; one VHF D/F mobile tender with a SCR522/TR5043 (US transmitter-receiver), an AR17 (Radio Corp.), an A5 aerial assembly and two 1½kVA generators for its own power supply; one cypher vehicle with two type-X machines; one G2 servicing vehicle and one sig. office vehicle.

Immediately above can be seen airstrip control tower equipment used by 47 OBU at Labuan. At left is a Kingsley AR7 with VHF and HF speakers mounted above. A VHF 5043 is mounted beneath the desk, while at right is an Airzone-made BTRI, transmitter, receiver and identification equipment. The photo at top was taken from this control tower and shows three Mosquitos flying over the strip.

No. 1 Air Support Unit

The operation in Borneo was the first time that an Air Support Unit was used by the RAAF, as in previous campaigns, this type of unit was provided by Army. As the name indicates, its purpose is to provide communications detailing requests for air support for assault wave troops. Whilst these units were only very small they performed very important duties during the invasions of Tarakan, Labuan and Balikpapan.

The Air Support Unit was split into various sections namely:—*Air Liaison Parties,* which consisted of a Corporal and two LAC's equipped with an SCR300 (US-made FM pack-set) and an Astor ATR4A; *Air Support Parties,* comprising two officers and twelve other personnel with six AT5/AR8's (AWA) and two SCR522/TR5043 (US transmitter receivers); *Air Support Sections,* of three officers and 22 other personnel, each with eight AT5/AR8's and three SCR522/TR5043's; and the *Air Support Team,* which was the headquarters or controlling group located aboard the Command Ship controlling the invasion.

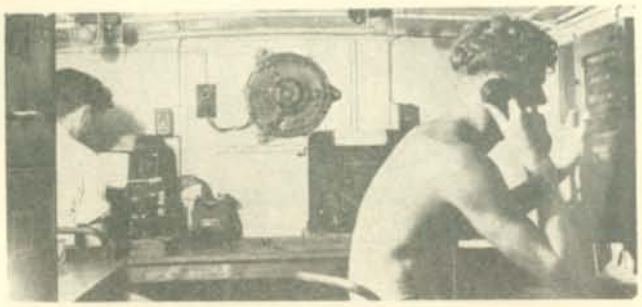
The Air Liaison Parties worked with Army battalions and went ashore with the first assault troops, communicating direct with the Air Support Team on the HQ ship. When the invasion progressed to the next stage and brigades were established on shore the Air Liaison Parties maintained their contact with the Air Support Parties which accompanied each Brigade and who in their turn communicated with the HQ ship.

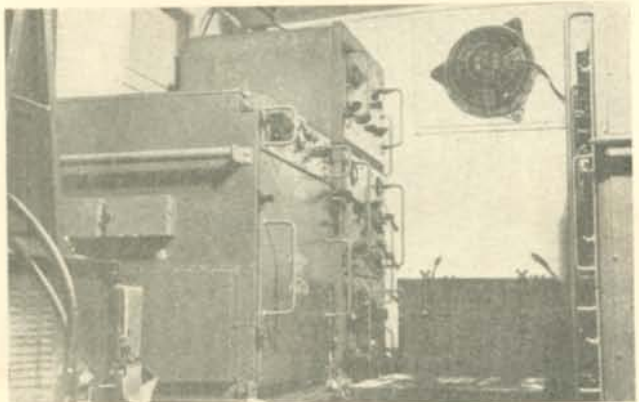
During the next stage, when Div. HQ was in the process of landing, the Air Support Parties communicated with the Air Support Sections which accompanied Div. HQ and also direct with the HQ ship until such time as Division HQ had been established on shore and was ready to take over operational command. At this stage, when the operational command transferred from the HQ ship to Div. HQ there was the accompanying transfer of the AOC and General.

The Air Support team during its operations aboard the HQ ship used the ship's radio equipment for its end of the communication links. The HQ ship at each invasion was used for the sole purpose of directing operations and maintaining contacts with individual units—it was a floating signals office.

The Air Support team consisted of the CSA (Commander Support Aircraft) who sat in the centre of a large semi-circular desk around which were the communication terminals from the Support Air Request Nets (from Air Liaison Parties, etc.), an Army officer operating an air observer's watch from an aircraft spotter, a Naval gunfire control officer, a representative of the GOC who allocated priorities, and an air-sea rescue watch. The CSA was in direct communication with the pilots of the air support aircraft.

Four of the personnel of the Air Support Unit have been recommended for decorations and four others have been mentioned in despatches for their actions during the Borneo campaign. The highest credit was given by all sections of the forces to the job that was done by the Air Support Unit. At Brunei, Brigadier Windeyer congratulated the 13 Air Support personnel attached to his brigade in front of a full brigade parade.





At right are views of the interiors of two of the mobile signals trucks used by 84 OBU (a section of 86 Attack Wing) at Labuan. Top, the Sig. office truck with two teletypes and a 30-line switchboard. Below, a transmitter truck housing an AWA-made AT13C (left) and an AT15A made by Thom & Smith (right).

The full strength of the unit was 23 officers and 267 other personnel, all of whom were signals personnel with the exception of officers who directed aircraft and these were all ex-operational pilots.

RAAF Command Posts

From Labuan, I visited RAAF Command Posts at Kuching and Singapore which had been established to provide facilities for RAAF aircraft operating in those areas in support of occupational troops and for the purpose of evacuating P.W's and internees.

Kuching is located on the south-west coast of Borneo and is the capital of the independent State of Sarawak, which is controlled by an English family and ruled by Rajah Sir Charles Vyner Brooke, who is known as "The White Rajah." Kuching was one of the Japanese strongholds in Borneo.

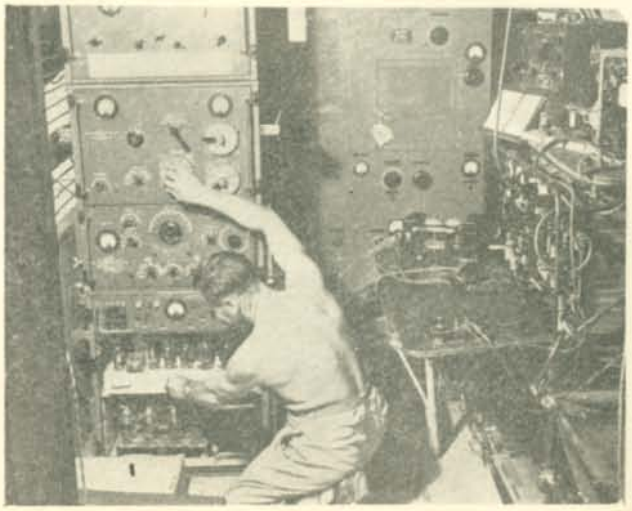
The signals section of the Command Post at Kuching operated with two AT5/AR8 which were used for communications with Labuan and with aircraft. Two spare sets of valves for this equipment were carried and also a multimeter (Syme-ESM), a Bendix wavemeter and a battery charger. Power was supplied by two 1½ kVA generators. All of this equipment was flown to Kuching by Catalina on the day following the arrival of the first Australian troops.

Singapore

The RAAF Command Post signals personnel that were sent to Singapore also took with them two AT5/AR8's (AWA). It was intended that one of these should be used for point-to-point communications with Labuan and the other kept as a spare. It was found, however, that the RAF, who were controlling aerodrome signals facilities, had insufficient equipment and the spare AT5/AR8 was loaned to the RAF and installed and operated for them by the RAAF as a homing beacon.

A few days later, an AT13C (AWA) transmitter and and AR7 (Kingsley) receiver were sent to Singapore to replace the AT5/AR8 which was being used for communications with Labuan, providing greater power for this circuit. The AR7 was loaned to the RAF on its arrival and was used by them for a point-to-point watch with Ceylon, and the RAAF continued to use a British AR88 receiver which had been borrowed from

RAAF equipment in an RAF truck at Singapore is shown below. At left an AT13C (AWA), at right an AT5/AR8 (AWA) being used as a homing beacon, while in the centre is British Marconi T1190 transmitter.



Reading from top to bottom, the pictures on this page show: An Air Liaison Party of the RAAF Air Support Unit on Labuan using an ATR4A ("Astor") and at right a US-made VHF SCR300. Next shows another Party from this unit with a Jeep-mounted 5043 (foreground) and two AT5/AR8's (AWA) on trailer. Immediately above are two AT5/AR8's in use at the RAAF Command Post at Kuching. Below is an AR88 (US communications receiver) being used by one of the RAAF personnel at Singapore.

the RAF when the AT5/AR8's had been installed in the RAF transmitter trucks.

As a result of this interchange of equipment, RAF and RAAF signals at Singapore had merged into one organisation with the RAF supplying the sites for the signals office and the transmitting station while the RAAF provided some equipment and a measure of assistance in the maintenance of RAF equipment.

Good reports were received of the efficiency of the AT5 transmitter that was used as the homing beacon. Operating on 240 kc/s., it had been reported by aircraft at distances well over 100 miles.

At both Singapore and Kuching there had been no evidence of any Jap ground radio equipment. A few components were found, but the Japanese had been particularly thorough in removing or destroying what radio equipment they may have had operating in those places.

After visiting Borneo, Kuching and Singapore the return trip to Sydney was made via Morotai, Darwin and Brisbane.

RAAF North Western Area

The RAAF North-Western area HQ was located 57 miles south of Darwin on the North-South Road. The CSO W/C Lindo Taylor and his HQ staff controlled the operation of a communications system spread over a very large area.

Signal units within the area included the North-Western Area Telecommunications Unit, which functioned at NWA HQ; the Gorrie Telecom Unit 300 miles to the South; the RAAF station at Darwin; the ADHQ, which was nine miles from Darwin; OBU's at Gove, Batchelor and Truscott; detachments of the NWA Telecom Unit at Fenton and Timor; and 5 RIMU, located near the NWA HQ.

Signals equipment at the NWA Telecom Unit comprised 24 AR7's (Kingsley), five AT8's, four AT13's, two AT13B's (AWA), three AT20's, one AT14S (STC) and one TA2J (Bendix aircraft type transmitter).

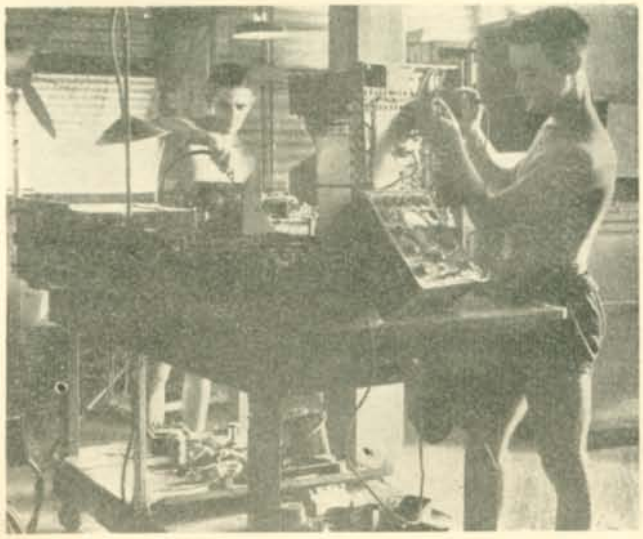
Gorrie was the main meteorological centre and the Telecom Unit there used 29 AR7's, four AT13's, five AT13B's, one AT13C, one AT14A, one AT15A, three AT17's, five AT20's, one TA2J, and one 96/200A, (a US made 5 kW transmitter).

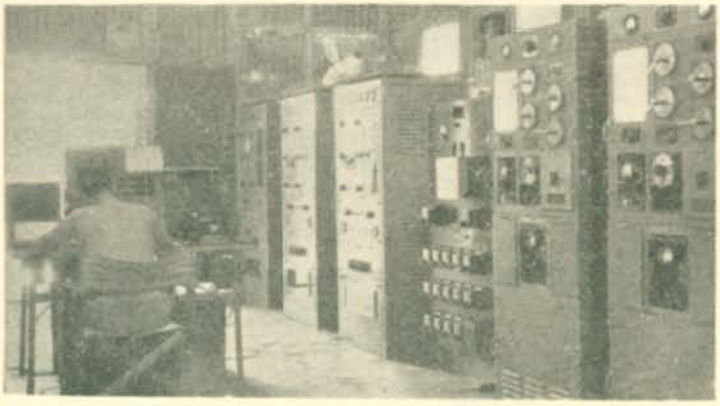
During the later stages of hostilities, the RAAF Darwin station was the main operations centre. The receiving station was located about four miles from Darwin airstrip and the transmitting station was on the North-South Road, about 11 miles out of Darwin. The receiving station housed 15 AR7's and one RA1B (the Bendix receiver from the TA2J transmitter). The transmitters used were two AT8's, one AT13, two AT13C's, two AT14's, one AT15, three AT20's, three AT14S's, one AT6 (200 watt AWA transmitter), one TA2J, one 96/200A, and one SWB8 (an English Marconi transmitter). There were a total of 13 radar stations working with the ADHQ, which utilised 26 AR7's, four AT13B's, six AT14's, one AT14A, six AT17's and two AT20's.

A general view of the ADHQ transmitting station at Darwin.

The OBU's at Gove and Truscott used very similar signals set-ups with 23 AR7's and one RA1B on the receiving side and two AT13B's, one AT13C, one AT14A, three AT17's, seven AT20's and one TA2J as their bank of transmitters, whilst 53 OBU at Batchelor operated on a slightly smaller scale. This listing of the equipments used by the main communications centres in the area gives some impression of the magnitude of the signals requirements for the area. The Radio Installation Maintenance Unit at Darwin was the largest of all RIMU's seen during the the tour. As could be expected, it had the appearance of a more established organisation and the workshops and stores were larger.

Two general shots of the RAAF Darwin transmitting station. At right is a mobile repair bench.





At top right is a general view of RAAF Darwin transmitting station. Top left shows the interior of the ADHQ station at Darwin with a line-up of AT5 transmitters at rear. Immediately above is the interior of the Telecom transmitting station at Darwin with two AT13's (made by AWA).

Radiosonde at Darwin

A Radiosonde station was also operated at Darwin. The Radiosonde consists of meteorological instruments associated with a radio transmitter and attached to a balloon which is released to ascend to the higher altitudes. The small radio transmitter which is part of the equipment, sends out signals indicating readings of the meteorological instruments and these signals are received and interpreted at the ground station. The Radiosondes used were made by Eclipse.

A different type of balloon was used for determining wind direction. It was called a "Rawin" and the only attachments to the balloon were two half-wave dipole reflectors. When the balloon is released its track is plotted by radar, thereby determining direction and speed of winds as the balloon ascends.

RAAF Command

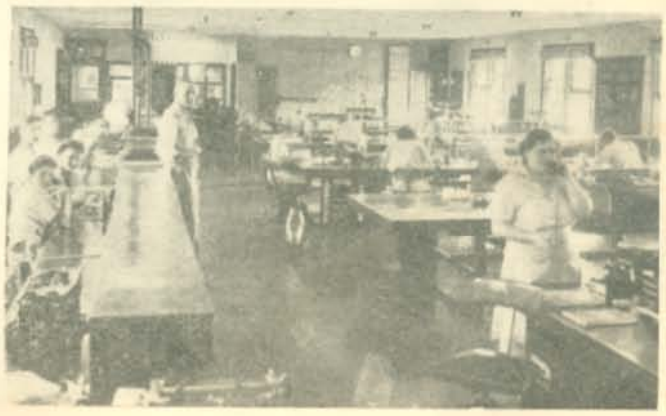
The headquarters of RAAF Command at Brisbane was the control centre for all RAAF operational activities. Although its part in the control of signals in operational areas has already been explained, this account of RAAF signals would not be complete without some mention of its HQ signals set-up.

From the RAAF Command signals office at Brisbane, communications were maintained to Melbourne, Delhi, NW area, NE area, Norcom, 1st TAF, 11 Group, Eastern area, Manilla and Torokina. Although nine AR7 (Kingsley) receivers were installed in the signals office they were kept as emergency receivers, the main bank of 24 AR7's being located in a remote receiving station at Zillmere, about eight miles out of Brisbane.

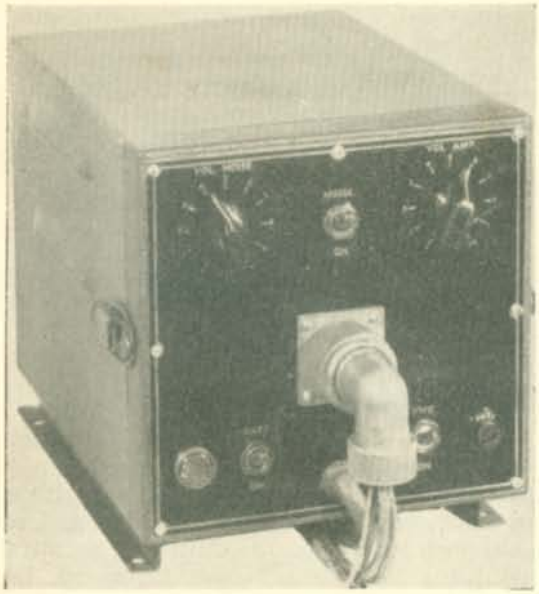
The transmitters used by RAAF Command were provided by 3 Aircraft Depot at Amberly where an RCA 15 kW transmitter was kept for the high-speed circuit to India, and 15 other transmitters (AT13's and AT14S's) were used for the other circuits.

The brief visits to NWA at Darwin and RAAF Command at Brisbane completed the tour that had been commenced ten weeks earlier. During that comparatively short space of time I had travelled approximately 17,000 miles and visited so many places, and so many more individual units and camps that I returned with crowded impressions of the immensity of the task that had been accomplished by the signals organisations of the Australian Services.

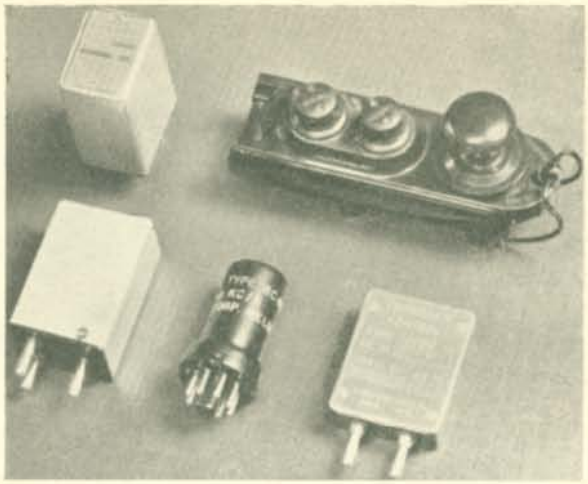
Below left: A "Rawin" balloon being released at Darwin. Right: The sig. office at RAAF Command HQ at Brisbane.



Accessories and Components

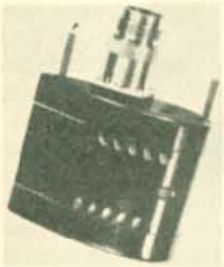


The training of efficient W/T operators provided a real problem for all Services—Bland Radio of Adelaide assisted the RAAF with the noise and interference simulating amplifier shown at left.

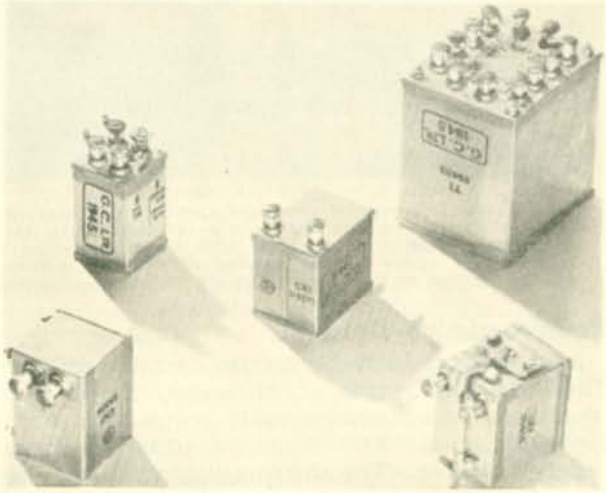


Radio Corporation produced a wide range of telecom. accessories for the Services—particularly valuable work being done with a full range of precision crystal control units. Typical assemblies of this type are shown above, together with a RAAF type "F" morse key, also produced by Radio Corporation.

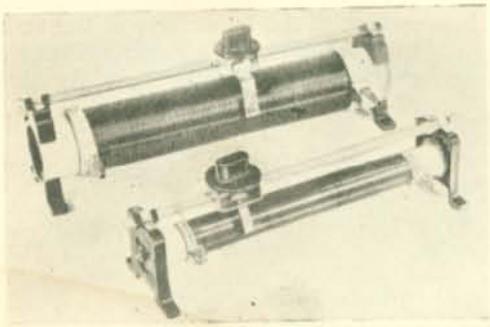
At left is shown a precision radar range potentiometer produced by IRC (W. J. McLellan) for Service use.

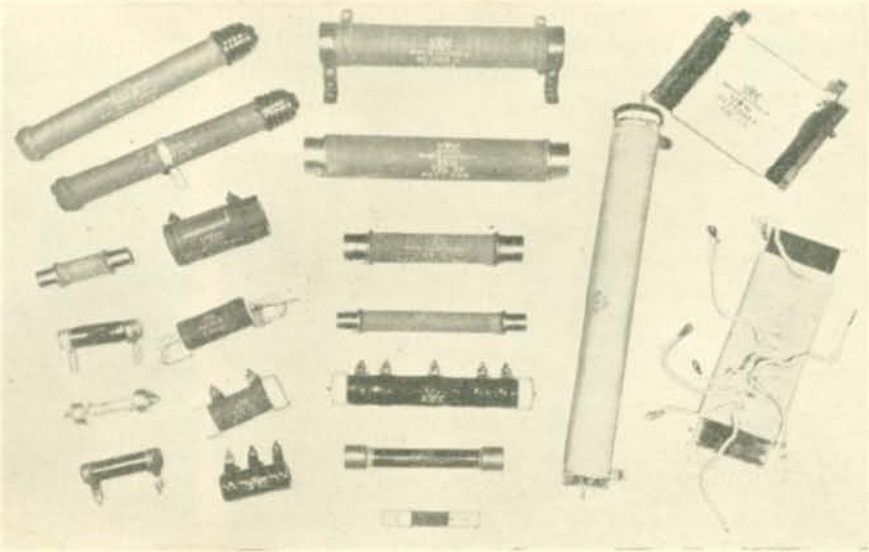


Kriesler of Sydney assisted the Australian aircraft production program with many special electrical items. Here we show an immersion switch (left) and an identification lamp switch (right).



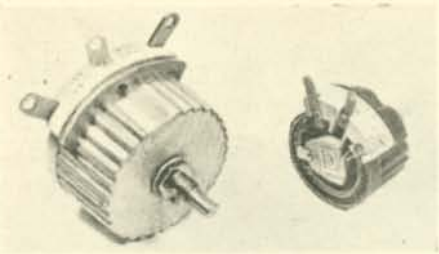
The necessity for "tropicalisation" called for new techniques in component production. Above is shown a group of hermetically-sealed radar transformers built by The Gramophone Co. (HMV). Note the metallised glass lead-out insulators.



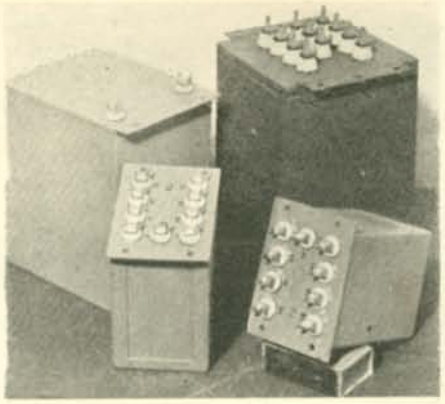


Examples of the variety of resistive components produced by IRC (W. J. McLellan) for the Services are shown above and at right. The rheostats shown above are special controls for marine "degaussing" circuits, while a representative range of wire-wound power resistors is illustrated at the right.

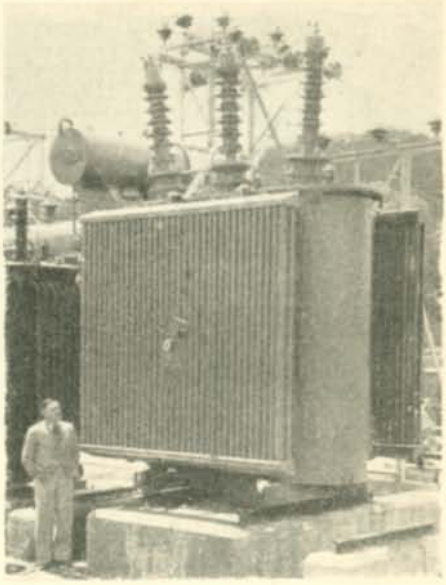
At right are hermetically-sealed equipment transformers and chokes produced by Transmission Products, of Sydney.



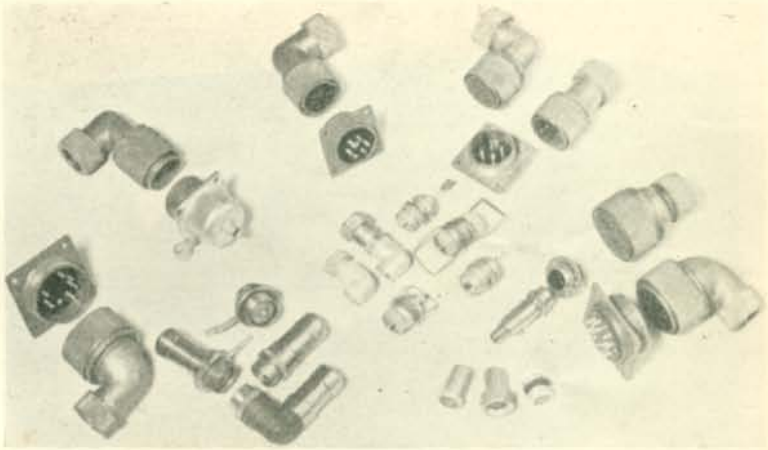
Illustrated above are two items from the range of IRC Power Rheostats produced by W. J. McLellan for Service equipment. Rated at up to 50 watts, these units previously were imported from overseas.



Above and at right are shown two sharply-contrasting examples of the scope of telecoms. production in Australia. At right is a heavy-duty oil-immersed transformer produced by Wilson Transformers, of Melbourne.

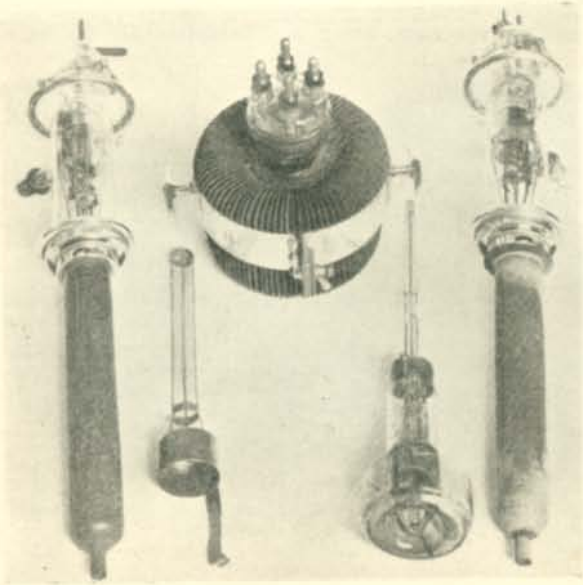


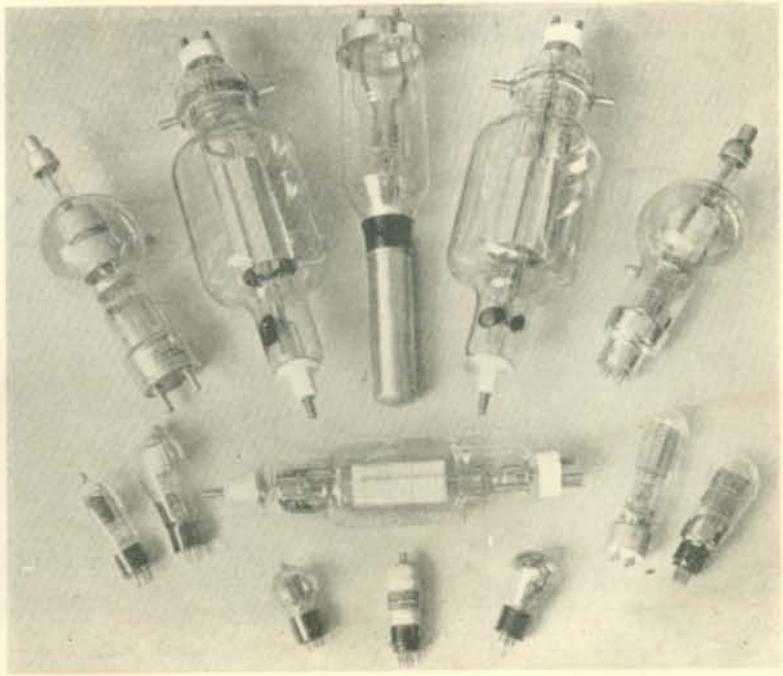
Telecommunications Production Covers Wide Scope

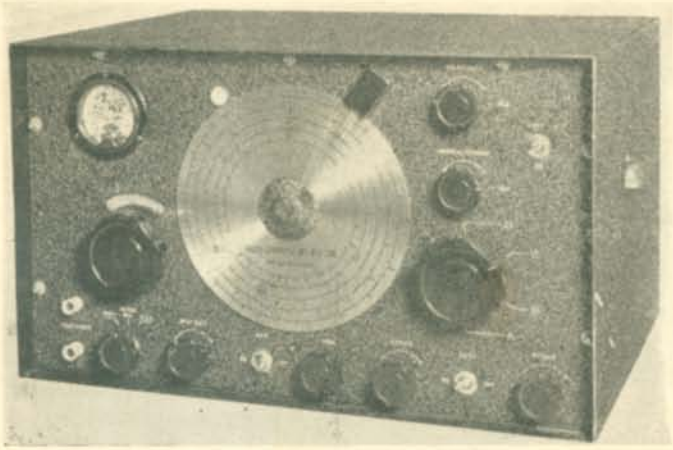


As part of their Radar production, HMV developed a wide range of special coaxial and multi-pin connectors which were used very extensively in Australian telecoms. equipment. Typical items are illustrated above.

Below and at right are shown examples of the stage reached by Australian valve manufacturers during the war. Amalgamated Wireless Valve Co. were responsible for the water and air-cooled transmitting valves shown below, while a group of transmitting and telephone repeater valves made by Standard Telephones & Cables is illustrated at right.

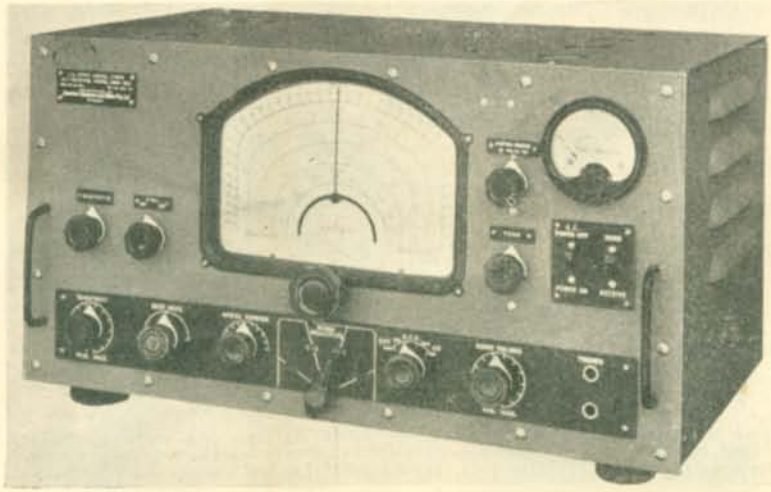






Radio Corporation produced the communications receiver illustrated above for the RAAF who designated it the "AR12" and used it for AOB's and in conjunction with the "AT9" transmitter. A feature of this receiver is that it operates completely from dry batteries, which can be checked by the panel meter. Providing coverage from 150 KC/s. to over 15 MC/s., this set incorporates a crystal filter and a continuously-variable selectivity control.

One of the Amalgamated Wireless series "C6940" general-purpose communications receivers is shown above. These sets were widely used by the Royal Australian Navy for both shipboard and land-station work. Several variants of this equipment were produced for special applications—the set illustrated being the "3C6940," providing coverage of the range 100 KC/s to 3.1 MC/s.



Precision-Built Communications Receivers

Standard Telephones also were active in the production of communications receivers and the STC A679K, adopted by the US Forces as the "AMR300," is illustrated above. This equipment operates from 12V. DC or 110/240V. AC and provides coverage of the range 1.5 to 24 MC/s. The "H" and "J" versions of this set, for rack and case mounting, respectively, were widely used by the RAN.

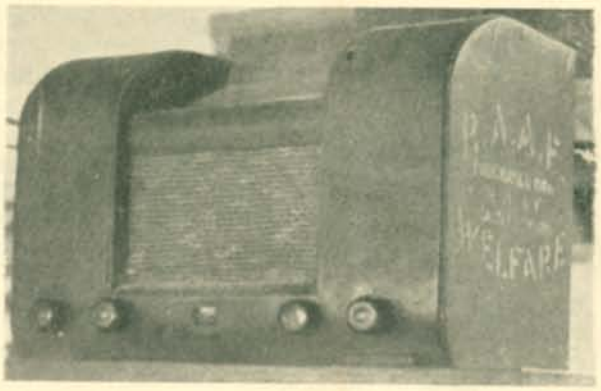
Illustrated below is the "AMR100" communications receiver, produced for the US Forces by AWA. This equipment used plug-in coil assemblies to cover the range 550 KC/s. to 24 MC/s. and operated from 12V. DC. or 110/240V. AC. A rack-mounted version, known as the "AMR101" was used for static installations and also formed the basis of an elaborate "diversity" equipment. A further variant was adopted by the Aust. Army as "Reception Set No. 8C."

Services' Amenities Receivers

In many respects, morale was just as important as communications and a high priority was placed on the manufacture of "amenities" radio receivers for the Armed Forces. Typical examples of such sets, produced by Australian Industry, are shown on this page—some of them photographed "on the spot," and doing the job for which they were intended, by "Retailer's" War Correspondent.

AWA's solution of the demand for "morale-boosting" receivers is shown above—a dual-wave, fully-tropicalised unit designed for battery or AC operation and known as the "C17020." These sets performed particularly well in all areas.

Stromberg-Carlson produced the business-like "amenities" set shown at left and photographed in action at Morotai. This receiver covered two wave-bands and had provision for connection of a pick-up and an extension loudspeaker.



Philips Electrical Industries were responsible for the ACF radio receiver shown at left, above, while Standard Telphones produced the RAAF Welfare set at right. Jack Angus spotted these two in his travels—the Philips in Borneo and the STC at Madang.

No "operational" photographs were obtained of the two sets shown at left and below, but this does not mean that "they were never there"—they were, in a big way! Tasma produced large numbers of their "AM5" dual-wave, dual-power, amenities set shown at left, and the US Forces used them all the way to Tokio. Australian Sound Systems ("Cadet" Radio) were responsible for the "V5" illustrated below and did such a good job that they found it difficult to meet the demand.

Signals with 9 Aust. Div.

*By Colin Mingay**

IT is felt that the Borneo campaign gave a typical picture of the use of signal equipment and for that reason, and also because the writer participated in the second phase (Labuan operations) and was in a position to obtain reliable information, the following information is presented.

At the beginning of 1944, the Ninth Australian Division returned from New Guinea to give the men a spell, some hard-earned leave and to re-equip. In the middle of 1944 the Division reassembled on the Atherton Tablelands in Northern Queensland and made its home near Ravenshoe. Here the job of re-equipping the Division was carried out, and with the large number of reinforcements arriving to bring the Division up to full strength it was essential that an intensive period of training be undergone to familiarise the men with their new equipment, which included the newly-introduced Australian "Yellow Band" No. 22 Wireless Sets in partial replacement of the previously used No. 11 and 109 sets.

For eight months this training continued and solid training it was. In the tropical country around Ravenshoe manoeuvres were practised constantly and interspersed with amphibious operations at Trinity Beach near Cairns.

These manoeuvres were thorough, and it is no exaggeration to say that the demands placed upon the signal equipment were much more severe than those ever incurred when the Division later went into action. The standard method of transport on these manoeuvres was a jeep, and it can be safely left to the reader's imagination to appreciate the shocks, strains and stresses which a wireless set would experience strapped in the back of a jeep which was driven along all manner of roads, through ditches and across fields. Then, having stood up to this treatment the wireless set was expected to do its job of providing communications. By the end of this training period, the Australian 22 set had proved itself as suitable for the job.

The 22 was not the only set used by 9th Aust. Div., as 133's, 112's, 11's and 19's (all by A.W.A.), 108's and 208's (both by Radio Corp.), US F-M SCR300's, SCR-536's (American handie-talkies), and the British 46 set were also used.

The 133's and 112's were used at Divisional Headquarters, the 11's, 19's and 22's between Divisional Headquarters and the Brigade and Battalion Headquarters, while the 108's, 208's, SCR300's, SCR536's and the 46's were used forward of Battalion Headquarters.

At first it did not seem as though there would be much change in the type of line instruments used, but about December a new type of field telephone was issued to replace the D Mk. V. This new phone was known as the "L" phone and, in addition to being of sealed "tropic" design, incorporated a magneto calling system instead of the buzzer used in the earlier instrument. The Fullerphone still remained as our standard telegraph instrument, its capabilities were already known and it could always be relied upon.

Just as the training period was drawing to a close and rumours of embarkation were rife, several additional types of telephone switchboards appeared on the scene, including a 6-line universal call type—a smaller version of the standard 10-line universal call—an American SB-TC12 (12-line) and also a 50-line board, as well as a number of U-C boards converted by the use of new line units for magneto operation with the new type "L" telephones. These instruments were later found very satisfactory.

February and March, 1945 saw considerable activity in the camp. Stores were checked, equipment was overhauled and packing was begun. In March the first parties left Australia and the end of April saw the majority of the Division on Morotai which was to be the jumping-off place for the invasion of Borneo. Two months were spent there, during which time the equipment was unpacked, overhauled and cleaned up in preparation for the invasion.

It was necessary that particular care be taken in regard to waterproofing of equipment. Salt water can wreak havoc if once it gets inside signal equipment. Fresh water is bad enough but the corrosive action set up by salt water can ruin the best equipment in no time at all. Wireless gear that did not have to be used during the actual landing was wrapped in sisalkraft, sealed with pitch and then enclosed in a waterproof rubber bag. The accumulators which accompanied these sets had their terminals covered with an asbestos waterproof grease, the vent holes blocked up and treated similarly—this last being done just before landing and removed at the first opportunity.

Speedy Set-up of Communications at Landing

The large amount of wireless communications from ship to shore during the actual landing on June 10, 1945, was done by special wireless sections whose job it was to keep communications going until the Divisional Signal Units had established their stations ashore and could take over the communications. They used high-powered transmitters and operated from the control rooms on the command ships to the stations on the shore.

There was little trouble experienced in rapidly setting-up the Divisional wireless communications, and Divisional Headquarters soon had two separate networks communicating with the Brigade Headquarters and adjoining units to Brigade Headquarters; one designated "A" wave, the other designated "B" wave. Wireless silence was broken at 100815 (8.15 a.m. on 10th), when the initial landing on Labuan Island was commenced.

The Div. "A" and "B" wave each supplied communication to both the Brigades which had already landed—the 24th Brigade on the beach of Labuan Island, and the 20th Brigade on the mainland about 80 miles

* Ex 9 Aust. Div. Signals

away. The "A" wave was in communication with all four outstations in fifteen minutes. The "B" wave with only two outstations was in communication in six minutes.

The establishment of wireless communication was no easy job as the operators had to contend with both morse and speech interference from numerous other, and in some cases more powerful, stations in the vicinity. However, the Americans, for it was they who had the powerful transmitters, proved extremely co-operative and, when one of their frequencies clashed with ours, would always share the air, when they could quite easily have ignored us and drowned us out.

At 12.30 p.m. Divisional Headquarters had selected their first position ashore and promptly proceeded to establish communication with the 20th and 24th Brigades from that site. Until this time communication with the Brigades had been effected from the Command Ship in the harbour where powerful transmitters had been used, but when the communications were taken over by Divisional Headquarters the 22 set was brought into use. Although this set had a power of only eight watts it was performing a job for which it had been designed, and its performance showed that it had been designed well.

In the next 24 hours Divisional Headquarters Signal Office changed its location twice. This involved the dismantling, packing up, moving and re-establishing of the wireless stations, but in spite of this, 4,500 groups (i.e., words or code groups) were passed in those 24 hours. The following figures show the number of groups passed daily in the first six days of the campaign and the number of articles handled by the S.D.S. The S.D.S. is the Special Delivery Service which is the task performed by the Signals Despatch Riders.

June	Wireless	Line	S.D.S. Articles
10	8060	986	146
11	23852	6972	1298
12	22278	6854	662
13	19596	5220	677
14	18582	5860	648
15	16785	4907	555

The busiest day experienced by the wireless personnel was 18th June when 28,916 groups were handled.

Jamming

Only one instance of deliberate jamming by the Japs was reported. This occurred on June 11, the day after the landing, when Sig. Greg Shelley, who was working a 22 set in the Brunei area on the mainland, reported two Japanese conversing on his frequency. Unable to change frequency he continued to work through them so they then began to send a carrier sweeping to and fro across his frequency. He continued to work through this new interference and after about half an hour the Japanese sprung a new trick and the carrier changed to an intermittent noise resembling the interference given by an unsuppressed vehicle. Unfortunately for the Japs, however, they still could not prevent Sig. Shelley from passing his traffic, and though they kept this interference going for seven hours were completely unsuccessful.

Security Relaxed After Surrender

When the Japanese surrendered in August a change took place in the work Signals were called upon to do. Orders came through from Landforces relaxing the degree of security which had been previously necessary. Apart from forward areas all wireless traffic had been sent in cipher, but with the easing of the regulations, traffic relating to comparatively non-vital matters was not enciphered. This traffic covered such information as increases in allotments to dependents, requests for compassionate leave and messages passed for the British Borneo Civil Administration.

In addition, it was now permissible to use speech over the radio—beforehand only morse communication had been allowed. It was decided therefore to introduce a radio-telephone service between Divisional Headquarters and the Headquarters of both the 20th and 24th Infantry Brigades. At this stage Divisional Headquarters was situated on Labuan Island and the 24th Brigade was at Beaufort, approximately 40 miles from Labuan on the mainland, while the 20th Brigade was at Kuala Belait about 80 miles south of Labuan on the coast of the mainland.

It was decided to use 22 sets (Radio Corp.) for the job and two detachments were equipped with them and sent out to the respective brigades. At this stage supplies of the new model 22 had arrived and one was given to the detachment which went to the 20th Brigade. This new model was a later production version of the "Yellow Band" sets originally issued.

The purpose of the radio-telephone service was to provide the Divisional Staff Officers with instant communication to the staffs at both Brigade Headquarters. Normally there would have been a line telephone service but as Divisional Headquarters was on an island, this was not possible. The control radio set at Divisional Headquarters was "remotely controlled" and connected to the switchboard in the Divisional Signal Office, which in turn was the central switchboard for all the telephones in the Divisional Headquarters area. The switchboard in the Divisional Signal Office also had trunk lines to all other exchanges on the Island. This meant that anyone on the Island could contact the Divisional Signal Office and be connected by radio through the switchboard to either of the Brigade Headquarters on the mainland. Both Brigade Headquarters had wireless and line communication to their respective battalions and when required could request any particular battalion to tune in on the frequency of the radio-telephone service and speak to anyone at Divisional Headquarters.

By this time the Army had done its best to make it a "9 till 5" war. The fighting was over and all that remained to be done was the rounding up of the Japanese forces and the collection of their arms and equipment. Unfortunately communications still had to be maintained 24 hours a day, and so a certain percentage of the Signal personnel were on duty at night. Radio telephone service, however, only operated as such during the daylight hours. There was practically no necessity for it at night and it was not usable for speech between 6 p.m. and 11 p.m. due to the heavy static so common in tropical regions. So at night time it became a link for passing ordinary messages by wireless telegraphy.

This radio-telephone service gave even better results than had been expected, and completely satisfied the Divisional Staff who, without it, would have had considerable difficulty in co-ordinating the disarmament of the Japanese forces, and it is safe to say would have had to spend a considerably longer period in completing that disarmament. A senior Signals Officer who

had been with the Ninth Division in the Middle East in charge of a wireless section, said that in all his time in the Army he had never known a wireless link to give such excellent service.

A large amount of the credit for such a successful job goes to the operators who worked on that link, but it can be said without fear of contradiction that it was mainly due to the excellent performance put up by the Australian made 22 set that the service was such an outstanding success.

It had its lighter side, however, in one sense it was a veritable 24-hourly "Information Please". Troops everywhere seemed to know about the service and it was quite a common occurrence for some person to call up one of the stations with a message for someone whom he could not contact by normal means and request it be passed for him. There was even the bright spark who suddenly came on one Saturday afternoon without identifying himself and requested the placings in the third race at Randwick. He got them!

Outstanding Success of Radio

In the Borneo campaign the Australian troops equipped with No. 22 sets, No. 11 sets and No. 19 sets and with good operators to work them, definitely proved how successful and essential is radio communication in modern warfare. It has been said that radio communication is particularly essential in armoured operations but in jungle warfare it proved equally essential. The laying of lines in the jungle is an extremely difficult, complicated and hazardous task and for that reason did radio prove itself invaluable. It was there when it was wanted.

Experiences with Signals Equipment

The following information has been compiled from official Army records and was obtained from an inspection of data held by the 9th Divisional Signals. Every Signals Section under the control of 9th Divisional Signals sent in periodical reports giving information as to the performances of the various types of equipment used by them, common faults that were experienced in that equipment, and suggestions for remedial measures.

The standard Army field telegraph instrument, the Fullerphone, an instrument which had already proven itself, still continued to do an excellent job. The high-powered telephones were most satisfactory although their high inductive qualities gave them a doubtful degree of security. The new field telephone—the L phone—gave good service as a telephone and its waterproof "tropic" design was a definite advantage. All types of switchboards performed satisfactorily which was most gratifying as trouble with them would have hampered communication considerably.

The Reception Set No. 4 (Philips) gave little trouble, and was used as the standard receiver with the 133 (A.W.A.) transmitters.

The frequency-modulated American SCR300 set did a good job and it was suggested should be used instead of the British 46 set. However, its extra weight and inability to work with A.M. sets made this suggestion rather impracticable. The American made SCR536 set—the "handie-talkie"—was a problem set. Few spare parts were available for these sets, with the result that in the case of a major breakdown a set instead of being repaired would be written off as unserviceable. However, when in working order these sets were a distinct asset to communications and proved extremely valuable.

Slight troubles were experienced with the 46 set (British) but it performed well, and one instance was noted of a set being completely immersed for 15 seconds in water, but performing perfectly after the battery was changed. Possibly the set with the best record of any was the 108 Mk. III (Radio Corp.). This portable set used in forward areas, was spoken of very highly by all ranks and gave little trouble. They could be relied upon to give 12 to 15 hours' running on one dry battery pack.

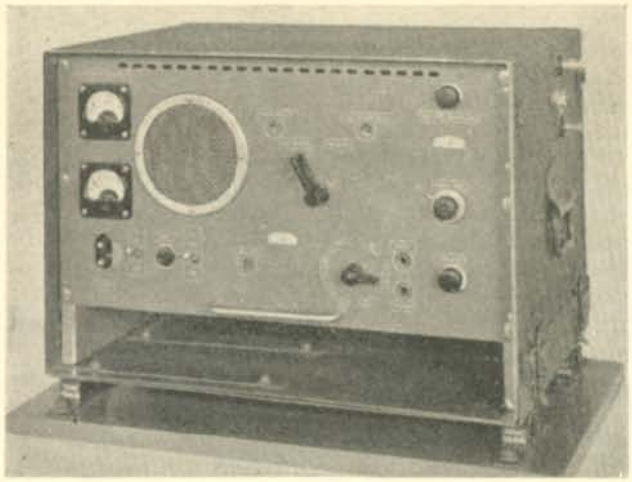
To provide communication over the long distances between Divisional Headquarters and Corps Headquarters A.W.A. made 133's were used in conjunction with the No. 4 reception set (Philips). These 133's with a power of 300 watts did a very good job, particularly in supplying communication from Labuan across Borneo to Tarakan (where the 26th Bde. of 9th Aust. Div. was established), and Balikpapan (held by 7th Aust. Div.), and also to Morotai.

For special wireless jobs at Divisional Headquarters involving the use of a more powerful set than the 22 set the 112 (A.W.A.) was used. This set was particularly good for passing morse traffic, though its speech communication was not favoured.

No. 19 sets were used initially in the Headquarters Ships and the new Australian pattern proved very satisfactory in tanks though it was found that vibration affected the 6G8G's, 6J8G's and 6U7G's. Broken bases and grid caps were a common fault.

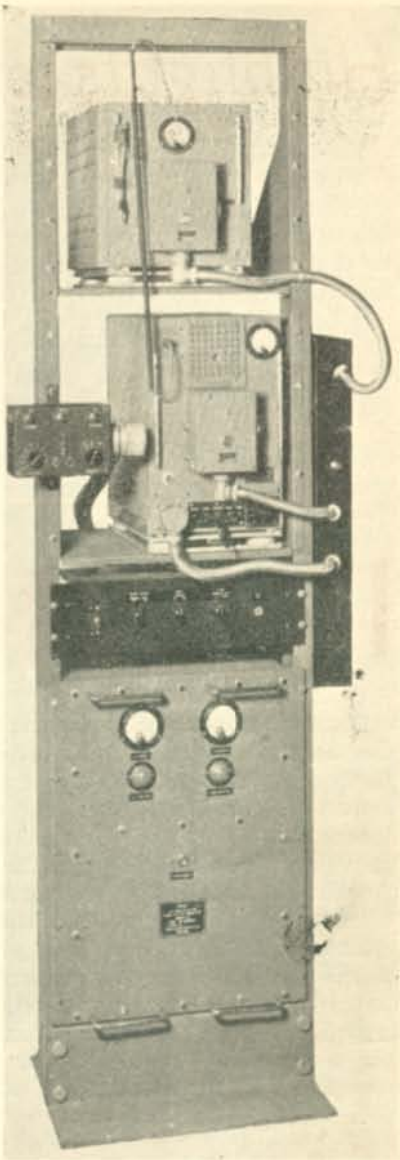
The bulk of the communications from Divisional Headquarters through Brigade Headquarters to Battalion Headquarters was handled by the 22 set (yellow band). These sets were the original ones issued a little more than 12 months previously and, due to the rough handling they had received during the training period in Queensland, were not in the best shape. However, the results provided by these sets were excellent. On two separate occasions it is recorded that an operator working from Beaufort to Weston—a distance of 18 miles through dense country—went outside his tent and found his aerial lying in water on the ground. He did not know how long it had been like this as it had not affected his communications in any way.

The successor to the 22 Yellow Band was the 22 (Aust.) which reached the Division just after the landing at Labuan and of which supplies were issued as soon as they had been unpacked and checked. This new 22 gave even better results than the Yellow Band model. It had a more sensitive receiver, a more powerful transmitter and structurally it was a stronger set. The "flick" mechanism was of an improved design and worked very accurately. Its performance was all that could be desired. A pleasing feature was the increased length of the microphone cord due to its being joined to the headgear at the snatch plug instead of at the yoke made by the junction of the leads from the individual headphones. Although the establishment of 22 sets to the Divisional Signals Wireless Section was nine, only three new 22's were allocated to the section as the initial supply was limited and other sections had to be considered also. No more were received by the Section and in December, 1945, it was relieved of its duties as a Wireless Section and its equipment handed over to the relieving units. As a result there was little opportunity of thoroughly testing the new model 22.



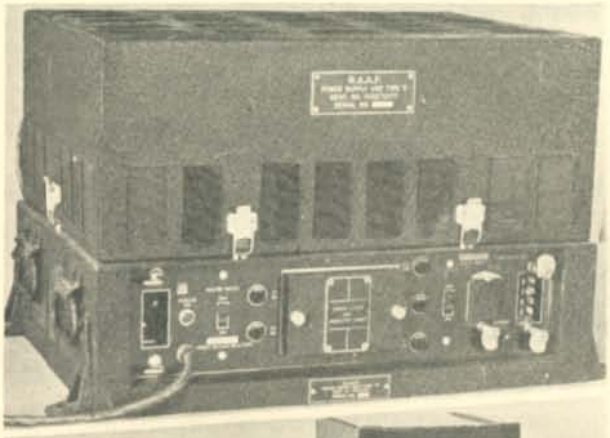
The compact transceiver illustrated above was produced by Philips Electrical Industries for the RN, RAN and USN. Known as the "DR106," this equipment is a 20-watt assembly working in the 60-80 MC/s. range and can be operated from battery or AC power supplies.

The rack assembly shown at right is a mounting frame and power supply unit produced by Radio Corporation for the RAAF to permit operation of Bendix (US) TA - 2J - 24 transmitters from AC power supplies. The unit was known as the "RC58" and converted the transmitter, originally installed in Catalina aircraft, into most efficient ground station equipment.

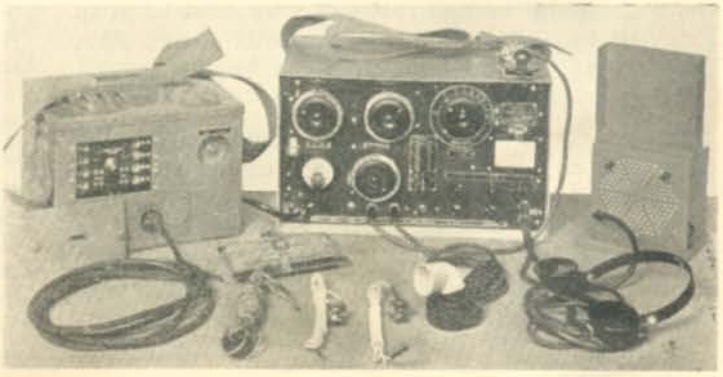


Transmitter-Receivers and Power Supply Units for Navy and Air

Another example of a "conversion" unit for an aircraft transmitter is shown below. Designated "Power Supply Unit X" by the RAAF, this assembly was built by Airzone and enabled the T1154 UHF equipment to be operated from AC power supply as an efficient ground-to-air communications unit. The employment of units such as this and the "RC58" simplified equipment problems considerably by making possible uniformity of apparatus without excessive battery charging.



The RAAF type "ATR2C" transmitter-receiver made by Radio Corporation is illustrated below and is one of a series of equipments which were used extensively for ground operations. Providing coverage over the range 3-7.5 MC/s. and an RT/CW power output of 10/15 watts, this equipment could be used with either battery or AC power units. One version of this set was used with great success by Army during the Timor "commando" operations and was adopted for general service as "WS No. 114A."



Highlights of the Industrial War Effort

Although it originally was planned to include in this publication a more or less detailed review of the activities of the various organisations which were involved in the production of telecommunications equipment for the Australian war effort, the steadily-mounting pile of information which has been amassed during compilation has demonstrated that the incorporation of such a detailed review would require a much more expansive publication.

However in the following pages we have reviewed the activities of representative groups of manufacturers and suppliers, as a typical cross-section of the Industry, with the prime object of rounding out the picture presented by other sections of this publication.

In compiling this review, no attempt has been made to mention every firm that contributed something to the production of telecommunications and associated equipment—that particular aspect has been covered in the "Honour Roll" schedules—nor has any attempt been made to mention every activity of those firms that have been mentioned. As stated above, the prime object has been to provide some elaboration of information given elsewhere in this publication, and thus broadly outline the industrial background which made possible the mighty production achievement which won the unstinted admiration, not only of Australia's leaders, but also that of her Allies.

For convenience of reference, the following review has been sectionalised into various groups of manufacturers and suppliers—major and minor equipment contractors, test equipment and component manufacturers, and so on—as it is felt that this grouping will provide a better indication of the activity in each particular field. By way of avoiding any misunderstanding, it may be pointed out that the terms "major" and "minor," as used, do not bear any direct relationship to the status of the organisations included under those headings—the terms refer purely to the nature of the equipment produced. Thus a complete radio transmitter is a "major" item, whereas a power supply unit —which may form only part of a major assembly— is a "minor" item.

Major Equipment Contractors

It is only logical that **Amalgamated Wireless (A/sia) Ltd.**, by virtue of its manifold activities and Government participation in its structure, produced the largest range of "major" equipments in the Telecommunications field. Although Commonwealth-wide in its ramifications, AWA has located its headquarters and manufacturing organisation in Sydney and its suburbs—the major production centre being the Radio-,Electric Works at Ashfield, where the factories in the group occupy about 13 acres of space. During the war, several branch factories were established in dispersed locations and, at peak, a total of over 5,000 people were employed, using about half a million square feet of actual floor space.

On the equipment side AWA was responsible for the production of a full range of radar equipment, radio transmitters ranging up to 10kW in power, static and mobile receivers and transceivers, a wide range of accesories, high-grade testing instruments, quartz crystals for frequency control and signalling lamps. Other activities, outside the purely telecom. field, included the production of shell fuses, aero. navigation instruments and high-frequency induction heaters.

In all, AWA's war production reached a total value of over £13,000,000 and included no less than 20,000 radio receivers, transceivers, and transmitters and over 70,000 aero. instruments—these last being in 60 different variations of 22 basic types.

Notable among the radio equipments produced in quantity by AWA were the widely-used "Teleradio" and the equally popular RAAF AT5/AR8. The first of these was a transportable 10-watt transmitter-receiver assembly developed from a pre-war design and was used by all Australian and Allied forces throughout the SWPA—one of its outstanding applications being as equipment for air-watching posts established in remote locations, in many cases deep in enemy-occupied territory.

The "AT5/AR8" was developed to a RAAF specification for a general-purpose 50-watt air-ground transmitter-receiver which also could be used for D/F and "homing" purposes. The eventual applications of the "AT5/AR8" far exceeded even the wide scope of the original intention, it being adopted by all Services—Army had minor modifications made to the ancillary equipment and called it "WS No. 112"—while other variants were produced, using the transmitter assemblies as the US Forces' "TW12" and "AMT150."

Other widely-used AWA products were the Army WS No. 133, 300-watt transmitter; the RAAF AT13 series 500-watt transmitters; the marine J5385 series 750-watt transmitters; the AMR-100, 101 and C6940 series communication receivers; Army field wireless transmitter-receivers 101, FS6 and 11; and the Army No. 19 dual transmitter-receiver and crew-communication set for use in armoured fighting vehicles.

In the communications field AWA, who pioneered, owned, and operated the Beam Wireless Service to UK, North America and other countries, increased its wordage traffic from 13 million in 1939 to 50 million in 1944. Its picturegram service handled a maximum of 354 pictures a year before the war, but in the eight months July, 1944 to February, 1945, this was raised to 1,387. Over 27 different pictures of the "D" Day

beach landings were published in one day by Australian newspapers.

The AWA Marine service played its part, too. During the last two years of the war over 1,200 overseas ships and hundreds of local ships were serviced, in addition to the supply and installation of a large number of complete radio equipments in Australian-built ocean-going ships and small craft.

Before leaving AWA, it is of interest to note that this organisation was one of the major contractors which shared production of the 100kW short-wave broadcaster established by the Federal Government at Shepparton, Victoria.

While dealing with AWA, it is appropriate that attention should be paid to the activities of its associate valve production organisation, **Amalgamated Wireless Valve Co. Pty. Ltd.**, also located at Ashfield, N.S.W., which commenced manufacture of "Radiotron" valves in Australia during 1932.

Although at first, AW Valve Co. production covered only receiving types, development of transmitting and special Service type valves was commenced during 1937 and first deliveries were effected during 1939. After the outbreak of war, new types were introduced and production facilities were expanded.

By the end of 1941, production had increased 50 per cent. over pre-war, and during 1942 over 2,000,000 valves were produced. Employment went up from about 300 to almost 800 persons, and even an extensive fire at the works during 1944 failed to do more than temporarily interrupt the steady flow of production.

In addition to the steady expansion of production, new valve types were constantly being added to the Australian Radiotron range, and most major types required by the Services were produced.

During 1942, a special valve section was established in co-operation with the Radio-Physics Division of CSIR, to undertake secret research and production of valves for Radar equipment.

As a result of this tie-up, Klystron receiving valves, special magnetrons, and silicon-crystal detectors were produced—the first Klystron being produced within three weeks of the receipt of technical data. In addition, several types of "centimetre" magnetrons were produced, as well as gas-filled TR switches.

As a final note on AWA's activities, mention is made of the valuable work carried out by the **"Telcon"** Division, which provided very considerable assistance to the Services and equipment manufacturers in the supply of special high-frequency cables.

Leaving New South Wales for the time being and turning attention to the southern States, the first organisation to attract notice is the **Electronic Industries** group—an organisation that was responsible for the lion's share of telecoms. production outside of N.S.W. One of the subsidiary manufacturing concerns of Electronic Industries Ltd., namely, **Radio Corporation Pty. Ltd.**, of South Melbourne, Vic., was selected during 1942 as the manufacturer of the Australian Army No. 22 set, which was required urgently to meet the new warfare conditions then being encountered. The company (known as manufacturers of Astor Radio) already heavily engaged on other equipments for all the Forces, entered into this project with determination and vigor and produced results that met, not only the operational problem, but also with the approbation of the American and British Armies.

This achievement was not by any means Astor's only contribution to the war effort, as, early in the war and long before "Pearl Harbour," Astor produced for the Army many one-man portable radio sets (Wireless Sets No. 108 and 208), also low-power portable radio telephony sets (ATR4A) for the RAAF, which were used, among other instances, by the US Army to supply their Intelligence Officers in the Philippines and other places held by the enemy. This type of set was also very successfully used by the Australian Forces marooned in Timor. The Australian Navy also participated in Astor production and found wide use for the RC8 transmitter-receiver, which was developed from a somewhat similar equipment (the ATR2 series) produced for the RAAF.

The introduction of Frequency Modulation impelled the RAAF to demand a radio transmitter and receiver that would operate on both AM and FM. The AR17 Astor receiver, with a frequency range of 100-150 mc/s, to work in conjunction with the AT17 Tasma transmitter, proved most satisfactory, both for communications and as the basis of a VHF D/F equipment.

Another of Astor's Radio's contributions was the development of piezo-electric quartz crystals for frequency control in radio equipment. In addition to its production activities in this respect, the firm also developed a quartz mine at Glen Innes, N.S.W., which filled a dangerous gap when overseas supplies of raw quartz were threatened.

Another manufacturing division of Electronic Industries Ltd., in South Melbourne, Vic., was **Eclipse Radio Pty. Ltd.**, whose change-over from purely domestic radio set production to that of Radar, 500-watt radio transmitters and highly efficient communication receivers plus many other items, was an eye-opener to many, who may have thought "they can't do it!"

The Eclipse effort on the production of Radar, for use in conjunction with anti-aircraft guns equipped with predictor apparatus, was more than eye-opener. They also made Radar apparatus for shore defences and acquitted themselves with merit. The ASV Radar was another specialised equipment that came out of the Eclipse factory. In association with Astor, they assisted in many other items, too.

The production of an 18-valve communication receiver (AMR200) to operate from 110 or 200/240 volt, 40/50 cycle A.C. supply or from a 12-volt accumulator, on a frequency range of 1,250 kC to 30 mc/s was undertaken for the US Signal Corps, which recorded by letter its appreciation of this particular receiver as being equal to, if not better than, a similar type of receiver made in USA.

To jump into the manufacture of a 500-watt H.F. Transmitter (AT20) as a mobile unit was no simple task to a factory that had never before done such work, but again the combined resources of the Electronic Industries organisation enabled excellent results to be achieved. And finally, the production of the Radiosonde for RAAF meteorological purposes, proved again that Australian initiative and engineering can produce results comparable to overseas production.

Before leaving the Electronic Industries group, it is of interest to note that, hundreds of miles away from Melbourne, where Astor was busy on the Aust.

Army 22 set, **National Radio Corporation Ltd.**, of Adelaide, S.A. (also a division of Electronic Industries), organised to produce, among other items, Remote Control units, type F for use with the 22. Remote Control of equipment was an essential requirement in operations. The transmitter location could be spotted by the enemy and bombed, so control from a distance permitted efficient siting of the radio set without disclosure of, or jeopardy to, the site of the signal office.

Radar Production

Mention already has been made of the work of AWA and Eclipse on the production of Radar equipment, and to view the work of these and other firms in its true perspective it is important to bear in mind that, although Radar production always was rated as "absolute" priority, its "ultra secret" classification at first made it difficult for engineers and manufacturers to understand fully what they were doing or what they were expected to do. This situation, largely unavoidable, cost much worry, sweat and almost tears, until those concerned learned the hard way and were gradually let into the secrets of this fascinating and extremely intricate equipment.

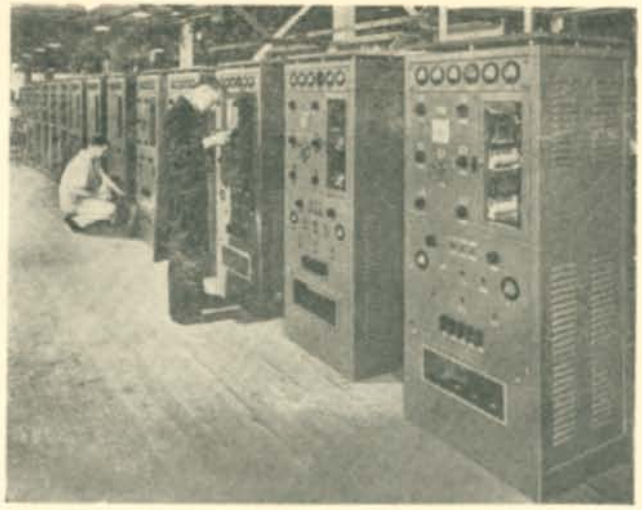
One of the outstanding Radar production sources in Australia was **The Gramophone Co.** (HMV), whose factory at Homebush, N.S.W., was devoted almost exclusively to Radar, and turned out over 5,000 units of Radar equipment and associated test gear. It was not a case of just following a blue print. Original design, research, and improvisation resulted from the efforts of HMV engineers and production staffs, who have every reason to be proud of their achievements. Theirs was not the luck of having big production runs—rather were they called on to perform miracles in radar equipment production that must have taxed their physical and mental resources no end.

One of the first Radar items produced by HMV was the CSIR-designed "LW/AW" (Air Warning) equipment which was developed early in 1942. This transportable equipment earned great popularity with the RAAF, and later with the American Forces, who recorded their appreciation in writing of these Australian-made equipments. Other equipments and modifications to overseas equipments followed, and at the close of the war, HMV had commenced production of a lightweight, fully-tropicalised Radar identification and navigational device for use by aircraft and air-borne troops. Complicated though the Radar sets were, their associated test equipments were equally complicated, yet HMV successfully achieved results that received the approbation of all who had the opportunity of using such essential equipments.

Another phase of HMV's activities was the production of a wide range of co-axial and multi-pin connectors. These originally were developed for use in the fabrication of Radar apparatus, but their characteristics were such that they found wide application in many other items of telecommunications equipment.

Another meritorious contribution to Radar equipments was made by **A. G. Healing Ltd.**, of Melbourne, Victoria, who specialised in ASV receivers and auxiliary test equipment for Radar installations.

Production of the CSIR Photocell Chronometer for measuring muzzle velocity of projectiles for purposes of range finding and correction was another of Healings' activities. This equipment, which has been dealt with elsewhere in this publication, originally was developed by CSIR for the Army, but later found application in ships of the RN, RAN, and RNZN.



Final assembly of RAAF AT8 transmitters at STC's Sydney factory.

To provide the maximum utilisation of their well-equipped machine shop, Healings also manufactured over 500 capstan lathes, as well as a quantity of 150 cm. searchlight projectors.

Leaving the Radar production picture for a while and turning attention to the broader aspects of telecommunications, it is necessary to pay due tribute to the part that **Standard Telephones & Cables (A/sia) Pty. Ltd.**, of Alexandria, N.S.W., played in Australia's war effort. This Australian branch of a world-wide organisation has always played a major role in this field, and during the war its activities were considerably widened.

Long established in this country, STC's factory occupied 30,000 square feet in 1936 and employed 250. In September, 1939, it was increased to 75,000 square feet with 500 employees, and again 1941 to 100,000 square feet, with 1,000 employees; but at VP Day they had 250,000 square feet and 2,200 employees. Those figures speak for themselves.

Early in 1939 S.T.C. tendered for the manufacture of an Australian Army field wireless set to be an effective substitute for the No. 9 British set. As a consequence the Aust. 109 was designed and produced. This equipment served Aust. Army Signals in the Middle East campaign and the Forces back in Australia and, although designed for only 25 miles range, the STC 109, with improvised aerials, covered radio circuits 200 and more miles along Australia's coastline when other equipment was in short supply. Over 1,500 of these were produced.

By way of contrast to this, it is of interest to note that the RAN 200 kW LF radio-telegraph transmitter at Belconnen, near Canberra, was manufactured and erected by STC, who also supplied three 20 kW HF transmitters and some smaller equipment for this same Naval station. Also in the high-power field, STC was responsible for part of the production of the equipment for the 100 kW Government short-wave station at Shepparton, Victoria.

In between these extremes, STC was active in the production of 500/1,000 watt ground and mobile transmitters, particularly for the RAAF, and of these, about 1,000 complete equipments were produced, notable among them being the "14.S" and "AT20" series.

STC's activities were by no means restricted to radio, as this firm has always been a specialist in the line transmission field, and here its contributions were of particular value. The equipment produced in this sphere ranged from Army field telephones (types "D," "F," and "L") and 10-line switchboards to complex multi-channel carrier telephone and voice-frequency telegraph systems—these last being produced both for the Services and the PMG's Department. The production of telephones and associated hand-sets, etc., ran into many thousands, while literally hundreds of thousands of keys, switches, jacks, etc., were manufactured for inclusion in various other items of line equipment.

Considerable work was done on specialised items of fire-control equipments, and over 8,000 magslip connectors were produced for use in anti-aircraft predictor equipment. Another specialised job undertaken was the production of a radio-operated height-indicator for use in RAAF torpedo-bombers.

Prior to the war, STC had commenced production of selenium rectifier assemblies, and this activity was considerably expanded during the war period—over one million discs being produced, together with large numbers of complete rectifier assemblies and charging units.

Mention must also be made of the work of STC in the production of Radar, Radio and Telephone Valves. This was commenced as a war-time project and was concentrated largely on types to meet the requirements of the Services. Items produced included special repeater valves for carrier telephone systems; high-power mercury-vapour rectifiers; transmitting valves ranging from 15 to 1,200 watts anode dissipation; and four types of special Radar valves.

The contribution made by Australia's Telecommunication Industry was not always limited to that field, because, as has already been seen, quite a number of organisations possessed facilities that were utilised during the war for making other things.

This was particularly evident in the case of the Australian branch of another overseas organisation —Philips—and the wide sphere of activity of **Philips Electrical Industries** in Sydney and Adelaide even included naval gun sighting gear, gun mounts, Astro compasses, and all kinds of lamps and lighting, as well as a variety of "telecom" equipment.

Philips in Australia possess one of the only three valve-producing plants in this country, which although hardly under way when the war broke out, made its contribution to that important phase of requirements. Among other things, this factory undertook the job of developing and producing the first cathode-ray tubes made in Australia.

Radio transmitters, large and small, for the Australian and Allied Forces, came out of their factories. Complicated communication radio receivers by Philips functioned well in operational areas.

In sound amplification and inter-communication equipments for the Fighting Services, ARP Services and industrial application, they did an excellent job. Their staff of specialists were always prepared to, and did, carry out a number of projects entirely new to Australia.

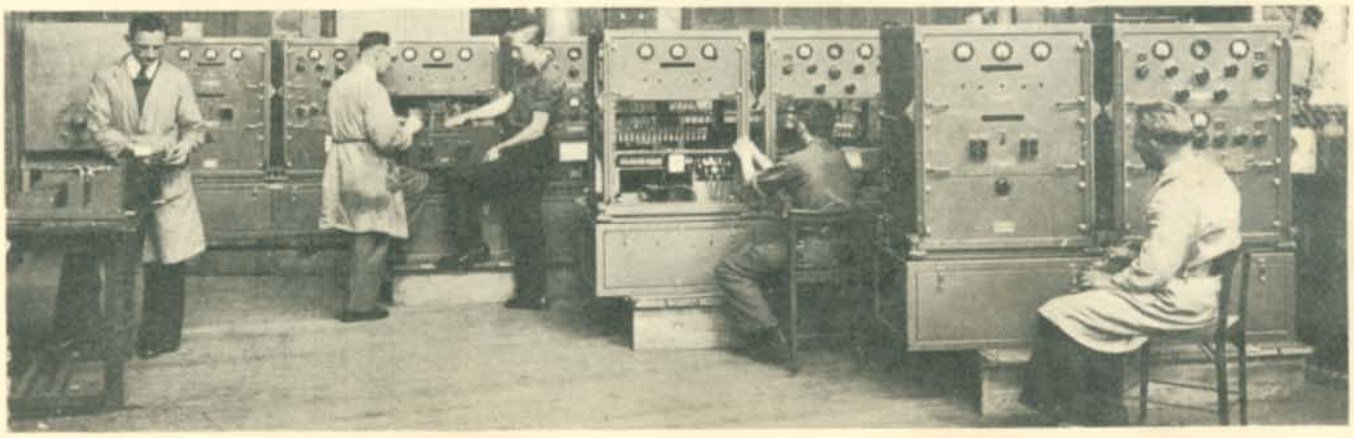
Not the least of Philips' activities in the telecommunications field was the production of precision testing equipment for workshop and laboratory use—a notable example of this type of apparatus being the "TA101" series of Signal Generators which were used by all Services for Radar and Radio equipment installation and maintenance.

Several factories were engaged in Philips production activities—the main apparatus and valve works being in Sydney, with another factory making sound equipment in Adelaide.

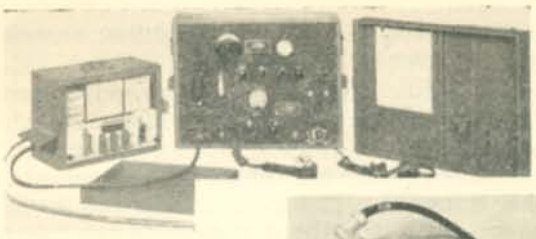
Another example of an organisation producing a wide range of equipment, in addition to its basic activity in the telecommunications field is provided by **Airzone (1931) Ltd.**, of Camperdown, N.S.W., which switched from its peace-time work on domestic radio sets, vacuum cleaners and auto-ignition coils to produce a wide range of Radar apparatus, dynamotors, aluminium cases for field telephones, aircraft carburettor parts, fractional horse-power motors, casings for hand grenades and, last but not least, submarine detection gear.

During the war Airzone established a new factory, occupying over 30,000 square feet, and in the course of their war-time activities, produced over 200 complete Naval Asdic equipments for anti-submarine operations, several hundred HF wavemeters, 500 power supply units of various types, and quantities of ASV Beacon transmitters, Radar equipments for searchlight control, and Cathode-ray oscilographs for Radar

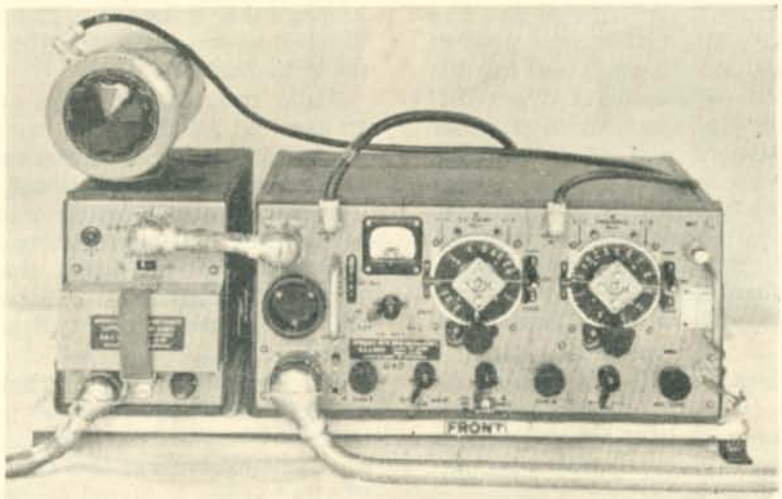
RAAF AT20 transmitters on the production line at the South Melbourne factory of Eclipse.



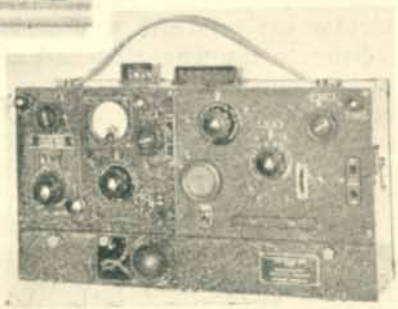
Transmitter-Receivers for all Allied Forces

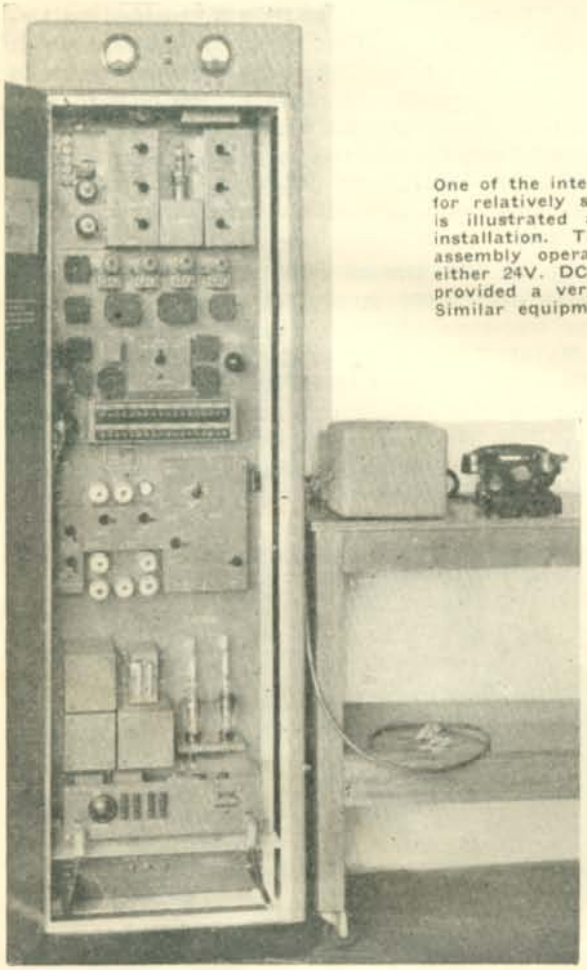


This group of three illustrations reveals the developmental trend of medium-power, vehicle-mounted transmitter-receivers for the Australian Army. The small illustrations above and at the lower right show the STC "109" and AWA "FS6," respectively, while the remaining equipment is the AWA-made No. 19 Mk. 2 (Aust.).



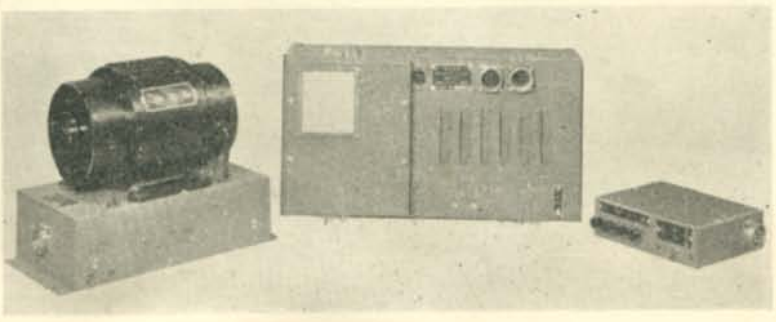
Army wireless sets "109" and "FS6" originally were produced as substitutes for the British Army mobile wireless set No. 9 and performed very valuable service. However, the emphasis on mechanised warfare necessitated production of a much more elaborate equipment, comprising two separate transceivers and a crew intercom. system for installation in armoured fighting vehicles. The prototype for this set was the British No. 19, which had replaced the No. 9, and Australian development was commenced during 1941. The contract was successfully executed by Amalgamated Wireless and considerable quantities were used, not only in AFV's but also in other vehicles and small-craft.

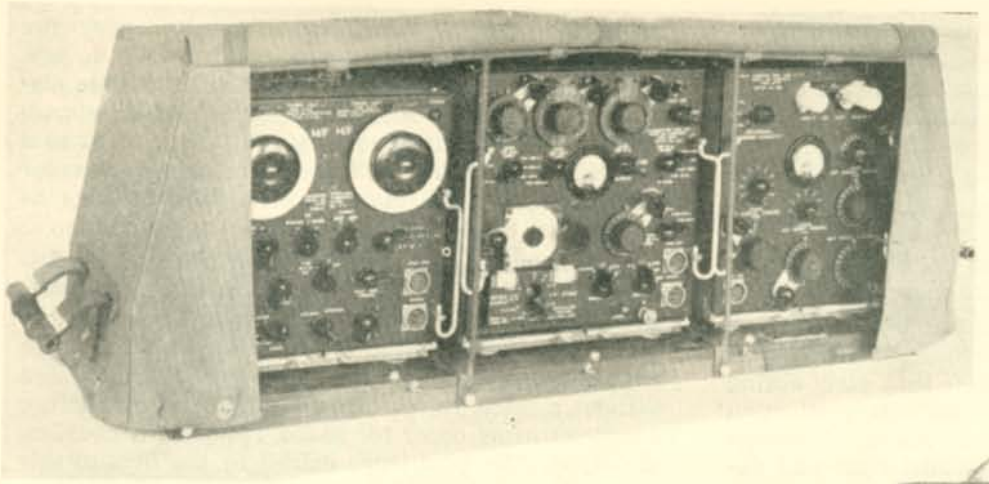




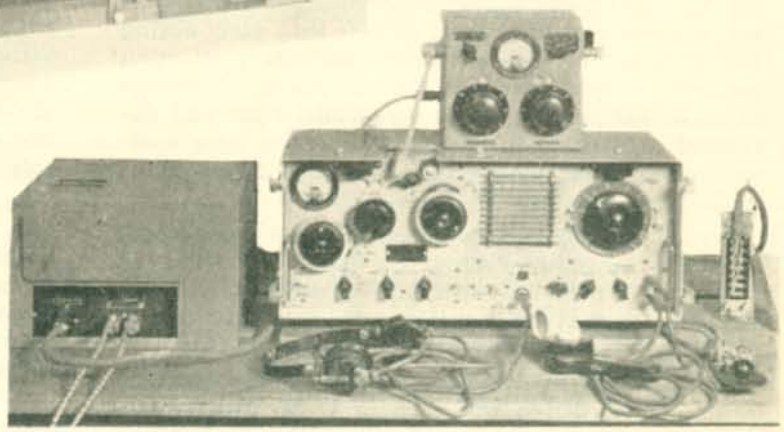
One of the interesting developments of the war period was the growing utilisation of radio for relatively short-range telephone links. A typical example of this type of equipment is illustrated at left in the form of the AWA-made RAAF ATR7 duplex telephone installation. This equipment comprised a 10-watt transmitter and interlinked receiver assembly operating in the range from 30-50 MC/s., with power supply obtained from either 24V. DC or 220-260V. AC. Directional aerial arrays were used and the equipment provided a very efficient and simple means of communication over quasi-optical ranges. Similar equipments were made by AWA for emergency defence services.

The production of fighter aircraft in Australia, such as the "Boomerang" interceptor necessitated production of suitable radio equipment, highly simplified for use by a pilot who already had enough to do without having to worry about radio tuning and controls. Radio Corporation were entrusted with the production of a suitable set which was known as the "ATR5" and is illustrated below. The equipment is operated entirely from the control box at the right and provides 4 push-button selected automatic send/receive channels in the range 3-9 MC/s.

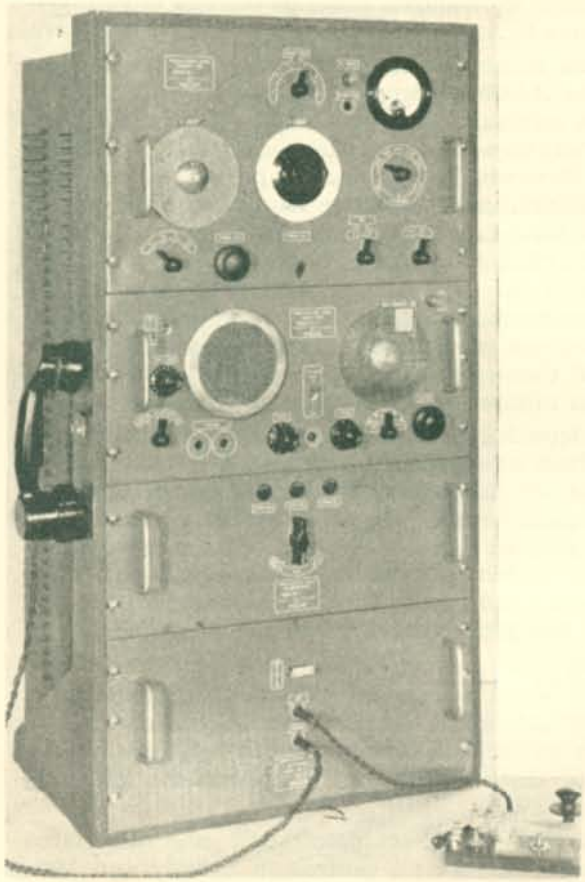




Illustrated at left is the justly-famous "AT5/AR8" which was made to RAAF specifications by Amalgamated Wireless. This general-purpose aircraft equipment comprised a 50-watt transmitter operating on medium and high frequencies and a receiver, and in addition to providing crew intercom. could also be used for D/F and homing. Army used a slightly modified version as WS No. 112.

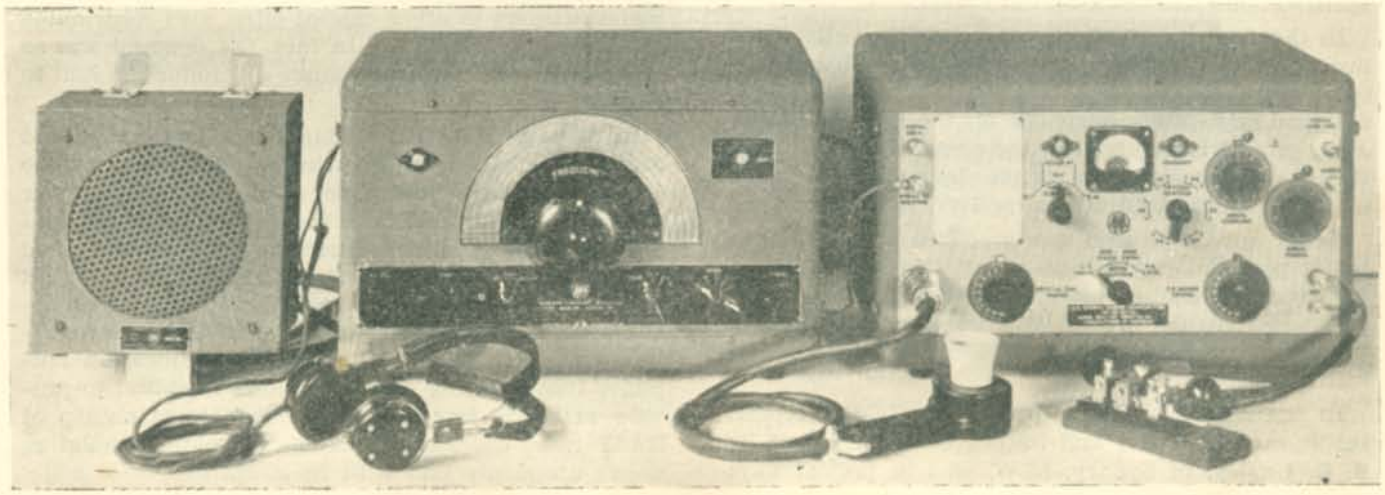


The versatile transmitter-receiver shown above was developed by Radio Corporation for the RAN and was known as the "RC8." This equipment had a power output of over 10 watts and operated in the 3-10 MC/s range. Major application of the RC8 was in the Navy's "small craft," where it did a particularly fine job.



Philips Electrical Industries produced the "DR101" transmitter-receiver illustrated at left for the US Navy. Capable of operation from AC or battery supply, this assembly had a power output of 40 watts and operated in the 1.8 to 3.1 MC/s range.

One of the later versions (the "3BZ") of the AWA "Teleradio" equipment is shown below. Developed from a pre-war commercial design, this equipment saw very wide application by all Services and was used in air-warning networks, small craft and for many other purposes. The equipment normally was battery-operated and comprised separate transmitter and receiver units, covering 2.5—10 MC/s.



testing. Production outside of the telecoms. field included several thousand fractional horse - power motors and dynamotor assemblies, over 10,000 sets of parts for carburettors, and over 160,000 hand grenade casings.

In compiling this review of Australia's Telecommunication Industry's war effort, it is most gratifying to note the many examples of firms achieving the seemingly impossible, by doing so much with so little previous experience, materials and manpower.

One of these is **Thom & Smith Pty. Ltd.**, of Mascot, N.S.W., makers of Tasma Radio. Enterprise was their keynote and it is of interest to note that early during the war, before the telecommunications production program really commenced, Tasma took up a contract to make 100 million plastic core bullet-tips—and developed a machine to make them. They were commended for their quality and regularity of delivery of those tips.

Eventually they secured an initial order from RAAF for radio transmitters AT14. So well did they do this —despite no previous experience in such complicated equipments—that they quickly got orders for AT15, AT14A, AT15A, and the combined FM-AM AT17.

Tasma displayed originality in design and standardisation. Their design was such as to facilitate rapid conversion from one type of transmitter to another merely by substituting new exciter and P.A. units. The Allied Services, who used these Tasma transmitters were most satisfied. Their early design was such that when tropic proofing became essential, no substantial alteration was necessary.

Their deliveries even bettered promised schedules and, in fact, their production effort won the praise of all who came into contact with the organisation.

Among those manufacturers who pre-war were concerned only with domestic radio sets, but who got into the war effort with projects outside the telecommunication field was **Kriesler (A/asia) Pty. Ltd.**, of Newtown, N.S.W.

Up to VP Day they were engaged on over 470 projects in a variety of fields. Many of these were concerned with electrical equipment for aircraft, particularly the Australian Mosquito project. One important "aircraft" item was the secret Reflector Electrical Gunsight for fighter aircraft. Wire-wound resistors were another item that Kriesler produced to meet the rigid specifications laid down by the Forces.

In the telecoms. field also Kriesler was active, and in addition to producing the 1kW AT19 for the RAAF, successfuly developed a hermetically sealed, tropic designed high-power telephone for the AMF. Another Army project interrupted by the cessation of hostilities was the production of a tropic designed and sealed lightweight communications receiver.

Radar apparatus also was produced by Kriesler—a major project being a high-power (150 kW) modulator assembly required urgently for modification of existing equipments. Other items successfully produced were trigger and strobe units for Services' Radar equipment.

In the Australian radar production field, a typical instance of ingenuity and initiative was displayed by **S. G. Ungley**, of Sydney, NSW, who in prewar days made lampshades, floor standards, decorative fire screens, etc., for which the war effort had no use. However, the firm's metal-working facilities were discovered by the US Army in Sydney and they were asked to produce a radar target for attachment to a free balloon, which then could be tracked with radar instruments. In this manner, wind velocity could be determined to aid aircraft operations.

After much experimentation, they produced a satisfactory sample, which in the words of the US authorities was "more effective than those produced in America." They received an order for 10,000 of these "Rawin" targets, and this quantity was produced without a single reject. This was followed by another American Army order for 20,000, requiring a doubling of output. The experience gained by the firm in this and similar work should make its services of considerable value to Australian industry in the post-war era.

As has been mentioned elsewhere in this publication, the RAAF requirement for an efficient general-purpose communication radio receiver was laid down in pre-war days, and very early in the war, and before "Pearl Harbour," the production project was successfully undertaken by **Kingsley Radio Pty. Ltd.**, of Melbourne, Vic. Later, this equipment was adapted for the Australian Army as their Reception Set No. 1. Production of the AR7 communication receiver for the RAAF continued throughout the war, and this receiver was most universally used. They also produced Irondust RF Cores, as well as Copper Powder for oil-less bearings in aircraft, with outstanding results.

An interesting example of specialised production of a major item of equipment is provided by **Raycophone Pty. Ltd.**, of Annandale, N.S.W., who were entrusted with a considerable proportion of the production of anti-submarine gear for the RAN. With a pre-war experience in motion picture sound equipment, their ready adaptation to turning out anti-submarine apparatus was productive of very efficient material.

Among other items produced by Raycophone during the war period was sound-reinforcing equipment for coast forts, designed to withstand the impact of heavy gun fire on such delicate apparatus. Raycophone also produced 35mm. sound-film equipment for all Allied Forces in SWPA.

Production of telecommunication and associated equipment was not all centred in Sydney and Melbourne, even in pre-war days; and during the war manufacturers in other capital cities also contributed to the production drive. In fact, the demand was so great that every available source of production had to be utilised.

In Adelaide, S.A., **Bland Radio Ltd.** had established for many years a manufacturing organisation for radio sets, transformers, and other items, so in the war period the firm's production facilities were utilised and did a good job in making Fortress amplifiers that stood up well to the stiff requirement. They also produced an auxiliary transmitting-receiver set for life-boat installation on troop transports. For the RAAF, production was established of an intercommunication amplifier incorporating electronic noise injection to provide artificial interference during the training of RAAF radio operators, with the object of simulating noises commonly met with in aircraft.

Queensland also entered into the production picture, and when the invasion of Australia appeared imminent, the rush with the job to equip our northern coastal defences was terrific. In that regard, the Queensland coastal defences required radio electric gunnery controls, loud speaker equipments, and such like. Considerable assistance with this work was given by **Crammond Radio,** of Brisbane, who designed and produced many special items of equipment for the AMF and other Services. The firm also was responsible for some original developmental work in connection with the transmission of teletype impulses by radio.

Another example of assistance rendered outside of the major production centres was that of **Bush & Co.,** of Brisbane, who supplied public address systems and carried out their installation in food and other factories. They also assisted the Army Canteen Service in mainteance of "amenities" radio sets that the troops found so helpful in all fields of operations.

While on the subject of sound amplification systems it is appropriate to note the work of several firms who may be regarded as specialists in this field. The names of three firms—Australian Sound Systems, Steanes Sound Systems and Velco Sound Systems—come to mind and, strangely enough, the headquarters of all three are located in Melbourne.

The first mentioned of the above firms, **Australian Sound Systems,** is located at Abbotsford, Victoria, and, in addition to producing a range of sound systems rated at up to 400 watts, it produced crystal and magnetic gramophone pick-ups, inter-communication systems and a very fine "amenities" type radio receiver known as the "V-5." This last was a fully tropic-designed dual-wave receiver for AC or 6-volt operation and saw wide service with all Forces in the SWPA.

In addition to equipment for the Services, Aust. Sound Systems were active in the production and installation of sound systems for music reproduction and paging in factories.

Velco Sound Systems Pty. Ltd., of Melbourne, operated in conjunction with its parent organisation, A. J. Veall Pty. Ltd., also of Melbourne, to provide an extremely wide variety of sound reproduction equipment for the Services and Industry and, in addition, produced a range of "amenities" receivers, radio tuners for sound systems, and several items of specialised test equipment—these last including a versatile wide-range 5-inch cathode-ray oscillograph.

One of the most important, although very "hush-hush," jobs undertaken by Velco was the production of "FLB" (front-line broadcasting) units for the Allied GHQ unit responsible for propaganda warfare in the SWPA. These equipments, which are illustrated elsewhere in this issue, were highly-mobile battery-operated 30-watt amplifier systems for record and speech reproduction which were taken right into front-line areas for the purpose of "broadcasting" (aurally) propaganda messages to enemy troops. These equipments supplemented the radio broadcasts and leaflets which were so widely used and performed extremely well.

In the industrial field Velco produced factory amplifier systems ranging in power up to 2,000 watts and employing 500 loudspeakers. They also were responsible for a number of high-power systems for Services' camps, as well as several very elaborate installations in military hospitals.

Tropic packing of radio batteries at the Melbourne factory of J. H. Magrath.

Steanes Sound Systems, located in Melbourne and Sydney, also, were responsible for a wide variety of special work as well as their basic production of service and Industrial sound systems and "amenities" type radio tuners and broadcast receivers.

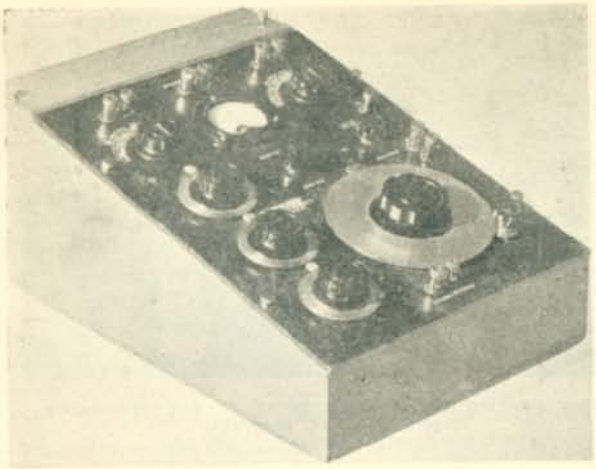
This firm successfully established production of throat-type microphones for aircraft use and assisted "sound" manufacturers generally by the manufacture of dynamic microphones and high-power projection-type loudspeaker units—these last, rated at 15 watts and fully tropic-proofed, were widely used in "loud-hailing" systems for beach control during landing operations.

Other work undertaken by Steanes included the production of aircraft magneto synchronisers, aircraft ignition harness testers and ignition coils.

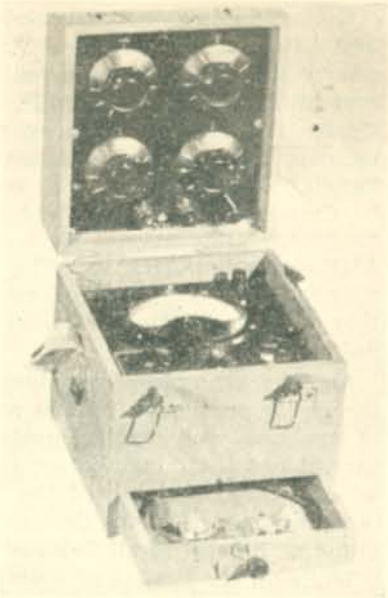
In addition to the work done by the above "specialist" firms in the "sound" field, it may be noted that many of the larger "communications" organisations were also active in this direction—the work of AWA and Philips being particularly noteworthy as both of these firms established quantity production of special-purpose amplifier systems to meet Service specifications.

While on the subject of activity in the "sound" field, it is appropriate to mention the work of the **Rola Co. (Aust.) Pty. Ltd.,** of Richmond, Victoria, as this firm was responsible for many of the loudspeakers and dynamic microphone and receiver insets used by the Forces. The production of these last items is a story in itself and for the moment it must suffice to say that the successful production of moving-coil microphone and receiver assemblies for use with the Aust. Army wireless sets "19," "22" and "112" was largely due to the untiring efforts of Rola—an effort which entailed much original research and development of magnet materials and structures new to Australia. This work, while primarily directed toward the production of microphone and receiver insets, proved of considerable value in other fields such as radar and meter manufacture.

Important as was Rola's work in the above directions, it was at least equalled by that firm's activities in the production of magnet winding wires. Production of these wires, in a wide variety of gauges and coverings, reached very considerable proportions and was a material contribution to the war effort at a time when overseas supplies, on which industry previously had largely relied, were no longer available.



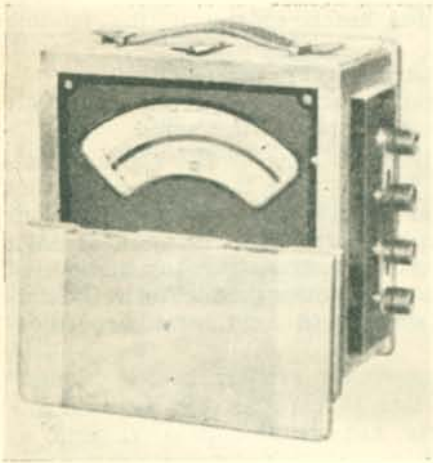
A typical example of Australian-made laboratory-type testing equipment is illustrated at left in the form of Transmission Products' "LCR" Bridge. Built to a high standard of precision, numbers of these Bridges were supplied to the Forces and telecoms. manufacturers.

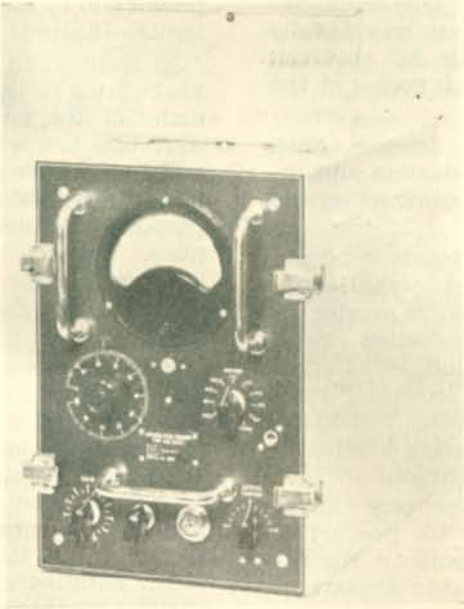


Precision Testing Equipment

A particularly wide range of radio and electrical testing gear was produced by Radio Equipment Pty. Ltd., of Sydney, and two examples, the "D9" and "D12," are shown at left and above, respectively. The D9 is a compact low-range ohmmeter for blasting circuit testing, while the D12 is a combined resistance decade box and aircraft instrument tester.

A. J. William, of Melbourne, produced some fine examples of substandard instruments and one of the firm's 5½in. scale type P16 portable instruments is shown at left.





Reed-type panel mounting frequency meters were a critical item until A. J. William commenced Australian production. One of the firm's "SR6" series of frequency meters is illustrated.

In addition to its extensive production of Radar equipment, the Gramophone Co. (HMV) produced many items of testing apparatus for Radar installation and maintenance. Three typical examples are shown. At the left is Test Set A58; above is Field Strength Receiver, type D32; and at the right is the type A18 test set for air-warning equipments. Each of these equipments had associated with it a specially-stabilised power supply unit housed in a similar case assembly.

Mention of the work done by Rola on the production of magnets brings to mind the activities of another firm that contributed materially to Australian industry's requirements of magnets and magnetic devices. This firm, **Quality Castings Pty. Ltd.**, of Waterloo, NSW, established a special division to concentrate solely on the production of magnets and devices such as magnetic chucks and separators which were supplied not only to the telecommunications industry but also to other sections of industry engaged in the war effort.

Quality Castings produced a wide variety of magnet materials in shapes to meet an extensive range of requirements and their work in this direction was a very important contribution to the war effort, besides being of material value to peace-time industry.

Meters and Testing Equipment

Although considerable quantities of metering and testing equipment were produced by the major equipment manufacturers such as A.W.A., Radio Corporation, Philips, H.M.V., Airzone and others, the basic production of indicating meters was carried out by a number of "specialist" firms, some of whom also produced complete items of testing equipment. Most of these firms were active in the Industry in pre-war days, but wartime exigencies necessitated a considerable expansion of their facilities and production and a brief review of their activities will be of interest.

Among these meter manufacturers who played a contributory part was **Warburton Franki Ltd.**, of Sydney and Melbourne, with their Sangamo meters. In pre-war days they were actively engaged in making the Sangamo house-service electric meter but rapidly turned over to war production of electrical instruments for the aircraft projects in Australia, an undertaking which entailed the manufacture of small instrument springs, frameless moving coils and instrument jewels—items previously imported to Australia. Then instruments for use with radar equipment were needed, and the experience already gained proved extremely valuable in achieving early production of these items, which included six-inch projecting pattern moving-iron voltmeters and ammeters for alternator switchboards. Many design and production problems were overcome in the successful manufacture of these instruments—an achievement of which the firm might well be proud.

Another firm that participated in the production of indicating meters for vital Radar equipments was the **Master Instrument Company**, of Chippendale, NSW, who produced over 30,000 such meters for the SWPA Forces. To meet "tropic-design" requirements vacuum-impregnation and sealing against humidity was accomplished by Master Instruments using their "Microvac" process. The demand for miniature meters from all the Services in 1944, encouraged this manufacturer to design and produce a miniature meter weighing only two oz. with a flange diameter of 1¼ in a barrel of 1/1-8 in diameter and 7/8 in deep.

The need for *pH* meters to determine acidity and alkalinity in food processing and chemical laboratories brought **Geo. H. Sample & Son** (Vane Instruments) of Sydney, NSW, into this and other instrument fields. Starting off with a staff of three in 1939, this small but efficient production unit had fifty employees and could have used many more had they been available. This personnel shortage was common to all industrial units in a country geared for 100% war effort.

Apart from meters and complete instruments, thermo-couples made by Vane for use in radio equipment for all the Forces proved most satisfactory and solved another of those many problems that telecommunication equipment production continued to present. It is of interest to note that the production of these thermo-couples entailed the welding of three dissimilar wires—one of them only 0.0008" in diameter.

A first-class example of a firm undertaking, almost overnight, the production of many types of indicating meters and instruments, previously imported, is provided by **A. J. William Electrical Instruments**, of Melbourne, Vic. This firm concentrated largely on precision instruments of the sub-standard type, but also produced a wide range of electrical switchboard meters of various types, including panel-mounting frequency meters, wattmeters, etc. In addition, a large range of laboratory accessories, such as standard resistances, bridges, etc., was produced. In the production of these instruments, many new problems were tackled, with such success that jobs such as the making of meter pivots having a spherical point with a radius of 0.0005" and the production of drawn seamless aluminium tube with an outside diameter of 0.028" and walls of 0.001" with a cross section of 0.00000078 sq. in. became workshop routine.

Many thousands of precision instruments were produced by A. J. William during the war period and it is a matter for congratulation that not only British Standard Specifications, but also the rigid requirements of "tropicalisation" were fully observed.

In the field of complete testing instruments, a particularly useful job was done by **Radio Equipment Pty. Ltd.** (University Instruments), of Broadway, Sydney, NSW. This firm produced a particularly wide range of workshop testing equipment for the Services—the items including the "D" series of electrical test gear; radio multimeters and super-testers; modulated oscillators; and a representative selection of panel indicating instruments.

All of this equipment was produced to Service specifications and in considerable quantities—it is to the credit of the firm that deliveries always were maintained at a high rate, despite the inescapable wartime difficulties of material supply and manpower.

Also engaged in the production of testing equipment, but primarily for Base Workshop and Laboratory purposes, was the progressive organisation of **Transmission Products Pty. Ltd.**, of North Sydney, NSW, while this firm was also active in the line equipment and radar accessory fields—one particular example of this last being the design and production of a special type of "range" potentiometer used extensively in RAAF and USAAF lightweight, air-warning radar equipment.

Most of the items produced were of a specialised "short-run" character, requiring precision workmanship and highly-skilled personnel, so that the firm laboured under more than the usual amount of "manpower" trouble. This was intensified by the initiation of a special 24-hour repair service on certain items of equipment for the US Navy, but it is pleasing to report that Transmission Products met every demand that was placed on it.

Items produced included multi-channel line amplifiers, "LCR" Bridges, precision controls such as faders and attenuators, decade resistance boxes, relays, and a range of hermetically-sealed audio and power transformers and chokes.

A useful contribution to the production of accessory items was made by **D.W. Radio Co.**, of Chatswood, NSW, who manufactured distribution and protection frames for Army field telephone installations and other line equipment sundries.

Component Manufacture

Many of the firms already dealt with were responsible to a greater or lesser degree for the manufacture of various components and accessory items and mention already has been made of some of the items produced by these firms. However, as in other fields, there were several organisations specialising in the production of components and other accessory items and it is appropriate to examine the activities of a representative few.

The manufacture of over 10 million I.R.C. resistance units for all types of equipments for all the Forces was the proud achievement of **Wm. J. McLellan & Co.**, of Sydney, NSW. That is not the whole story because the multiplicity of types and sizes called for taxed even the Australian IRC factory which was functioning for years before the war. This firm's war effort started in the first week of September, 1939, and continued up to and beyond VJ Day. It was a continual race against time, and required the constant introduction of new designs to keep pace with demands from the Forces and equipment manufacturers.

In the radar field, the production of a series of resistances to an accuracy of one in 10,000 and of "range" potentiometers was an extremely important function and called for the highest degree of accuracy and reliability in performance.

In addition to resistors, electrical, radio and radar equipments of every kind use condensers of all types and sizes and **Ducon Condenser Ltd.** of Waterloo, N.S.W., played a major part in this field of production, as well as doing an impressive job on the development of Steatite Insulators in Australia.

In the condenser field, an important Ducon contribution was the successful utilisation of Chlorinated Diphenyl as a dielectric—a development that also permitted a reduction in physical dimensions. Not only was the problem of supplying initial equipment requirements in condensers met by Ducon, but the firm also undertook the manufacture of a multitude of types and sizes for replacement in foreign made equipment, used by the various Allied Forces in the SWPA. At the cessation of hostilities Ducon had 700 employees engaged on the manufacture of condensers, resistors and ceramics.

Another prewar condenser manufacturer who contributed to the making of these important components for the Forces, to meet the combined Services specifications CL1001 and CL1019, was **Tecnico Ltd.** of Marrickville, N.S.W. This manufacturer also made a wide range of Yaxley wave-change switches that had many applications in telecom. equipments.

Tecnico also played a very considerable part during the war in the manufacture of aircraft electrical units which were fitted to every type of aircraft built in Australia. They secured high marks for their complete manufacture of Bendix-Eclipse generators of types up to 3 kW at 30 volts, weighing only 26 lbs. Production at this factory also included engine starters, voltage regulators and the Bendix-Scintilla 14-cylinder aircraft magneto—much of this equipment being completely new to Australian manufacturing practice.

In the components field, mention must be made of a division of Electronic Industries Ltd., **Ferrocart (A'sia) Pty. Ltd.**, of Melbourne, who specialised in vibrator units. These devices were used in tens of thousands by the Forces, and the changing theatres of war operations compelled constant research and improvement of these vital items to ensure reliable operation under all conditions. The improvements found necessary and successfully applied are a credit to Ferrocart. This firm also was active in the production of iron-dust radio-frequency cores.

Although not a "component" in the strict sense—being rather a major item—it is timely at this juncture to mention the work done in Australia in the manufacture of field telephone cable, of which nearly a quarter of a million miles was produced during the war years.

This work was carried out by **Olympic Cables** at Footscray, Victoria, and represents a distinct achivement by Australian Industry.

Back in 1938, this company planned for the production of V.I.R. cables, field telephone wires and other rubber insulated conductors, although it was not until 1940 that production got going, but its usefulness was to be appreciated even later still. It is of interest to note that the cost of such cables was one-third lower than similar British cable and half the cost of American cables, while the standard of production was well in accordance with exacting Service requirements. As further experience was gained, Olympic was able to make still further reductions in cost, and even refund all the financial assistance it received under the "Cable & Wire Bounty Bill, 1941."

Machines for drawing, annealing and tinning of copper wire were developed and installed although prewar this was not contemplated. Associated with Olympic in the field telephone cable project as suppliers of raw materials, tinned steel wires, etc., were Rylands Bros. of Newcastle, the Broken Hill Pty. Co. Ltd., also of Newcastle, and Metal Manufactures Pty. Ltd. of Port Kembla, N.S.W., and great credit must be given for the team-work and co-operation that contributed so much to the success of the project.

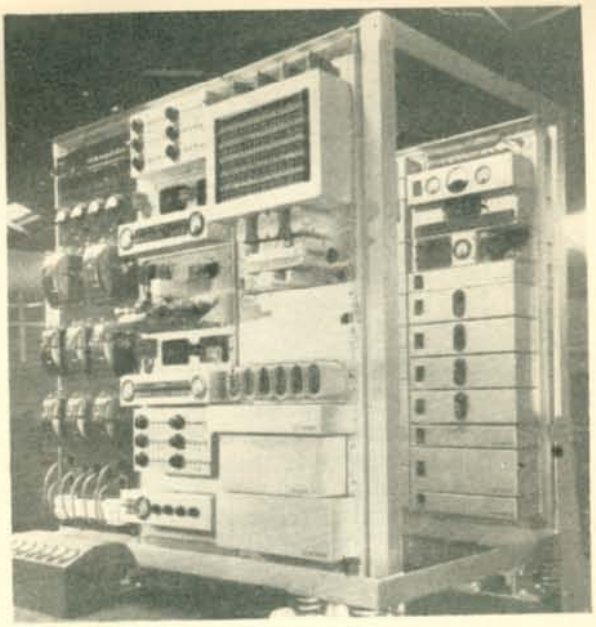
An important example of Australian productive effort in insulating electrical conductors for use in many applications is provided by **Moulded Products (A'sia) Ltd.** of Richmond,Vic., who successfully overcame the many problems associated with the production of several types of coaxial cables for radar and general telecommunications work.

The latest type of co-axial cables produced by Moulded Products utilise an inner dielectric of polythene, a new plastic originally developed in England by I.C.I. Ltd. The electrical properties of polythene are generally similar to those of polystyrene, but its big advantage is its flexibility, permitting it to be extruded directly on to a wire in a continuous seamless covering.

The need for flexible hookup and instrument wire suitably insulated with poly-vinyl-chloride to overcome humid conditions was met by Moulded Products and

Lines of Communication

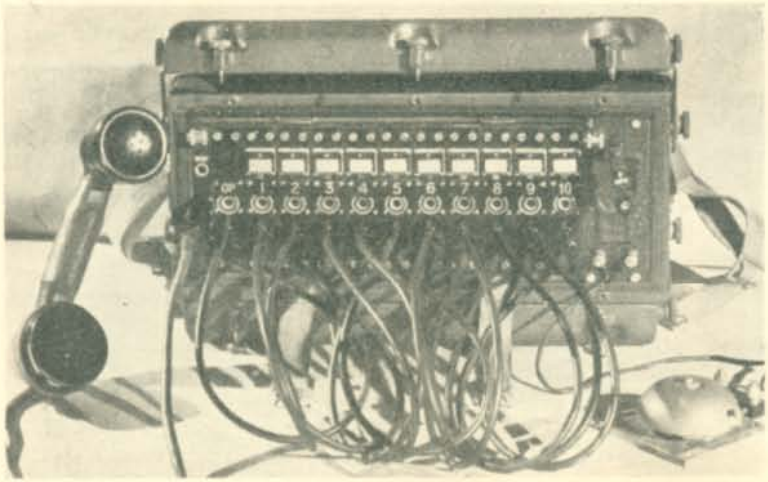
At left is shown a stack of the basic material for the Army's "lines of communication" — "Don" class telephone cable at the Melbourne works of Olympic Tyre & Rubber Co. The steel drums for this cable were produced by Richards Industries, of Adelaide.



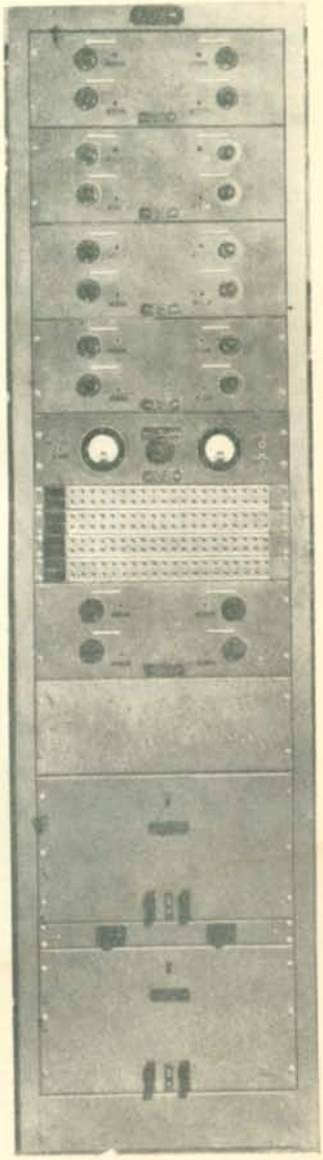
The PMG's Dept. produced for the AMF a quantity of mobile carrier telephone equipments, of the type shown above, as insurance against enemy damage to permanent installations.

To meet the exacting conditions imposed by jungle warfare in the SWPA, the Army required a new field telephone. Standard Telephones produced the answer, in the form of Telephone, "L" (Aust.) No. 2, illustrated at right.

The new "L" 'phone illustrated above necessitated provision of a new field switchboard and a completely-new tropic-designed magneto-call assembly was produced by MacKenzie & Holland of Melbourne. Two views are shown — at left, the unit sealed for transport and below, the equipment set up for operation.



Transmission Products, of Sydney, were responsible for the "AMS110" multi-channel line amplifier assembly shown at right. This equipment was made for the US Army.



eventually developed into the production of light and power cables of 60 different types, many in up to six colours.

Submarine telegraph cable used in northern operational areas having its primary conductor (7/.036) insulated with polythene was produced by Moulded Products, and proved most satisfactory. At one point on the ocean bed, this cable was three miles below the surface.

"Nylex" insulation was another development and many land telephone lines for jungle warfare used Moulded Products' "Nylex"-insulated cadmium-copper and hard-drawn copper wire for the operation of carrier-wave systems between bases and forward areas. The unique properties of this material enabled it to be made in transparent sheets, to totally enclose circuit diagrams, operating instructions and any such printed matter between two sheets laminated under heat and pressure, resulting in a water-, dirt- and fungus-proof job.

As mentioned previously, considerable work was carried out in Australia on the development of ceramics as insulating materials and in this connection, reference must be made to the activities of **Nilcrom Porcelains (Aust.) Pty. Ltd.**, of Northcote, Victoria. One of the Nilsen group of companies, this organisation commenced operations shortly after the outbreak of war and did a really first-class job for the Services and industry at large.

The advent of radar, with its exacting insulation requirements high-lighted Nilcrom's activities, as the organisation was successful in establishing quantity production of close-grained non-hygroscopic ceramic insulators and formers with tolerances as close as plus-minus two parts in a thousand. However, the firm's activities were by no means restricted to Radar insulants, as it also produced large quantities of high-voltage line insulators and a wide variety of terminal insulators, as well as a range of aerial insulators and transmission-line spreaders for Services' use in the field.

Power Supply and Accessory Apparatus

Equally as important as the work of the equipment and component manufacturers was the work of those firms specialising in the production of power supply equipment and other accessory items. Here again, many of the organisations already mentioned were responsible for quantity production of equipment coming into the categories mentioned, but it is important to pay due tribute to those firms whose work, while not so spectacular, nevertheless contributed its fair quota to the total effort.

As an example of this, consider the case of the **EMAIL (Electricity Meter & Allied Industries)** group of companies—while not engaged on any major projects which could be regarded as "telecommunications" in the strict sense, the manufacturers included in this group produced an almost-bewildering array of accessory items, without which telecoms. equipment produced elsewhere could not have functioned.

These items included microphone and receiver assemblies, H.T. rectifiers, vibrator units, terminal assemblies, meters, dynamotors and generating sets, while the same firms also were engaged on the production of fire-control equipment, such as predictors and fuse setters.

Particularly notable is the work of **Elcon Pty. Ltd.** in Melbourne, who were largely responsible for the production of dynamotor sets for the RAAF AT5/AR8 and **Westinghouse-Rosebery**, in Sydney who produced over 2,200 petrol-electric generators and alternator assemblies. Westinghouse also were active in the production of electrical control gear and ultra-violet "Sterilamps" for use in Service hospitals, blood banks and food storage depots.

The Services' requirement for large quantities of electrical generating and control equipment also exercised the attention of a number of organisations other than those included in the above group and particular mention must be made of the work of **Standard Waygood Ltd.**, of Waterloo, N.S.W. The name of this firm is closely associated with the production, installation and maintenance of lifts ("elevators," as our US friends prefer to call them!) but, as the Company points out—they don't only make lifts.

The recently-concluded hostilities provided ample proof of that, as Standard Waygood generating sets, alternators, searchlight carbon lamps, electrical control gear and high-power transformer assemblies were to be found throughout the SWPA. For some of these items, Standard Waygood were the primary contractors, while in other cases the firm acted as sub-contractor to producers of major equipments such as STC. A final example of the versatility of Standard Waygood was provided when it established a special factory to manufacture searchlight carbons, as these items were in such short supply that the continued operation of AA defences was jeopardised.

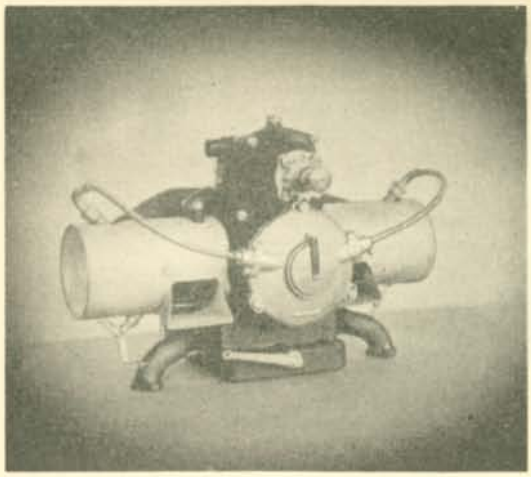
Also engaged on the production of power supply and related equipment for the Services was the old-established firm of **Durst Motors**, located at Forest Lodge, Sydney, N.S.W. The firm produced a wide variety of special motor-generator sets for Service use and did a particularly useful job for the RAN with the development and manufacture of pedal-operated DC generators for use as emergency power for signalling lamps.

In the realm of power supply equipment, the transformer manufacturers were well to the fore and mention has already been made of the work done by equipment manufacturers. As in other fields, specialist manufacturers played their part and, once again, the names of several Melbourne firms appear worthy of special mention.

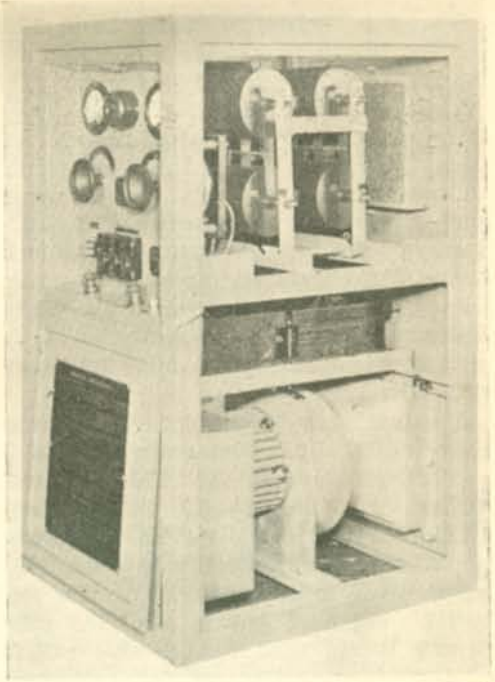
The first of these is the **Wilson Electric Transformer Co. Pty. Ltd.**, of Port Melbourne, Victoria, who supplied everything from step-down transformers for portable cinema equipments to 2000 kVA oil-immersed units for the reticulation system at the 100 KW short-wave broadcaster at Shepparton, Victoria.

Most of Wilson's production was in the "heavy" class and an example of the scope of the firm's activities, in addition to the instances above, is given by its manufacture of the transformer equipment for a 45 KW AC/DC arc-rectifier converter unit for use by the Royal Navy. In addition to items such as this, Wilson also supplied a wide variety of instrument transformers, aerodrome lighting units, welding transformers and industrial units ranging in power up to 3,500 kVA.

Power Supply Equipment

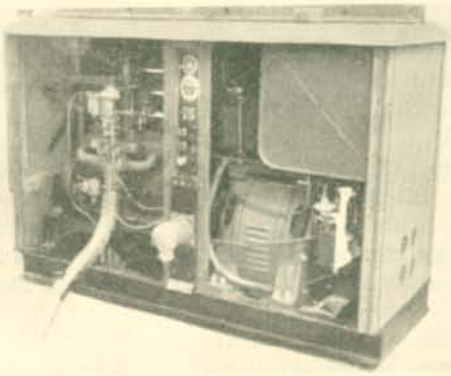


The "Enfield" twin-cylinder petrol motor shown above was made by K.L. Engines & Tractors, of Melbourne, as the prime mover for a 2.75 KVA alternator set which was widely used for Radar power supply.

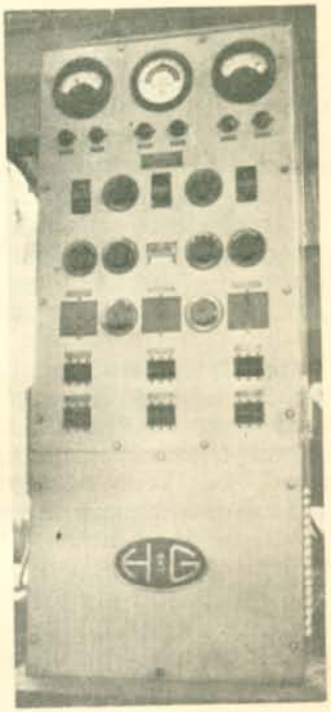


Standard Telephones made the high-power selenium rectifier assembly shown at right as a battery-boosting and starting unit to conserve battery power in armoured fighting vehicles.

At right is a petrol-driven 5 KVA alternator set made for the Services by Standard - Waygood, of Sydney. At left are shown the "Gledden" voltage regulator (top) and the centrifugal governor developed by Standard-Waygood for use in this assembly and also supplied separately for the Services.

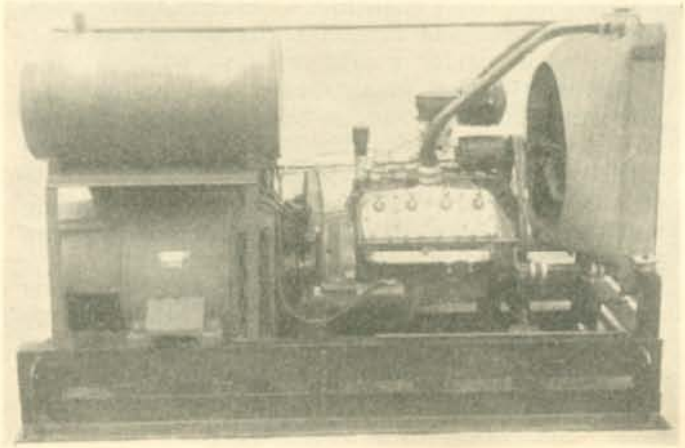


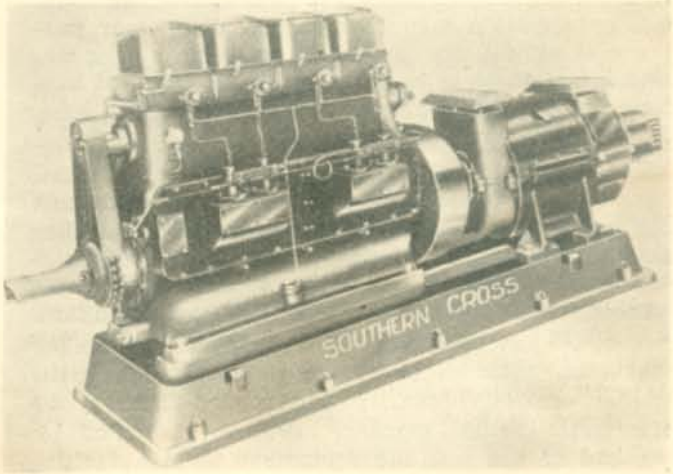
The extensive use of generating equipment in the field necessitated effective control and distribution facilities—a typical control board, made by Hodson & Gault, of Melbourne, is shown at right.



Below at right is a 20 KVA diesel - driven "Southern Cross" equipment manufactured for Service use by Toowoomba Foundry Ltd., of Queensland.

Standard-Waygood, of Sydney, also produced the 22 KW DC generator set illustrated below. This assembly was designed for searchlight operation.





Swales & Swann, of Coates Lane, Melbourne, were another firm active in the production of transformers for the Services, but the equipment produced by this organisation differed somewhat in magnitude, if not in importance, from that of the previous manufacturer. This firm concentrated its production mainly on equipment transformers, both power and audio, and it is a matter of record that "S & S" transformers were "among those present" in the Milne Bay operations. The organisation also did a particularly useful job of work on transformers for Radar equipment and was particularly co-operative in the production of experimental units for the Services' design authorities.

A valuable contribution also was made by Cliff & Bunting Pty. Ltd., who make **Trimax Transformers**, at North Melbourne, Vic. This firm was among the earliest in the field with fully sealed transformer assemblies for tropical service. The work of this firm is particularly noteworthy in that, not only was it called upon to supply transformers and chokes for initial equipment but it also was asked to supply (which it did with considerable satisfaction to all concerned) transformers for replacement purposes in communications and radar equipment of overseas origin. This last is especially meritorious in that it entailed the manufacture of units to meet space limitations originally determined by conditions much less exacting than those applying when the equipments were placed in service in the SWPA.

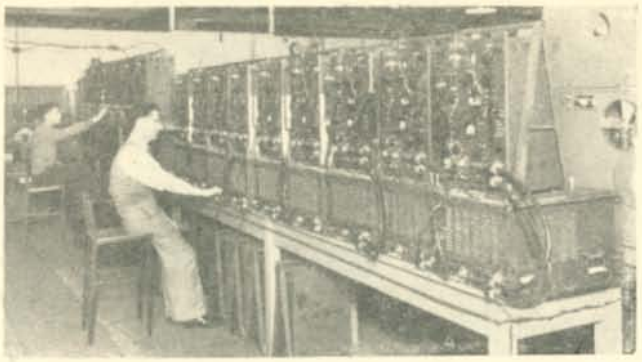
While most of the larger items of Service telecommunications equipment were AC-powered, many other equipments for highly-mobile field and patrol use were of necessity operated by means of either "dry" or "wet" batteries and the supply of these items reached very considerable proportions.

Apart from a few special types produced for aircraft use, the accumulators employed were largely of standard design—differing mainly in the provision of special terminal connections or carrying arrangements. The **Vesta Battery Co.**, of Leichhardt, NSW, was one of the many firms that participated in production of these items and is mentioned because of its extensive work on experimental production.

In the field of dry batteries of all sizes and types, **Eveready (Australia) Pty. Ltd.**, of Rosebery, NSW, played the most prominent part, being the largest manufacturer of such batteries in Australia. With their Melbourne associate, **Widdis Diamond Dry Cells**, this organisation manufactured for direct war purposes, 47 million dry cells of all types during the war period and these cells were used in 61 types of batteries, many of which were previously unknown here. The peak staff was 650.

The production of dry batteries for use in signal equipment in tropical operational areas, proved most difficult and compelled much research. Hermetically-sealed metal containers were finally adopted as a satisfactory packing medium to ensure batteries reaching the "front-line soldier" in good condition.

Also, it was important on account of portability that such batteries be of the lightest weight with greatest possible capacity and, under Ministry of Munitions (DRSS) guidance, Eveready installed by the end of the war the equipment to manufacture



A line-up of AMT150 transmitters undergoing final test at AWA's Ashfield Radio-Electric Works.

the "Mini-Max" type of battery which provided a solution of this problem. Unfortunately, this project did not reach full production before VJ Day, but the development provides an example of the manner in which Eveready and their American associates (National Carbon Co.) did everything within their power to give the Forces the best kind of battery possible.

The only other company producing dry batteries in prewar days was the **Stan-Mor Dry Cell Company Pty. Ltd.**, of Brighton, Vic., and although not a big organisation, it made a most valuable contribution to the Forces dry battery requirement.

Being a purely Australian-owned and operated company, during the war period they did a lot of work on whatever raw materials were available in Australia without relying on overseas supplies and their results after many "headaches" were most gratifying. Examples of Stan-Mor's activities in these respects are the development and production of zinc strip and carbon rods, and the mining and treatment of Australian manganese, which proved most helpful in an otherwise difficult situation.

Miscellaneous Activities

Although not classified as "telecommunications" in the strict sense, the production and general activities of a large number of manufacturers other than those already mentioned were a material contribution to the general effort and in this respect mention may be made of the work done by the **Australian General Electric Pty. Ltd.** throughout Australia. This firm had a huge productive capacity available at its Granville, NSW, works as well as considerable supply facilities by virtue of its overseas affiliations. Among the items supplied were large quantities of electrical gear, electrical insulation and varnishes and thermostatically-controlled ovens for quartz crystals.

Another electrical manufacturer that performed a very useful function was the **Langco Electric Jug Co.**, of Rozelle, NSW. This firm turned its productive capacity over to the manufacture of a large variety of electrical items such as radiators and heating appliances for hospitals and also produced signalling projectors and depth-sounding equipment.

Manufacturers were not the only people who made substantial contributions to the war effort in the supplying of parts, completed equipments and associated accessories. Many were the occasions when the stocks of wholesalers were called upon and availed of to supply odd bits and pieces to the Forces and to

150cm. searchlight projectors in production at the Melbourne factory of A. G. Healing Ltd.

essential services. The maintenance of the people's domestic radios was also an essential requirement. In that regard, **A.S. Radio Parts**, of Melbourne, assisted materially as did many others.

Another example of this co-operation with the larger manufacturers and Services is provided by the Melbourne wholesale firm of J. H. Magrath & Co. and its associate, the **Aegis Mfg. Co. Pty. Ltd.**, of Lonsdale Street, Melbourne.

Although a small concern, Aegis contributed much by way of specialised items in small quantities that much larger concerns could not touch. "Problem children" were their speciality and their results helped substantially in solving those small but urgent problems for the Services. At one stage, they turned to and assisted in extensive tropic packing of dry batteries. Such was their versatility and enthusiasm.

Other wholesale and distributing organisations that made a substantial contribution, both by way of assistance to manufacturers, and also to the Services, in the form of special supplies, include the **Sun Electric Co.**, of Melbourne; **Radio Wholesalers**, of Adelaide; **Cooke Bros. Pty. Ltd.**, of Sydney; and **R. E. Jeffries Pty. Ltd.**, also of Sydney. These and many other similar organisations had such a variety of activities that it is difficult to do more than mention their participation, but a few highlights will be of interest.

Sun Electric made its chief contribution in the supply of telephone and electric cables and flexibles and was closely associated with the Olympic organisation on the production and distribution of such items.

Radio Wholesalers in Adelaide were active in many directions and played a very useful part as a South Australian outlet for many products—prominent among them being the range of sound-reproduction and electro-acoustic apparatus produced by Aust. Sound Systems in Melbourne.

In Sydney, Cooke Bros. played a similar part and handled the distribution and supply of many electrical lines, while R. E. Jeffries Pty. Ltd. concentrated largely on the supply of insulating materials and varnishes—these last now include the products of Lewis Berger & Sons—as well as a range of portable electric tools.

Right throughout the war, woodworking played an important part, and in this direction a prominent part was played by **F. Dickin Pty. Ltd.**, of Leichhardt, N.S.W., who in pre-war days supplied tens of thousands of various types of radio cabinets and specialised in plywood. They were quickly involved in assisting production in Australia of the Mosquito aeroplane spars and some components.

The supply of transit cases for radar and radio equipment called for experienced wood workers, which the Dickin organisation can rightly claim to be. The firm's work on plywoods proved of considerable value in the production of these items, as well as on the "Mosquito" project, as the requirements of "tropic-design" made the use of "bonded" waterproof materials essential.

In addition to what has been said elsewhere in this publication, the above reference to the necessity for waterproofing emphasises the fact that the greatest problem facing the industry in its manufacture of telecommunication equipment for the Forces operating in the S.W.P.A. was that of overcoming the exceedingly high humid conditions, the consequent fungus growths, water absorption by materials or condensation of moisture on the surface of components.

In 1942, the Forces experienced all these troubles and the mortality rate of equipments was terrific. It was a continual fight against fungus and humidity. All insulating materials were affected and many were the suggested and attempted remedies. Tropical insulating varnishes were investigated, concocted and applied not only in Australia, but also in America, where this problem was concerning telecommunications just as much as here. The US Forces in the SWPA experienced all the difficulties that the Australian Forces met up with.

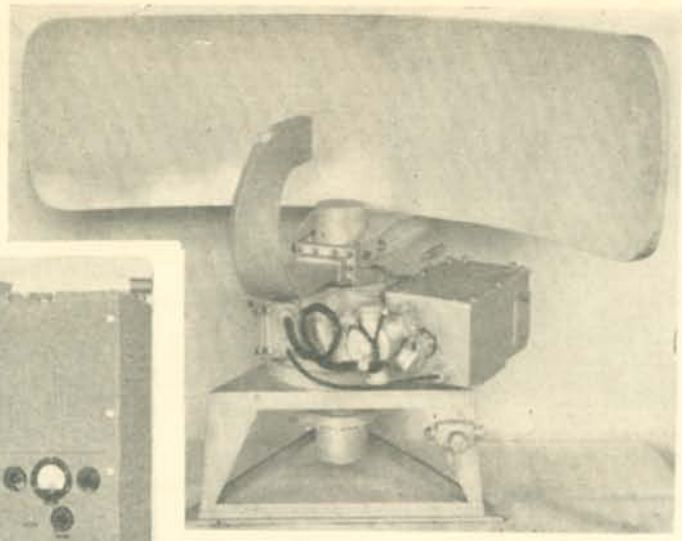
Among those manufacturing varnishes here were **Taubmans Ltd.**, of St. Peters, N.S.W., and **Lewis Berger & Sons**, of Rhodes, N.S.W., and the efforts of both these firms on this tropic-proofing problem were considerable. Their insulating varnishes and other products were used on practically every kind of telecom. equipment. Special tropical insulating varnishes were formulated for lowering of surface leakage and in every respect, the activities of these two organisations were highly commendable.

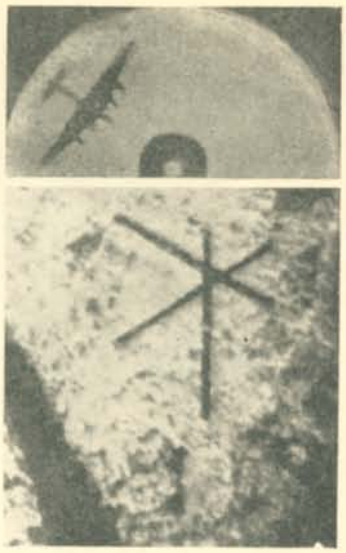
Another firm that played an important part in the supply of special insulating materials was the **Mica & Insulating Supplies Co. ("Misco")**, of Melbourne, Vic., who made their contribution in fabrication of a variety of insulating products.

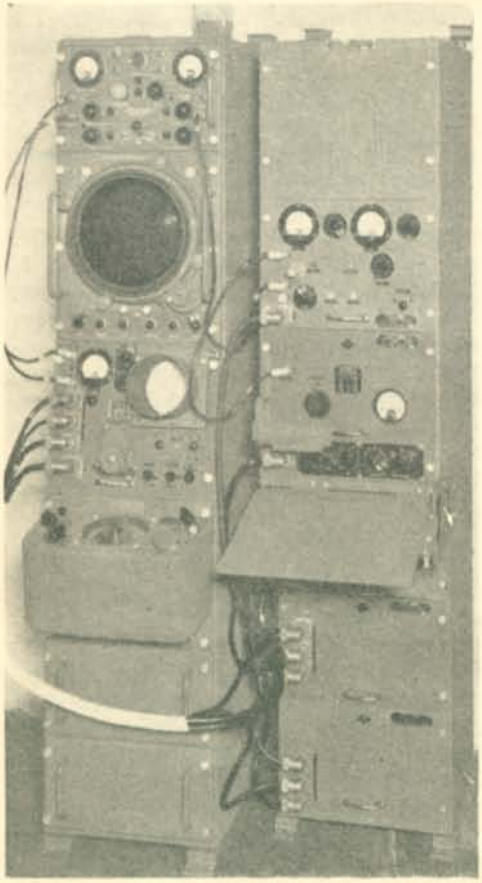
With many pre-war sources overseas cut off from Australia, the need for improvisation with many hitherto unknown materials was vital. The application of these insulating materials extended into the high-powered machinery field and Misco were responsible for supplying the insulation required for two 3,000 h.p. armatures that were stripped, coils reinsulated and completely rewound in eleven working days, when labour and materials were at a high premium.

However, insulating materials were not the only r quirements of the Industry, and to conclude this r view a contrast is provided by the activities of a firm that concentrated solely on the supply of conducting materials. This firm was **Austral Bronze Co. Pty. Ltd.**, of Alexandria, N.S.W., and as manufacturers of non-ferrous rolled and extruded raw materials, the products of Austral Bronze were incorporated in most of the telecommunication equipments of all sizes and types. From humble beginnings in 1914, the company grew until in 1937 its output was 5,157 tons, which rose to 10,272 tons in 1940 and to a peak of over 24,000 tons in 1942. This firm was a sub-contractor for non-ferrous parts to most of the major equipment manufacturers and its products are found in everything from field telephones to the 200 kw Belconnen transmitter.

Radar Apparatus



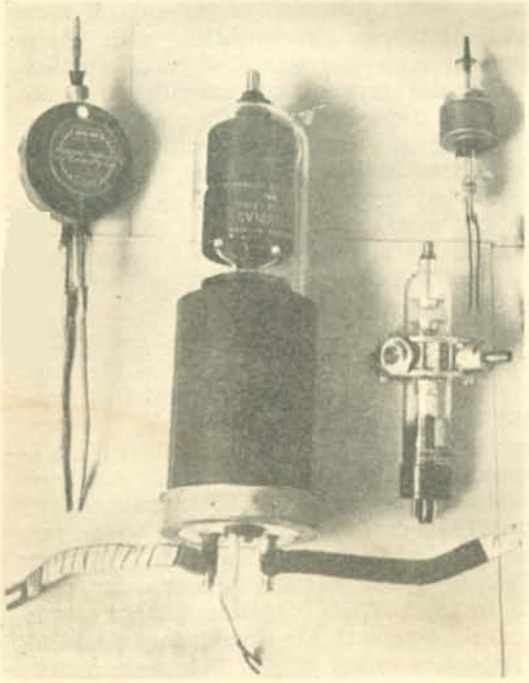


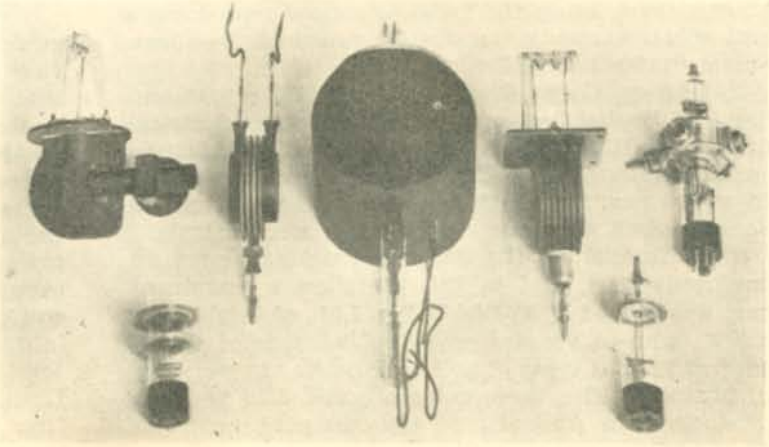


Above is shown the aerial reflector and wave-guide assembly of a naval radar equipment produced by Amalgamated Wireless, while the associated apparatus racks, also by AWA, are seen at left. At top right are two typical PPI "displays" obtained from air-borne equipment of a similar type.

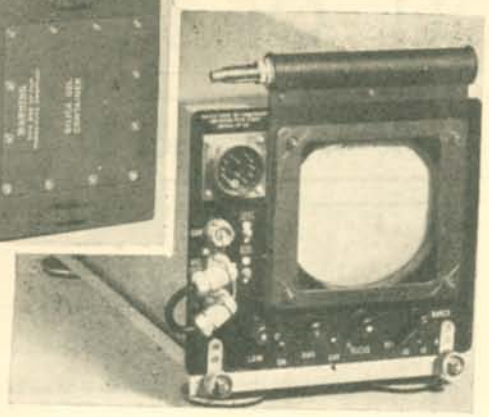
Alongside at right is shown a high-power (150 KW) modulator assembly produced by Kriesler for modification of early low-power radar equipment.

One of the most noteworthy achievements of Australian industry during the war was the successful production of many types of special radar valves. At the lower left we show a group of such valves produced in Australia by STC, while some valves and T/R switches produced by AW Valve Co. are shown below.

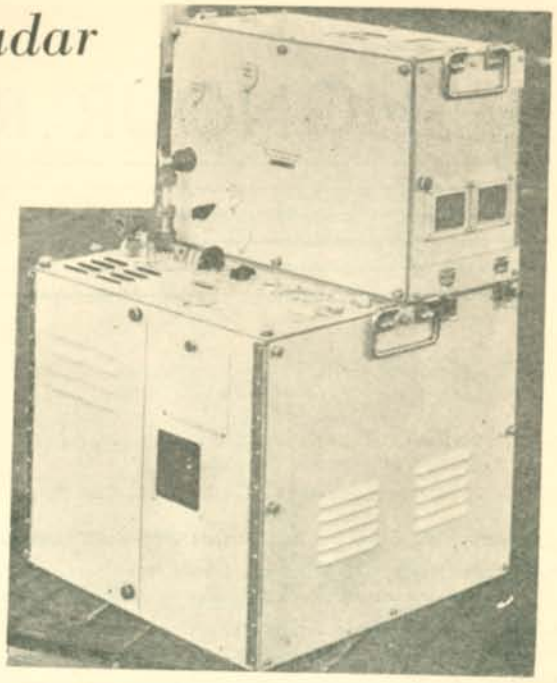




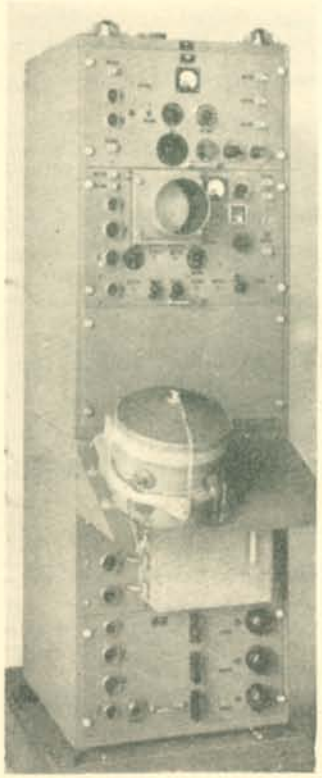
Services' Radar



Above and at right are shown two sections of a special lightweight, tropic-designed navigational radar equipment built by HMV for the RAAF.

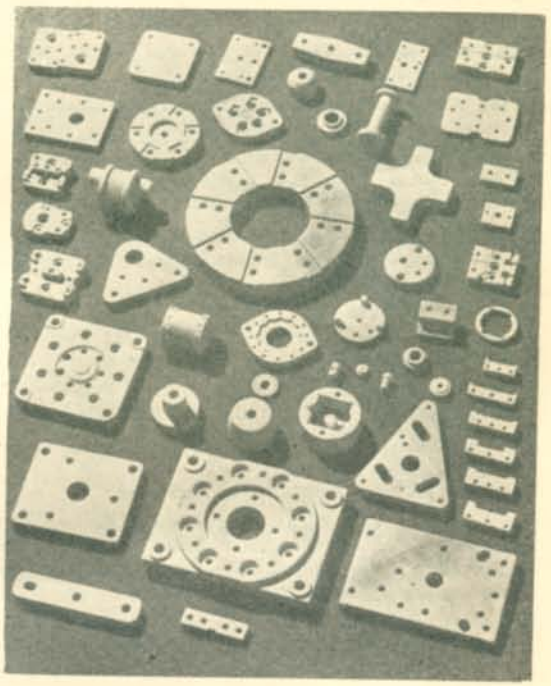


Illustrated at top right is the transmitter-modulator cubicle of a high-power naval radar equipment produced for the RAN by HMV.

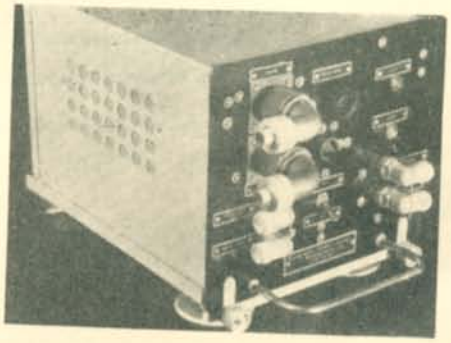


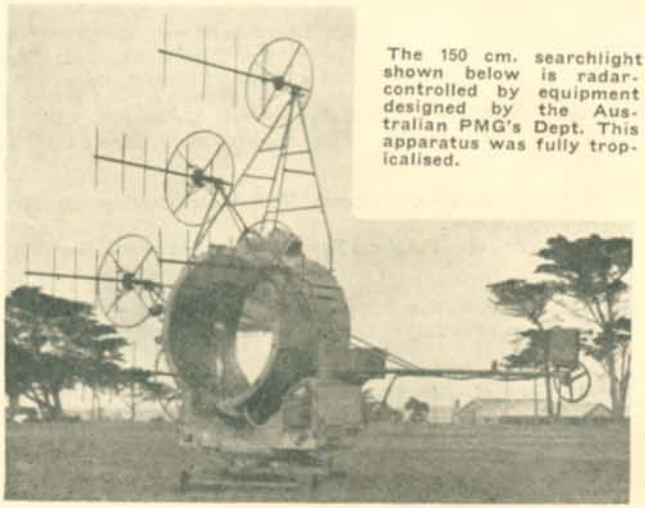
The equipment shown at left is the receiver, aerial control and power supply rack of an air-warning equipment produced by AWA for the Services.

The production of radar equipment placed heavy demands on the industry for high-grade insulating materials and at right is shown a representative group of precision ceramics produced by Nilcrom Porcelains.



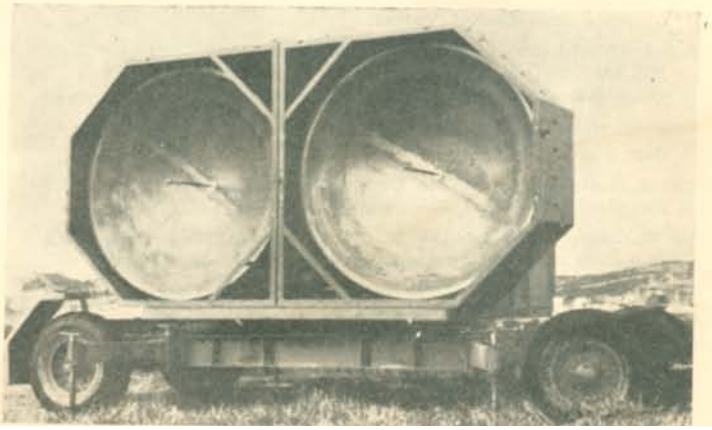
Kriesler (A/sia) Pty. Ltd. produced the trigger unit shown below for association with Service radar equipment.





The 150 cm. searchlight shown below is radar-controlled by equipment designed by the Australian PMG's Dept. This apparatus was fully tropicalised.

Shown below are the 80-in. parabolic reflector aerials of a mobile "coast-watching" radar equipment produced for the AMF by Amalgamated Wireless.



HONOUR ROLL OF INDUSTRY

Alphabetical List of Contractors

A

A.C.I. Plastics Pty. Ltd., Dowling Street, Waterloo, N.S.W.
Suppliers of:—Plastic Mouldings.

A.R.C. Engineering Pty. Ltd., 430 Little Collins Street, Melbourne, Vic.
Suppliers of:—Barrows, Drum; Arc-Mesh Crates.

A.S. Radio Parts, 157 Elizabeth Street, Melbourne, Vic.
Suppliers of:—Radio Components; Test Equipment.

A.W.A. Telcon Pty. Ltd., 47 York Street, Sydney, N.S.W.
Suppliers of:—High Frequency Cables.

Ackland, A. E., 200 Queen Street, Melbourne, Vic.
Suppliers of:—Electrical Equipment.

Adams, Wm. & Co. Ltd., 175 Clarence Street, Sydney, N.S.W.
Suppliers of:—Electrical Accessories.

Adelaide Potteries Ltd., Coglin Street, Brompton, S.A.
Suppliers of:—Ceramics; Insulators.

Advanx Tyre & Rubber Co. Pty. Ltd., Neild Avenue, Rushcutters Bay, N.S.W.
Suppliers of:—Rubber Mouldings.

Adverts Pty. Ltd., Victoria Street, North Melbourne, Vic.
Suppliers of:—Name Plates; Etching; Luminous Painting.

Aegis Mfg. Co. Pty. Ltd, (J. H. Magrath), 208 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Radio Test Equipment; Radio Components; Control Units.

Aerostat Co. of Australia, Lawson Square, Redfern, N.S.W.
Suppliers of:—Volume and Tone Controls.

Alpha Engineering Co. Pty. Ltd., 62-68 Layton Street, Camperdown, N.S.W.
Suppliers of:—Gear Cutting; Switches.

Airzone (1931) Ltd., 168 Parramatta Road, Auburn, N.S.W.
Suppliers of:—Radio Apparatus; Radar Equipment; ASV Beacons; Anti-Sub. Equipment; Test Equipment; Radio Components; Motor Generators, etc.

Amalgamated Wireless (A'sia) Ltd., 47 York Street, Sydney, N.S.W.
Suppliers of:—Radio Transmitters; Radio Receivers; Radar Equipment; Quartz Crystals and Ovens; Test Equipment; Signalling Lamps; Radio Components; Aircraft Instruments.

Amalgamated Wireless Valve Co. Pty. Ltd., 47 York Street, Sydney, N.S.W.
Suppliers of:—Transmitting and Receiving Valves; Radar Crystals and Special Valves.

Amplion (Aust.) Pty. Ltd., 36 Parramatta Road, Camperdown, N.S.W.
Suppliers of:—Charging Sets; Loudspeakers, Rectifier Units.

Anchor Electroplating Works, 100 King Street, Newtown, N.S.W.
Suppliers of:—Plating and Anti-Corrosion Treatments.

Angus & Coote Pty. Ltd., 500 George Street, Sydney, N.S.W.
Suppliers of:—Panel Engraving; Precision Dials, etc.

Apex Engravers, Pty. Ltd., 9 Hardware Street, Melbourne, Vic.
Suppliers of:—Tuning Tablets; Panels; Indicator Plates.

Arcadian Radio Pty. Ltd., 26 Rainford Street, Surry Hills, N.S.W.
Suppliers of:—Chassis and Metal Pressings.

Arendson, A. H., Malvern Road, Malvern, Vic.
Suppliers of:—Buckles and Fittings for Webbing; Straps, Etc.

Armco (Aust.) Pty. Ltd., 422 Little Collins Street, Melbourne, Vic.
Suppliers of:—Steel Sheets, Transformer Laminations.

Ashwin, E. M., 2 Coates Lane, Melbourne, Vic.
Suppliers of:—Line & Special Radio Equipment and Components.

Austral Bronze Co. Pty. Ltd., O'Riordan Street, Alexandria, N.S.W.
Suppliers of:—Brass Sheets and Rod; Non-Ferrous Materials.

Australasian Engineering Equipment Co. Pty. Ltd., 476 Latrobe Street, Melbourne, Vic.
Suppliers of:—Condensers; Resistors.

Australian Aluminium Co. Pty. Ltd., Unwin Street, Granville, N.S.W.
Suppliers of:—Aluminium and Dural Sheets; Rods; Tubes.

Australian General Electric Pty. Ltd., 93-95 Clarence Street, Sydney, N.S.W.
Suppliers of:—Electrical Equipment; Insulating Varnishes; Crystal Ovens.

Australian Porcelain Insulator Co. Pty. Ltd., 116 Queen Street, Melbourne, Vic.
Suppliers of:—Insulators; Ceramics.

Australian Sound Systems, 65 Park Street, Abbotsford, Vic.
Suppliers of:—Amplifiers; Radio Tuners; Phone Pick-ups; Radio Receivers.

Automatic Electric Telephones Ltd., 229 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Telephone Equipment; Relays.

B

Bambach, A. F., Parramatta Road, Petersham, N.S.W.
Suppliers of:—Winding Wire, etc.

Barr, Walter, Pty. Ltd., Gillespie Avenue, Alexandria, N.S.W.
Suppliers of:—Plastic Mouldings.

Bedford, Wm., Pty. Ltd., 476 Lt. Lonsdale Street, Melbourne, Vic.
Suppliers of:—Aerials & D/F Gear; Test Equipment; Corner Reflectors; Slidex R/T Codes; Metal Cases & Boxes.

Begg, William, & Sons, 422 Collins Street, Melbourne, Vic.
Suppliers of:—Machinery & Metal Parts; Electrical Components.

Berger, Lewis, & Sons, Cathcart House, 11c Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Paints; Varnishes; Lacquers; Fluorescent Paints.

Beveridge, W., 9 Walter Street, Hyde Park, S.A.
Suppliers of:—Valve Amplifying Potentiometers.

Blackwood, J, & Son, 86 Sussex Street, Sydney, N.S.W.
Suppliers of:—Machine Tools.

Bland Radio Ltd., Coromandel Place, Adelaide, S.A.
Suppliers of:—Amplifier Systems; Power Supply Units; Noise-Simulators.

Blaxland, Rae, Pty. Ltd., 63 Salisbury Road, Camperdown, N.S.W.
Suppliers of:—Metal Parts.

Bloch & Gerber Ltd., York Street, Sydney, N.S.W.
Suppliers of:—Radio Components.

Blogg, Wm., McLachlan Avenue, Rushcutters Bay, N.S.W.
Suppliers of:—Lamps; Electrical Accessories.

Bowen & Pomeroy Pty. Ltd., Macauley Road, Nth. Melbourne, Vic.
Suppliers of:—Timber Supplies; Transit Cases.

Bradley Bros. Pty. Ltd., Wentworth Avenue, Sydney, N.S.W.
Suppliers of:—Castings (Non-Ferrous).

Braided Products Pty. Ltd., Trafalgar Street, Annandale, N.S.W.
Suppliers of:—Cable Coverings; Wiring Looms; Cables.

Brearley, H., 192 Princes Highway, Arncliffe, N.S.W.
Suppliers of:—Aerial Accessories.

Brehaut, H. E., Pty. Ltd., 791 Whitehorse Road, Mont Albert, Vic.
Suppliers of:—Communication Earpieces; Electrical Equipment.

Brett, E. H., & Sons Pty. Ltd., 4 Little Avenue, East Balmain, N.S.W.
Suppliers of:—Canvas Covers; Bags, etc.

Breville Radio Pty. Ltd., 67 Missenden Road, Camperdown, N.S.W.
Suppliers of:—F.M. Transceivers; Mine Detectors; Test Equipment; Beacon Monitors; Humidity Control Gear.

Brewer, W. H., Pty. Ltd., 22 Blackwood Street, North Melbourne, Vic.
Suppliers of:—Insulating Materials.

British-Australian Lead Mfrs. Ltd., Cabarita Road, Cabarita, N.S.W.
Suppliers of:—Paints & Varnishes.

British General Electric Co. Ltd., 104 Clarence Street, Sydney, N.S.W.
Suppliers of:—Electrical Equipment; Telephone Equipment; Components.

British Insulated Cables, 84 William Street, Melbourne, Vic.
Suppliers of:—Aerial Wires, etc.

British Tube Mills (Aust.) Pty. Ltd., Kilburn, Sth. Aust.
Suppliers of:—Aerial Rods; Steel Tubes.

British Xylonite (Aust.) Pty. Ltd., Pt. Nepean Road, East Brighton, Vic.
Suppliers of:—Nameplates; Line Tags; Insulation.

Broadcasting Recording Supplies, 8 Dorcas Street, South Melbourne, Vic.
Suppliers of:—Phono. Turntables; Pick-ups.

Brolite Pty. Ltd., 42 Meaden Street, Sth. Melbourne, Vic.
Suppliers of:—Paints & Lacquers.

Brown, E. T., Ltd., 17 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Battery Carrying Frames; Sheet Metal Work.

Brownbilt Steel Equipt. Co., Botany Road, Mascot, N.S.W.
Suppliers of:—Steel; Cases; Pressed Metal Work.

Bruce Small Pty. Ltd., Clarendon Street, Sth. Melbourne, Vic.
Suppliers of:—Metal Frames.

Brunswick Springs Pty. Ltd., 8 Stanley Street, West Brunswick, Vic.
Suppliers of:—Earth Pins.

Bryant & Hunter, 28 Guildford Lane, Melbourne, Vic.
Suppliers of:—Dials; Motors; Crystal Holders; Precision Controls.

Bryant & May Ltd., Church Street, Richmond, Vic.
Suppliers of:—Sleeves; Self-Soldering.

Burley, L. G., 160 Edward Street, Brisbane, Qld.
Suppliers of:—Electrical Installations.

Burns, Clarke & Doctor, 61A Victoria Street, Burwood, N.S.W.
Suppliers of:—Metal Parts.

Burrows Plating, 95 Pyrmont Bridge Road, Camperdown, N.S.W.
Suppliers of:—Electroplating and Anti-Corrosion Treatments.

Bush & Co., 505 Queen Street, Brisbane, Qld.
Suppliers of:—Electrical Installations; Special Maintenance.

C

C.C. Engineering Co. Pty. Ltd., 213 Pyrmont Bridge Road, Glebe, N.S.W.
Suppliers of:—Die-Castings.

Cable Makers (Aust.) Ltd., Illawarra Road, Liverpool, N.S.W.
Suppliers of:—Wires & Cables.

Calder, R. S., Pty. Ltd., 64 Kingston Road, Summer Hill, N.S.W.
Suppliers of:—Aerial Switches; Electric Motors.

Carew, Huckett & Co., Albert Street, Northcote, Vic.
Suppliers of:—Canvas Covers and Carrying Bags; Satchels.

Carmichael, W. T., Ltd., Rawson Street, Auburn, N.S.W.
Suppliers of:—Metal Cases.
Park, Sth. Aust.

Carr Fastener Co. of Aust. Pty. Ltd., Tapley's Hill Road, Royal
Suppliers of:—Lock Washers; Clips; Pin jacks & Sockets.

Carr, J., Pty. Ltd., 661 George Street, Sydney, N.S.W.
Suppliers of:—Plastic Mouldings.

Caslake, C. R., 42 Macfarlan Street, Sth. Yarra, Vic.
Suppliers of:—Line Equipment; Carrying Frames, etc.

Casper Precision Engineering Pty. Ltd., James Street, Redfern, N.S.W.
Suppliers of:—Machinery and Metal Parts; Radar & Asdic Components; Plastic Mouldings.

Cecil Bros. Pty. Ltd., Holt Street, Sydney, N.S.W.
Suppliers of:—Cartons and Packing Materials.

Challenge Electric Co., 26 King Street, Sydney, N.S.W.
Suppliers of:—Charging Sets, 4kW.

Challingsworth, A., 476 Swan Street, Richmond, Vic.
Suppliers of:—Steel Masts; Aerial Accessories.

Chalmers, H. B., 110 Brunswick Street, Fitzroy, Vic.
Suppliers of:—Knobs, Plugs, Moulded Radio Panel Accessories.

Chivers, H. A., 111 A'Beckett Street, Melbourne, Vic.
Suppliers of:—Controls & Instruments.

Chubb's Australian Co. Ltd., 164 Clarence Street, Sydney, N.S.W.
Suppliers of:—Steel Frames; Radar Aerial Arrays.

Clay Bros. & Co., 111 Queens Parade, Clifton Hill, Vic.
Suppliers of:—Spare Valve Boxes.

Cliff & Bunting Pty. Ltd. (Trimax Transformers), 29 Flemington Road, North Melbourne, Vic.
Suppliers of:—Power & Audio Transformers; Chokes.

Colville Wireless Equipment Co. Pty. Ltd., Australia House, Carrington Street, Sydney, N.S.W.
Suppliers of:—Radio Transmitters; R.F. Amplifiers.

Clyde Wilson-Reid Pty. Ltd., 101 Wellington Street, Windsor, Vic.
Suppliers of:—Precision Controls; Dial Assemblies.

Commonwealth Aircraft Corporation, Fishermen's Bend, Port Melbourne, Vic.
Suppliers of:—Throat Microphones.

Commonwealth Moulding Pty. Ltd., 242 Princes Highway, Arncliffe, N.S.W.
Suppliers of:—Fuse Holders; Plastic Mouldings.

Commercial Steels & Forge Co. (Aust.) Pty. Ltd., Bowden Street, Alexandria, N.S.W.
Suppliers of:—Drop Forgings.

Cooke Bros. Pty. Ltd., 481 Kent Street, Sydney, N.S.W.
Suppliers of:—Radio Accessories; Electrical Apparatus.

Cook, F. L., & Williams Pty. Ltd., 40-68 Mollison Street, Abotsford, Vic.
Suppliers of:—Electrical Equipment; Electrical Accessories.

Cooke S., Pty. Ltd., 225 Queen Street, Melbourne.
Suppliers of:—Chassis Hardware Screws; Rivets, etc.

Cooper, C. A., Birmingham Street, Alexandria, N.S.W.
Suppliers of:—Tool & Die Maker.

Coote & Jorgensen Ltd., Botany Road, Alexandria, N.S.W.
Suppliers of:—Gear Cutting; Machinery.

Corrugated Fibre Containers Pty. Ltd., Victoria Street, North Melbourne, Vic.
Suppliers of:—Containers and Packing Material.

Honour Roll of Industry

Cowan, D. F., 134 Bank Street, Sth. Melbourne, Vic.
Suppliers of:—Metal Frames, etc.

Crammond Radio, 8 Queen Street, Brisbane, Qld.
Suppliers of:—Radio-Teletype Units; Fortress Signals Equipt.

Crook, Alan S., Electrical Co. Pty. Ltd., Herbert Street, St. Leonards, N.S.W.
Suppliers of:—Switches; Measuring Instruments; Signalling Lamps.

Crown Crystal Glass Co. Ltd., 52-58 William Street, Sydney, N.S.W.
Suppliers of:—Aerial Insulators; Metallised Glass Insulators.

Crusader Plate Co. Pty. Ltd., 651 Victoria Street, Abbotsford, Vic.
Suppliers of:—Line Labels; Ident. Plates, etc.

Cummings & Wilson, 29 Alberta Street, Sydney, N.S.W.
Suppliers of:—Film Projectors; Precision Engineering.

Currie & Richards Pty. Ltd., 473 Elizabeth and 229 Franklin Streets, Melbourne, Vic.
Suppliers of:—Sheet Metal Work.

D

D. W. Radio Co. Pty. Ltd., 466 Victoria Avenue, Chatswood, N.S.W.
Suppliers of:—Line Equipment; Frames, D.&P.

Dalton, H., & Co., 2 Holden Street, Redfern, N.S.W.
Suppliers of:—Plastic Mouldings.

Dane, Taylor & Co. Pty. Ltd., 70 Normanby Road, Sth. Melbourne, Vic.
Suppliers of:—Steel & Metal Parts.

Danks, J. & Son Pty. Ltd., 324 Pitt Street, Sydney, N.S.W.
Suppliers of:—Small Tools and Hardware.

Davey, F. W., & Co. Pty. Ltd., 566 Elizabeth Street, Melbourne, Vic.
Suppliers of:—Hand Generators; Motor Generators; Electric Fans & Blowers.

Davies, Coop & Co. Ltd., 625 Swanston Street, Carlton, Vic.
Suppliers of:—Canvas & Webbing Bags & Equipment.

Davies, Shephard (Sydney) Pty. Ltd., 2 Bridge Road, Stanmore, N.S.W.
Suppliers of:—Non-Ferrous Castings; Gear Cutting.

Demco Machinery Co. Pty. Ltd., Cleveland Street, Redfern, N.S.W.
Suppliers of:—Machine Tools.

Dempsey & Co. Pty. Ltd., 9 Cremorne Street, Richmond, Vic.
Suppliers of:—Trimmer Condensers.

Deutscher-Haigh Resistances Pty. Ltd., 380 Pt. Nepean Road, Brighton, Vic.
Suppliers of:—Resistors (Wire-Wound).

Deutscher, W. A., Pty. Ltd., 374 Pt. Nepean Road, Brighton, Vic.
Suppliers of:—Metal Parts.

Dickin, F., Pty. Ltd., 18 Lords Road, Leichhardt, N.S.W.
Suppliers of:—Carrying Cases; Cabinets; Bonded Plywoods.

Die Casters Ltd., 126 Cromwell Street, Collingwood, Vic.
Suppliers of:—Die-Castings.

Display & Radio Pty. Ltd., 47 Alice Street, Newtown, N.S.W.
Suppliers of:—Transformers; Chokes; Radio Components.

Dobbie Dico Meter Co. Ltd., 11 Sultram Place, Adelaide, S.A.
Suppliers of:—Metal Screws, Rivets and Small Hardware.

Dominion Radio, 39 Lothian Street, Nth. Melbourne, Vic.
Suppliers of:—Hand Microphones.

Don Electric Co. Pty. Ltd., 17 Gibbons Street, Camperdown, N.S.W.
Suppliers of:—Battery Chargers.

Don, R. S., Pty. Ltd., 10 Minnie Street, Brunswick, Vic.
Suppliers of:—Cable Laying Accessories.

Downs & Sons, Pty. Ltd., 441 Little Bourke Street, Melbourne, Vic.
Suppliers of:—Rope and Cordage.

Duco-Dulux Pty. Ltd., 301 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Paints & Lacquers.

Ducon Condenser Ltd., Bourke Street, Waterloo, N.S.W.
Suppliers of:—Radio & Electrical Condensers; Ceramics; Resistors.

Dunlop Rubber Co. (Aust.) Pty. Ltd., 27-33 Wentworth Avenue, Sydney, N.S.W.
Suppliers of:—Rubber Mouldings & Packing.

Durst Motors, 189B St. Johns Road, Forest Lodge, N.S.W.
Suppliers of:—Pedal Generators; Motor Generators; Dynamos & Alternators.

E

Eagle & Globe Steel, Swanston Street, Melbourne, Vic.
Suppliers of:—Steel, Drills, etc.

Eclipse Radio Pty. Ltd., 11 Sturt Street, Sth. Melbourne, Vic.
Suppliers of:—Radio Transmitters; Radio Receivers; Radiosondes; Radar Equipment; Fortress Amplifiers; Line Amplifier Equipment.

Edson Plating Co. Pty. Ltd., 9 Whiteman Street, Sth. Melbourne, Vic.
Suppliers of:—Electro-plating.

Efco Mfg. Co. Pty. Ltd., 108 Princes Highway, Arncliffe, N.S.W.
Suppliers of:—Die Casting, Anti-Corrosion Treatments.

Elcon Pty. Ltd., 182 Stawell Street, Burnley, Vic.
Suppliers of:—Power Supply Units; Motor Generators; Electric Fans & Blowers.

Electrical Plant Mfrs. Pty. Ltd., Botany Road, Waterloo, N.S.W.
Suppliers of:—Transformers; Electrical Control Gear.

Electric Construction Co. of Aust. Ltd., Gebble Street, Mayne, Brisbane, Qld.
Suppliers of:—Generating Sets.

Electric Control & Engineering Co. Ltd., 2 Chester Street, Camperdown, N.S.W.
Suppliers of:—Generating Sets; Electrical Equipment; Switchgear; Contactors.

Electricity Meter Mfg. Co., Joynton Avenue, Waterloo, N.S.W.
Suppliers of:—Power Supply Units; Headsets; Measuring Instruments; H.T. Rectifiers.

Electronic Industries Ltd., Grant Street, South Melbourne, Vic.
Suppliers of:—Quartz Crystals.

Elektran Products Co., 377 Post Office Place, Melbourne, Vic.
Suppliers of:—Line Equipment; Electrical Fittings.

Endurance Electric Co., Nirranda Street, Concord West, N.S.W.
Suppliers of:—Power & Audio Transformers; Chokes.

English Electric Co. Ltd., 189 William Street, Melbourne, Vic.
Suppliers of:—Generating Sets; Electrical Equipment.

Enticott, A. H., Pty. Ltd., Lt. Lonsdale Street, Melbourne, Vic.
Suppliers of:—Process Engraving; Panels, Dials, etc.

Eveready (Aust.) Pty. Ltd., Harcourt Parade, Rosebery, N.S.W.
Suppliers of:—Dry Batteries.

Extruded Metals Pty. Ltd., Hampstead Road, Maidstone, Vic.
Suppliers of:—Brass and Manganese-Bronze Rod.

Eyelets & Metal Products Pty. Ltd., Henderson Road, Arncliffe, N.S.W.
Suppliers of:—Eyelets and Small Metal Parts.

Eyelets Pty. Ltd., 40 Green Street, Windsor, Vic.
Suppliers of:—Eyelets & Small Metal Parts.

F

Fairway Scales & Tube Co., 9 Evans Street, Brybrook, Vic.
Suppliers of:—Coil Clamps, Hardware.

Federal Felters Pty. Ltd., Dynon Road, Footscray, Vic.
Suppliers of:—Felt Pads; Washers; Gaskets, etc.

Felt & Textiles of Aust. Ltd., 261 George Street, Sydney, N.S.W.
Suppliers of:—Felt Pads; Gaskets; Washers, etc.

Ferguson's Radio, 12 McMahon Street, Willoughby, N.S.W.
Suppliers of:—Transformers & Chokes.

Ferrier & Dickenson, Edinburgh Road, Marrickville, N.S.W.
Suppliers of:—Air Circulating Equipment.

Ferrocart Pty. Ltd., 126 Grant Street, Sth. Melbourne, Vic.
Suppliers of:—Vibrator Cartridges; Iron-dust Cores; Potentiometers.

Ferro-Enamels (Aust.) Pty. Ltd., Bourke Road, Alexandria, N.S.W.
Suppliers of:—Sheet Metal Work.

Fielding, J., & Co. Ltd., 9 Buckingham Street, Sydney, N.S.W.
Suppliers of:—Cartons & Packing Material.

Fitzgerald, E. L., 5 Douglas Parade, Williamstown, Vic.
Suppliers of:—Carrying Cases; Woodwork.

Flood, J., Pty. Ltd., 320 St. Kilda Road, Melbourne, Vic.
Suppliers of:—Charging Trolleys, Racks, Frames, etc., Cases, Transit.

Futcher, T. W. & Son Pty. Ltd., 55 A'Beckett Street, Melbourne, Vic.
Suppliers of:—Sheet Metal Work; Metal Frames, etc.

G

Gadsden, J., Pty. Ltd., Abbotsford Street, West Melbourne, Vic.
Suppliers of:—Metal Containers; Sealed Packings.

Gage, H., Pty. Ltd., Tempany Street, Nth. Fitzroy, Vic.
Suppliers of:—Carrying Cases; Woodwork.

Gainsborough Furniture Pty. Ltd., 120 Church Street, Richmond, Vic.
Suppliers of:—Packing & Transit Cases.

Galloways Panel Works, 216 High Street, Prahran, Vic.
Suppliers of:—Slidex R/T Codes.

Galvanizers (Aust.) Pty. Ltd., 67 Raglan Street, Waterloo, N.S.W.
Suppliers of:—Galvanising and Corrosion Proofing.

Gardiner Gasket Mfg. Co., 83 Commonwealth Street, Sydney.
Suppliers of:—Gaskets.

Garrett & Davidson Pty. Ltd., 29 Nicholls Street, Surry Hills, N.S.W.
Suppliers of:—Special Rolled Metal Parts.

General Accessories Pty. Ltd., Clarendon Street, Sth. Melbourne, Vic.
Suppliers of:—Mounting Racks; Frames.

General Mfg. & Dist. Co. Ltd., 70 Darlington Street, Darlington, N.S.W.
Suppliers of:—Sheet Metal Workers.

Gerard Industries Ltd., Park Terrace, Bowden, S.A.
Suppliers of:—Morse Keys; Telephone Plugs.

Gilbert, F. B., Devonshire Place, off Pirie Street, Adelaide, S.A.
Suppliers of:—5kVA Generating Sets.

Gilbert Lodge & Co. Pty. Ltd., 9 Hanna Street, Sth. Melbourne, Vic.
Suppliers of:—Special Electrical and Communication Cables.

Gladwell & Barlow Ltd., 23 Hanna Street, Sth. Melbourne, Vic.
Suppliers of:—Insulators.

Gloria Light Co. Pty. Ltd., 360 Post Office Place, Melbourne, Vic.
Suppliers of:—300W Charging Sets.

Godfrey Pty. Ltd., 15 Amelia Street, Waterloo, N.S.W.
Suppliers of:—Electrical Control Gear; Relays.

Goodwin, J. C., & Co. Pty. Ltd., Myrtle Street, Chippendale, N.S.W.
Suppliers of:—Special Glass.

Goudy, G., 64 Lt. Latrobe Street, Melbourne, Vic.
Suppliers of:—Metal Supplies; Hardware.

Gramophone Co. Ltd., The, Parramatta Road, Homebush, N.S.W.
Suppliers of:—Radar Equipment; Testing Instruments; Coaxial and Multi-pin Connectors.

Green, F. W., 80 Gibbes Street, Rockdale, N.S.W.
Suppliers of:—Aerial Accessories.

Greenmore Products Pty. Ltd., 11 Stewart Street, Richmond, Vic.
Suppliers of:—Electrical Equipment.

Griggs & Sons, 182 Woniora Street, Hurstville, N.S.W.
Suppliers of:—Metal Spinnings.

Galliers & Klaer Pty. Ltd., 135 Inkerman Street, St. Kilda, Vic.
Suppliers of:—Sheet Metal Work; Stainless Steel.

List of Contractors

H

Haigh & Russell, 393 Bay Street, Brighton, Vic.
Suppliers of:—Vitreous Resistors.

Handley, J. W., Pty. Ltd., 655 Victoria Street, Abbotsford, Vic.
Suppliers of:—Luminous Painting; Compasses, etc.; Precision Instruments.

Harrington, G. A. & L. Pty. Ltd., 9-15 Mary Street, Camperdown, N.S.W.
Suppliers of:—Pressed Metal Cases and Frames.

Harringtons Pty. Ltd., 386 George Street, Sydney, N.S.W.
Suppliers of:—Wire. (See also Raycophone Pty. Ltd.)

Harrison Metal Pressing Co. Pty. Ltd., 166 Burnley Street, Richmond, Vic.
Suppliers of:—Metal Pressings; Cases.

Hatrick, A. C. Pty. Ltd., Mentmore Avenue, Rosebery, N.S.W.
Suppliers of:—Glyptal and Tung-Oil Tropical Varnishes.

Harvey, Shaw Successors, Barkly Street, North Fitzroy, Vic.
Suppliers of:—Parkerising and Bonderising; Anti-Corrosion Treatments.

Hawke & Farrell (Hawke, A. E.), 201 St. Georges Road, Northcote, Vic.
Suppliers of:—Silver and Special Metal Contacts.

Haworth, R. M., 123 Layton Street, Camperdown, N.S.W.
Suppliers of:—Metal Parts; Toolmaking.

Haydt, A. E. W., 17A Pitt Street, Sydney, N.S.W.
Suppliers of:—Canvas Goods and Carrying Bags.

Hayman & Ellis, Pittwater Road, Manly, N.S.W.
Suppliers of:—Special Timbers.

Healing, A. G., Ltd., 167 Franklin Street, Melbourne, Vic.
Suppliers of:—Signalling Lamps; Radar Equipment; Test Equipment; Photocell Chronometers; Searchlight Projectors.

Hecht, H. & Co., 450 Collins Street, Melbourne, Vic.
Suppliers of:—Resistors; Condensers; Ceramics.

Hedley's Pty. Ltd., 291 Toorak Road, South Yarra, Vic.
Suppliers of:—Identification Strips; Canvas Cases, etc.

Henderson, P. A. & Co., Berry Road, St. Leonards, N.S.W.
Suppliers of:—Power Transformers and Chokes.

Henderson, Thos. G., 3 Chalder Street, Marrickville, N.S.W.
Suppliers of:—Toolmaking; Metal Parts.

Herschell's Pty. Ltd., 31 Agnes Street, Jolimont, Vic.
Suppliers of:—Photo Etching and Processing.

Hicks, Nolan & White, 9 Gower Street, Kensington, Vic.
Suppliers of:—Sheet Metal Workers.

Hilco Transformers Pty. Ltd., 97 Berkeley Street, Carlton, Vic.
Suppliers of:—Transformers and Chokes.

Hodson & Gault Pty. Ltd., Springvale Road, Spring Vale, Vic.
Suppliers of:—Generating Sets and Electrical Equipment.

Hoelle, J. J. & Co., 47 Alma Street, Darlington, N.S.W.
Suppliers of:—Solder Lugs and Connectors.

Holder, Stroud Pty. Ltd., Bourke Road, Alexandria, N.S.W.
Suppliers of:—Electroplating; Metal Spinnings.

Hopkins, Odlum, 268 Geelong Road, West Footscray, Vic.
Suppliers of:—Machine Belting.

Horton, H. C., 715 Dandenong Road, East Malvern, Vic.
Suppliers of:—Rubber Stamps; Panel Engraving.

Hoyle, R. H., 33 Guildford Lane, Melbourne, Vic.
Suppliers of:—5kVA Gen. Sets.

Hucksons Diecasting Pty. Ltd., 430 Bourke Street, Melbourne, Vic.
Suppliers of:—Die Castings.

Hudson, Edgar V., Pty. Ltd., 172 Adelaide Street, Brisbane, Qld.
Suppliers of:—Radio Receivers.

Hull, D. M., 187 Berkeley Street, Carlton, Vic.
Suppliers of:—Metal Parts; Spindles, Terminals, etc.

Honour Roll of Industry

I

Imperial Chemical Industries of Aust. & N.Z. Ltd., 251 George Street, Sydney, N.S.W.
Suppliers of:—Cleaning Agents; Plastics.

International Radio Co. Pty. Ltd., 254 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Valve Sockets; Shields; Amphenol Connectors; Radio Accessories.

International Resistance Co., 55 Addison Road, Marrickville, N.S.W.
Suppliers of:—Wire-wound and Metallised Resistors and Controls (see also W. J. McLellan).

J

James & Vautin, 661 George Street, Sydney, N.S.W.
Suppliers of:—Radio Accessories.

Jeffries, R. E. & Co. Pty. Ltd., 168-174 Day Street, Sydney, N.S.W.
Suppliers of:—Commutators; Insulating Materials.

Johns & Waygood Ltd., City Road, South Melbourne, Vic.
Suppliers of:—Generating Sets; Voltage Regulators.

Johnston & Phillips Ltd., 203 Clarence Street, Sydney, N.S.W.
Suppliers of:—Winding Wires and Cables; Boxes, Terminating.

Johnston, R., 21 Liverpool Street, Melbourne, Vic.
Suppliers of:—Electrical Equipment.

Jones, Groom & Co., 204 Grant Street, South Melbourne, Vic.
Suppliers of:—Metal Parts.

Jung, E. T., 112 Little Collins Street, Melbourne, Vic.
Suppliers of:—Coil Forms and Bobbins.

K

K.L. Engines & Tractors Pty. Ltd., 304 Spencer Street, Melbourne, C.1., Vic.
Suppliers of:—Poles and Masts, Sectional Steel; Generating Sets; Cable Layers.

Kelso Trading Supply Pty. Ltd., 52 Henderson Street, North Melbourne, Vic.
Suppliers of:—Sheet Metal Workers.

Kennett, C. E., Glen Road, Toorak, Victoria.
Suppliers of:—Ladders, Field Telegraph.

Kent, J. S., 103 Market Street, South Melbourne, Vic.
Suppliers of:—Metal Forgings.

Kenny Charlesworth Rubber Co. Pty. Ltd., 181-183 Lennox Street, Richmond, E.1., Vic.
Suppliers of:—Earpads; Sponge Rubber; Rubber Mouldings.

Keogh, E. P., 402 Swanston Street, Melbourne, Vic.
Suppliers of :—Scientific Apparatus.

Kiernan, T., 6 Adeline Street, Preston, Vic.
Suppliers of:—Battery Chargers.

King & Klein, 293 Abercromble Street, Redfern, N.S.W.
Suppliers of:—Packing Cases.

King, P. J., Pty. Ltd., 497 Victoria Street, Abbotsford, Vic.
Suppliers of:—Metallic Bellows; Precision Engineering.

Knightly, P. J., 150 Wilson Street, Newtown, N.S.W.
Suppliers of:—Glass Engraver and Etcher.

Kingsley Radio Pty. Ltd., 388 St. Kilda Road, Melbourne, Vic.
Suppliers of:—Reception Sets; Radio Accessories; Iron-dust Cores; Crystal Calibrators.

Kiwi Metal Products, 160 Rochford Street, Erskineville, N.S.W.
Suppliers of:—Drop Forgings.

Knox, Schlapp & Co., 360 Collins Street, Melbourne, Vic.
Suppliers of:—Brass and Copper Tubing.

Kosters Premier Pottery, Avonmore Avenue, North Norwood, S.A.
Suppliers of:—Insulators and Ceramics.

Kriesler (A'sia) Pty. Ltd., 43 Alice Street, Newtown, N.S.W.
Suppliers of:—Radio Equipment; Telephones, High Power; Radio Components; Radar Equipment; Aircraft Electrical Gear.

L

Langco Electric Jug Co., 32 Alfred Street, Rozelle, N.S.W.
Suppliers of:—Depth Sounding Equipment; Signalling Projectors; Non-luminous Heaters.

Lawrence & Hanson Pty. Ltd., 172 William Street, Melbourne, Vic.
Suppliers of:—Electrical Equipment; Switches; Crystal Ovens.

Lawrenson, R. H., Pty. Ltd., 29 Wyndham Street, Alexandria, N.S.W.
Suppliers of:—Die Castings.

Leggett's Products Pty. Ltd., Doonside Street, Richmond, Vic.
Suppliers of:—Anti-Vibration Mounts; Special Hardware.

Levee, A. B., 17-19 Alberta Street, Sydney, N.S.W.
Suppliers of:—Relays.

Liberty Plastic Products Pty. Ltd., 626 High Street, Northcote, Vic.
Suppliers of:—Polythene Insulation; Plastic Mouldings.

Lilley Bros., 33 Grant Street, Clifton Hill, Vic.
Suppliers of:—Coil Cans, Shields, etc.

Lindberg, Foster & Co., Maples Lane, Prahran, Vic.
Suppliers of:—Boxes, Terminal; Remote Control Units; Aerial Coupling Units; Wiring Looms.

Liverpool Electric Cable Co. Ltd., 190 Clarence Street, Sydney, N.S.W.
Suppliers of:—Winding Wires and Cables.

Lorimier Contacts Pty. Ltd., 517 Church Street, Richmond, Vic.
Suppliers of:—Special Metal Contacts for Relays, etc.; Relays and Switches.

Lusteroid Lacquers, Coventry Street, South Melbourne, Vic.
Suppliers of:—Varnishes and Lacquers.

Lysaght, J., Newcastle Works Pty. Ltd., 33 Macquarie Place Sydney, N.S.W.
Suppliers of:—Steel.

M

McColl Electric Works Pty. Ltd., 112 Moor Street, Fitzroy, Vic
Suppliers of:—Rotary Machines.

McConnell Building Co. Pty. Ltd., 193 Macquarie Street, Sydney N.S.W.
Suppliers of:—Transit Cases.

Machin, E. A., & Co. Pty. Ltd., 535 Elizabeth Street, Melbourne Vic.
Suppliers of:—Electrical Equipment; Contacts, etc.

Machining & Electrical Co. Pty. Ltd., 18-20 Newton Street Alexandria, N.S.W.
Suppliers of:—Electric Motors and Generators.

Mackay Silentruba Products Pty. Ltd., 1 Swan Street, Richmond, Vic.
Suppliers of:—Anti-Vibration Mountings.

McKenzie & Holland (Aust.) Pty. Ltd., Sutton Street, Newport, Vic.
Suppliers of:—Microphones, Hand; Switchboards, Magneto; Rectifiers; Battery Chargers.

McLellan, W. J. & Co., 55 York Street, Sydney, N.S.W.
Suppliers of:—Resistors; Condensers; Radio Accessories.

McMillan & Co., 122 Edward Street, East Brunswick, Vic.
Suppliers of:—Metal Castings.

McPherson, Thos. & Son, 493 Kent Street, Sydney, N.S.W.
Suppliers of:—Bolts; Screws; Hardware.

McPherson's Pty. Ltd., 546 Collins Street, Melbourne, Vic.
Suppliers of:—Air Compressors; Line Accessories; Small Tools; Hardware.

McQuade & Allen, 7 O'Connell Street, North Melbourne, Vic.
Suppliers of:—Carrying Cases; Sealed Containers.

Magrath, J.H., & Co., 208 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Test Equipment; Radio Accessories.

Malley's Limited, 50 Mountain Street, Broadway, Sydney, N.S.W.
Suppliers of:—Blower and Ventilating Assemblies.

Manufacturers Special Products Pty. Ltd., 47 York Street, Sydney, N.S.W.
Suppliers of:—Radio Accessories and Components.

Marsh, J., & Sons Pty. Ltd., 35 Villiers Street, North Melbourne, Vic.
Suppliers of:—Metal Cans.

Martin, G. H., Pty. Ltd., 32 Bathurst Street, Sydney, N.S.W.
Suppliers of:—Steel.

Masse Batteries Pty. Ltd., 115 Crown Street, Sydney, N.S.W.
Suppliers of:—Accumulators; Battery Chargers.

Master Instrument Co., 13 Blackfriar's Street, Chippendale, N.S.W.
Suppliers of:—Test Equipment; Meters; Measuring Instruments.

Melbourne Wire Works, 82 Cremorne Street, Richmond, Vic.
Suppliers of:—Brass Wire Mesh; Clips and Hooks.

Mellozing Pty. Ltd., 58 Victoria Street, Alexandria, N.S.W.
Suppliers of:—Metal Spraying & Anti-Corrosion Treatments.

Menzies, E. C., Electrical Pty. Ltd., 29 Hardware Street, Melbourne, Vic.
Suppliers of:—Insulating Materials; Resistance Wires.

Metal Coatings Pty. Ltd., 16 Bridge Road, Stanmore, N.S.W.
Suppliers of:—Metal Spraying & Anti-Corrosion Treatments.

Metalsprayers Pty. Ltd., off Railway Terrace, Mile End, S. Aust.
Suppliers of:—Metal Spraying and Anti-Corrosion Treatments.

Metals & Celluloids Pty. Ltd., James Street, Waterloo, N.S.W.
Suppliers of:—Metal Stampings.

Metters Ltd., 66 Grenfell Street, Adelaide, Sth. Aust.
Suppliers of:—Self-Supporting Aerial Towers.

Mica & Insulating Supplies Co., 562 Bourke Street, Melbourne, Vic.
Suppliers of:—Special Tropical Lacquer; Insulating Materials.

Michaelis, Hallenstein, 441 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Line Equipment; Climbers, Pole.

Mills, W. J., Mfg. Co., 187 Nelson Street, Annandale, N.S.W.
Suppliers of:—Resistors.

Modern Plating Works, 99 Market Street, Sth. Melbourne, Vic.
Suppliers of:—Electro-plating & Anti-Corrosion Treatments.

Mitchell & Co. Pty. Ltd., Cross Street, West Footscray, Vic.
Suppliers of:—Metal Working; Forgings.

List of Contractors

Moldex Co., 570 Burwood Road, Hawthorn, Vic.
Suppliers of:—Plastic Mouldings.

Morgan Crucible Co. (Aust.) Pty. Ltd., Bourke Road, Alexandria, N.S.W.
Suppliers of:—Motor & Generator Brushes; Resistors, etc.

Morris Pty. Ltd., 35 Pitt Street, Sydney, N.S.W.
Suppliers of:—Process Engraving.

Moulded Products (A'sia) Ltd., 155 Cremorne Street, Richmond, Vic.
Suppliers of:—Nylex Mouldings; PVC Insulation; Cables & Hook-up Wires; Plastic Mouldings; Polythene Insulation.

Morris & Walker Pty. Ltd., 243 Smith Street, Fitzroy, Vic.
Suppliers of:—Radar Calibration Targets; Special Containers.

Music Masters Radio Co., Stanley Street, South Brisbane, Qld.
Suppliers of:—Radio Equipment.

N

Nally Ltd., 5 Queen Street, Glebe, N.S.W.
Suppliers of:—Plastic Mouldings.

National Radio Corp. Ltd., 90 Grote Street, Adelaide, Sth. Aust.
Suppliers of:—Radio Equipment; Remote Control Units; Radio Accessories.

Naunton, A. G., 5 Montclair Ave., Brighton, Vic.
Suppliers of:—Electrical Equipment.

Nettlefold Pty. Ltd., Ballarat Road, Sunshine, Vic.
Suppliers of:—Screws; Rivets; Hardware.

New Air Pty. Ltd., 8 Dowling Street, Woolloomooloo, N.S.W.
Suppliers of:—Gaseous Arrestors and Indicator Tubes; Electrical Relays.

New Brunswick Brick & Pottery Co. Pty. Ltd., 48 Barkly Street, Brunswick, Vic.
Suppliers of:—Insulators.

Newton, McLaren Ltd., Leigh Street, Adelaide, Sth. Aust.
Suppliers of:—Radio Components; Electrical Accessories.

Nilcrom Porcelains (Aust.) Pty. Ltd., 221 Separation Street, Northcote, Vic.
Suppliers of:—Insulators & Ceramics.

Nilsen, Cromie Pty. Ltd., 26 Market Street, Sydney, N.S.W.
Suppliers of:—Electrical Equipment.

Noyes Bros. Ltd., 115 Clarence Street, Sydney, N.S.W.
Suppliers of:—Electrical Equipment.

O

O'Brien, F. G., Pty. Ltd., Allen Street, Waterloo, N.S.W.
Suppliers of:—Special Glass Work; Lense Grinding.

O'Brien, O. H., Pty. Ltd., 39 Pitt Street, Sydney, N.S.W.
Suppliers of:—Insulating Materials; Magnet Wire.

O'Donnell & Griffin Pty. Ltd., 51 Druitt Street, Sydney, N.S.W.
Suppliers of:—Charging Sets; Battery Chargers.

Ogilvie, I. M., 6 Mathieson Street, Camperdown, N.S.W.
Suppliers of:—Metal Castings.

Olympic Tyre & Rubber Co. Ltd., 68 Cross Street, West Footscray, Vic.
Suppliers of:—Wires & Cables; Special Connectors.

Ormiston Rubber Co. Pty. Ltd., 529 Mt. Alexander Road, Moonee Ponds, Vic.
Suppliers of:—Special Cables; Rubber Mouldings; Synthetic Rubber Seals.

Overseas Electric Distributors, 400 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Charging and Generating Sets.

Honour Roll of Industry

P

Parsons & Robertson Ltd., 172 Pulteney Street, Adelaide, S.A.
Suppliers of:—Wind-Driven Battery Chargers.

Paton Electrical Pty. Ltd., 90 Victoria Street, Ashfield, N.S.W.
Suppliers of:—Measuring Equipment; Test Instruments.

Patrick, A. E., Ltd., 4 Parramatta Road, Summer Hill, N.S.W.
Suppliers of:—Panel Plates; Transfers.

Paul & Gray Pty. Ltd., 400 Collins Street, Melbourne, Vic.
Suppliers of:—Screws; Bolts; Hardware.

Paykel Bros. (Aust.) Pty. Ltd., 242 Hoddle Street, Abbotsford, Vic.
Suppliers of:—Heat-Treatment Oils; Special Lubricants.

Peppys & Munnoch Ltd., 294 Botany Road, Alexandria, N.S.W.
Suppliers of:—Transit Cases; Special Woodwork.

Philips Electrical Industries of Aust. Pty. Ltd., 69-73 Clarence Street, Sydney, N.S.W.
Suppliers of:—Radio Transmitters; Radio Receivers; Amplifying Equipt.; Testing Instruments; Radio Accessories; Radio Valves; Cathode-Ray Tubes; Aircraft Components and Accessories.

Pickrell, W. G., Pty. Ltd., 42 King Street, Newtown, N.S.W.
Suppliers of:—Metal Parts; Sheet Metal Work.

Pioneer Webbing Co., Station Street, West Ryde, N.S.W.
Suppliers of:—Webbing & Canvas Bags & Fittings.

Plated Products, 94 Wilson Street, Newtown, N.S.W.
Suppliers of:—Aerial Rods; Electro-Plating.

Precise Electrical Instrument Co. Ltd., 173 Liverpool Road, Ashfield, N.S.W.
Suppliers of:—Meters; Test Equipment.

Precision Engineering Co. Pty. Ltd., 6 Nield Avenue, Rushcutters Bay, N.S.W.
Suppliers of:—Charging Sets.

Products Pty. Ltd., 137 Clarence Street, Sydney, N.S.W.
Suppliers of:—Plastic Mouldings.

Provan, D., & Sons, 62 Alexandria Parade, Clifton Hill, Vic.
Suppliers of:—Cable-Laying Equipment.

Q

Quality Castings Pty. Ltd., McEvoy Street, Waterloo, N.S.W.
Suppliers of:—Boxes, Terminating; Magnets; Magnetic Devices.

Quality Mouldings Pty. Ltd., 84 Waverley Road, East Malvern, Vic.
Suppliers of:—Plastic Mouldings.

Quartz Crystal Laboratories, 31 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Radio Crystals.

Queensbridge Motors & Engineering Pty. Ltd., 31 Queens Bridge Sth. Melbourne, Vic.
Suppliers of:—Generating Sets.

Quirk's Victory Light Co., 29 William Street, Melbourne, Vic.
Suppliers of:—Wind-Driven Charging Sets.

R

R. & S. Batteries Pty. Ltd., 234 Grant Street, Sth. Melbourne, Vic.
Suppliers of:—Accumulators.

R.C.S. Radio Pty. Ltd., 174 Canterbury Road, Canterbury, N.S.W.
Suppliers of:—Trolitul Mouldings.

Radio Corporation Pty. Ltd., 26 Grant Street, South Melbourne, Vic.
Suppliers of:—Radio Transmitters; Radio Receivers; Radio Accessories; Quartz Crystals; Radar Apparatus; Radio Components; Testing Equipment.

Radio Equipment Pty. Ltd., 206 Broadway, Sydney, N.S.W.
Suppliers of:—Meters; Test Equipment.

Radio Wholesalers, 29 Rundle Street, Adelaide, Sth. Aust.
Suppliers of:—Radio Components; Electrical Accessories.

Radix Power Supplies Ltd., 64 Lawler Street, Subiaco, West Aust.
Suppliers of:—Transformers and Chokes, Power and Audio.

Raycophone Pty. Ltd., Booth & Trafalgar Streets, Annandale, N.S.W.
Suppliers of:—Anti-sub. Equipment; Fortress Amplifiers; Sound-film Projectors; Signalling Lamps; Cathode-Ray Oscillographs.

Raynor's Pty. Ltd., The Boulevarde, Punchbowl, N.S.W.
Suppliers of:—Nameplates.

Reeve & Marshall, 286 City Road, Sth. Melbourne, Vic.
Suppliers of:—Aerial Bases and Adaptors; Brass Castings.

Renown Plate Co. Pty. Ltd., 28 Guildford Lane, Melbourne, Vic.
Suppliers of:—Electro-plating; Special Finishes.

Repetition Engineering Co. Pty. Ltd., 58 Clunden Street, North Brighton, Vic.
Suppliers of:—Lamps, Operators; Metal Parts; Special Screws, etc.; Terminals; Cable Connectors.

Reynolds, R. W., Pty. Ltd., 32 Ralph Street, Alexandria, N.S.W.
Suppliers of:—Relays.

Richards Industries Ltd., Keswick, Sth. Aust.
Suppliers of:—Cable Drums; Metal Containers.

Robertson, J., 136 Nelson Street, Annandale, N.S.W.
Suppliers of:—Metal Cases, etc.

Rodd, G. & E., 37 Greeves Street, St. Kilda, Vic.
Suppliers of:—Inductor Assemblies; Netting Switches.

Roeszler, C. G., & Son, 429 Lt. Collins Street, Melbourne, Vic.
Suppliers of:—Rubber Stamps; Engraving Stencils, etc.

Rola (Aust.) Pty. Ltd., The Boulevard, Richmond, Vic.
Suppliers of:—Loudspeakers; Microphones; Winding Wires; Magnets.

Rose, Frederick, Ltd., 28 Bond Street, Sydney, N.S.W.
Suppliers of:—Radar Reflectors; Synthetic Resin-Bonded Plywoods & Assemblies.

Ross, Maclean & Co., 222 Clarence Street, Sydney, N.S.W.
Suppliers of:—Process Engraving.

Ross-Smith & Co. Pty. Ltd., 671 Forest Road, Bexley, N.S.W.
Suppliers of:—Metal Turnings.

Rural Lighting Co., 161 William Street, Sydney, N.S.W.
Suppliers of:—Generating and Charging Sets.

Rustproofers Pty. Ltd., 14 Brompton Street, Marrickville, N.S.W.
Suppliers of:—Anti-Corrosion Treatments.

Rylands Bros. (Aust.) Pty. Ltd., 422 Lt. Collins Street, Melbourne, Vic.
Suppliers of:—Steel Wire Drawing & Tinning for Telephone Cable.

Sample, G. H., & Son, 280 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Electrical Measuring Instruments; Meters.

Sanders, W. J., Pty. Ltd., Bowen's Buildings, Railway Square, Sydney, N.S.W.
Suppliers of:—Silver Contacts, etc.

Sands & McDougall Pty. Ltd., Collins Street, Melbourne, Vic.
Suppliers of:—Paper Products; Labels.

Scanlan Electric Co. Pty. Ltd., 52 Pitt Street, Sydney, N.S.W.
Suppliers of:—Electrical Switch Gear.

Schick, R., 14 St. Francis Street, Melbourne, Vic.
Suppliers of:—Electrical Equipment.

Scott's Brass Works, 19 Burton Street, Melbourne, Vic.
Suppliers of:—Non-ferrous Castings.

Scruttons Pty. Ltd., 161 Clarence Street, Sydney, N.S.W.
Suppliers of:—Screws; Bolts; Hardware.

Security Electric & Mfg. Co. Pty. Ltd., Gardeners Road, Mascot, N.S.W.
Suppliers of:—Electrical Switchgear; Relays.

Sellers Pty. Ltd., Olivia Lane, Surry Hills, Sydney, N.S.W.
Suppliers of:—Aluminium Spinnings and Parts.

Sewell, S. G., Pty. Ltd., 7 Weston Street, Brunswick, Vic.
Suppliers of:—Special Bolts & Screws.

Servex Electrical Co. Pty. Ltd., 493 Albion Street, West Brunswick, Vic.
Suppliers of:—Electric Lanterns; Electrical Gear; Dial & Control Units; Tuning Cond. Assemblies.

Services Elevator & Electric Co. Pty. Ltd., 15 Goulburn Street, Sydney, N.S.W.
Suppliers of:—Motor-Alternators; Generating Sets.

Shell Co. of Aust. Ltd., 163 William Street, Melbourne, Vic.
Suppliers of:—Insulating Waxes and Solvents.

Sherwin, Williams Co. (Aust.) Pty. Ltd., 11c Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Tropical Varnishes & Lacquers.

Shopland & Pardy, Ricketty Street, Mascot, Sydney, N.S.W.
Suppliers of:—Metal Castings.

Siemens (Aust.) Pty. Ltd., 189 William Street, Melbourne, Vic.
Suppliers of:—Precision Electrical Meters and Test Equipment; Electrical Gear.

Simplex Products Pty. Ltd., 716 Parramatta Road, Petersham, N.S.W.
Suppliers of:—Condensers; Ceramic Parts.

Simpson, A. J., 5 Tinana Street, Haberfield, N.S.W.
Suppliers of:—Meters and Test Equipment.

Skelly, D. F., & Co. Pty. Ltd., 355 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Generating Sets; Electrical Equipment.

Smith Bros. Pty. Ltd., 10 River Street, Sth. Yarra, Vic.
Suppliers of:—Timber Supplies; Packing Materials.

Smith Bros. Pty. Ltd., Botany Road, Waterloo, N.S.W.
Suppliers of:—Boxes & Packing.

Southern Cross Porcelain Co., 1852 Malvern Road, East Malvern, Vic.
Suppliers of:—Insulators & Ceramic Parts; Plastic Mouldings.

Southern Panel Beating Works, 79 Coventry Street, Sth. Melbourne, Vic.
Suppliers of:—Anti-Vibrator Mountings.

Speakman, W. R., & Son, 65 Latrobe Street, Melbourne, Vic.
Suppliers of:—Electro-plating; Anti-Corrosion Treatments.

Spicers & Detmold Ltd., 377 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Paper Products; Labels.

Standard Telephones & Cables Pty. Ltd., 258 Botany Road, Alexandria, N.S.W.
Suppliers of:—Radio Transmitters; Radio Receivers; Telephone Apparatus; Telephones, Switchboards; Radar Equipment; Charging Equipment; Relays; Selenium Rectifiers; Headsets.

Standard Waygood Ltd., 84 Bourke Street, Waterloo, N.S.W.
Suppliers of:—Generating Sets; Voltage Regulators; Searchlight Assemblies & Carbons.

Stan-Mor Battery Co., 243 Bay Street, Brighton, Vic.
Suppliers of:—Dry Batteries.

Stapleton & Lewis Pty. Ltd., 81 Lennox Street, Richmond, Vic.
Suppliers of:—Transit Cases; Resin-Bonded Plywoods; Reson Glue Films.

Steane's Sound Systems, 60-80 Miller Street, Melbourne, Vic.
Suppliers of:—Amplifying Equipment; Microphones; Loudspeaker Units; Radio Receivers.

Stenco Die Castings, 345 Alison Road, Coogee, N.S.W.
Suppliers of:—Die Castings.

Sterling Varnish Co., Huntley Street, Alexandria, N.S.W.
Suppliers of:—Lacquers & Varnishes.

Stewart, E. H., 296 Pitt Street, Sydney, N.S.W.
Suppliers of:—Panel Engraving; Nameplates.

Stokes Foundry Pty. Ltd., Fallon Street, Brunswick, Vic.
Suppliers of:—Castings (Non-ferrous).

Stromberg-Carlson (A'sia) Pty. Ltd., Bourke Road, Alexandria, N.S.W.
Suppliers of:—Telephone Switchboards; Telephone Equipment; Fullerphones; Radio Equipment.

Sun Electric Co. Pty. Ltd., 111 Hardware Street, Melbourne, Vic.
Suppliers of:—Nylex Insulation, Bakelite Sheet, etc.; Electrical Cables.

Sunshine Potteries, 39 Derby Road, Sunshine, Vic.
Suppliers of:—Insulators & Ceramics.

Sutherland, A. P., 2 Maffra Street, South Melbourne, Vic.
Suppliers of:—Lighting Sets; Power Distrib. Cabinets.

Swales & Swann, 2 Coates Lane, Melbourne, Vic.
Suppliers of:—Power & Audio Chokes & Transformers.

Sydney Ornamental Steel Co. Pty. Ltd., Gardener's Road, Mascot, N.S.W.
Suppliers of:—Frame Assemblies.

Syme-E.S.M. Pty. Ltd., 13 Glebe Street, Glebe, N.S.W.
Suppliers of:—Headphones.

Honour Roll of Industry

T

Taubman's Pty. Ltd., Mary Street, St. Peters, N.S.W.
Suppliers of:—Tropical Varnishes; Paints & Lacquers; Lacquers; Plastic Cements.

Teare, Bennie Pty. Ltd., 97 Franklin Street, Melbourne, Vic.
Suppliers of:—Hardware and Small Tools.

Tecnico Ltd., Carrington Street, Marrickville, N.S.W.
Suppliers of:—Electrical Equipment; Radio Accessories; Radio Components; Voltage Regulators.

Telephone & Electrical Industries Pty. Ltd., Rosehill Street, Redfern, N.S.W.
Suppliers of:—Telephone Jacks; Meters; Relays.

Thom & Smith Pty. Ltd., 919-929 Botany Road, Mascot, N.S.W.
Suppliers of:—Radio Transmitters; Radio Receivers; Radio Accessories; Radar Beacons.

Thorne & Deane Pty. Ltd., 229 Burwood Road, Burwood, Vic.
Suppliers of:—Charging Sets; Electrical Generators.

Tilbury & Lewis Pty. Ltd., 51 Wangaratta Street, Richmond, Vic.
Suppliers of:—Power & Audio Transformers & Chokes.

Tilley, E. W., 123 Latrobe Street, Melbourne, Vic.
Suppliers of:—Plastic Mouldings.

Toowoomba Foundry Pty. Ltd., 277 Ruthven Street, Toowoomba, Qld.
Suppliers of:—Generating Sets; Charging Equipment.

Traeger, A. H., 11 Dudley Road, Marryatville, Sth. Aust.
Suppliers of:—Pedal-operated Transceivers.

Transformer Mfg. Co. Pty. Ltd., 71 Argyle Street, Fitzroy, Vic.
Suppliers of:—Power Transformers and Chokes.

Transmission Equipment Pty. Ltd., Doonside Street, Richmond, Vic.
Suppliers of:—Telephone Apparatus; Line Equipment.

Transmission Products Pty. Ltd., 126 Miller Street, Nth. Sydney, N.S.W.
Suppliers of:—Precision Testing Equipment; Power & Audio Transformers & Chokes.

Triplet, H., 19 Lt. Latrobe Street, Melbourne, Vic.
Suppliers of:—Basket Work; Panniers, etc.

Trol Injection Mouldings Pty. Ltd., 50A Glebe Street, Glebe, N.S.W.
Suppliers of:—Injection Mouldings; Polystyrene.

Tubecraft Engineering Co., 446 Bell Street, Preston, Vic.
Suppliers of:—Tubular Structures; Carrying Frames.

U

Ungley, S. G., 1 Belmore Street, Surry Hills, Sydney, N.S.W.
Suppliers of:—Radar Targets; Metal Containers; Sheet Metal Work; Radio Chassis.

Union Mouldings Pty. Ltd., Bourke Street, Alexandria, N.S.W.
Suppliers of:——Plastic Mouldings.

United Engineering & Malleable Co. Pty. Ltd., Gordon Street, West Footscray, Vic.
Suppliers of:—Metal Castings & Machinery.

Universal Meyer Sound Systems, 7 Hillard Street, East Malvern, Vic.
Suppliers of:—Amplifier Equipment.

V

Vacuum Oil Co. Ltd., 29 Market Street, Melbourne, Vic.
Suppliers of:—Bitumen Sealing Compounds; Solvents; Waxes.

Vane Electrical Inst. Co. Pty. Ltd., 280 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Meters and Testing Equipment.

Velco Sound Systems Pty. Ltd., 490 Elizabeth Street, Melbourne, Vic.
Suppliers of:—Radio Receivers; Amplifier Equipment; Test Equipment.

Vesta Battery Co. Pty. Ltd., 2 George Street, Leichhardt, N.S.W.
Suppliers of:—Accumulators; Battery Chargers.

Victor Sheet Metal Co., 87 Grant Street, Sth. Melbourne, Vic.
Suppliers of:—Sheet Metal Work; Metal Cases.

Victorian Meter Labs., 230 Collins Street, Melbourne, Vic.
Suppliers of:—Meters & Testing Equipment.

Victorlite Pty. Ltd., 92 Brighton Road, Richmond, Vic.
Suppliers of:—Coil Mountings, Plastic Bases etc.; Mouldings.

W

W. J. Manufacturing Co. Pty. Ltd., 9 Macpherson Street, Cremorne, N.S.W.
Suppliers of:—Coil Formers, Synthetic Resin-Bonded Plywoods.

Wall, A. H., 8 Tinning Street, Brunswick, Vic.
Suppliers of:—Steel Frames & Racks.

Wallis & Smythe Pty. Ltd., 134 Abercrombie Street, Sydney N.S.W.
Suppliers of:—Electro-plating and Enamelling.

Walsh Bros., 40 East Street, Granville, N.S.W.
Suppliers of:—Electroplating & Anti-Corrosion Treatments.

Walton, A. & Sons, 24 Dods Street, Brunswick, Vic.
Suppliers of:—Metal Stampings; Pressed Metal Work.

Warburton Franki Pty. Ltd., 380 Bourke Street, Melbourne, Vic.
Suppliers of:—Meters & Measuring Instruments.

Warburton, Thos., Pty. Ltd., 384 Bourke Street, Melbourne, Vic.
Suppliers of:—Small Tools; Hardware.

Watson, L. M., 2 Young Street, Annandale, N.S.W.
Suppliers of:—Galvanising and Hot-tin Dipping.

Watson, Victor, Ltd., 9-13 Bligh Street, Sydney, N.S.W.
Suppliers of:—Industrial X-Ray Equipment.

Waygood-Otis (Aust.) Pty. Ltd., 58 Wyatt Street, Adelaide, Sth. Aust.
Suppliers of:—Generating Sets.

Webb Industries Pty. Ltd., 286 City Road, Sth. Melbourne, Vic.
Suppliers of:—Wind Driven Charging Sets.

Weimer, H. J., 385 George Street, Brisbane, Qld.
Suppliers of:—Electrical Installations.

Western Mfg. Co. Ltd., 18 Bevin Ave., Fivedock, N.S.W.
Suppliers of:—Carrying Cases.

Westinghouse Rosebery Pty. Ltd., Dunning Avenue, Waterloo, N.S.W.
Suppliers of:—Electrical Equipment; Generating Sets.

While, J. & Son Pty. Ltd., 65 Crystal Street, Petersham, N.S.W.
Suppliers of:—Springs.

Widdis-Diamond Dry Cells Pty. Ltd., Wells & Park Streets, Sth. Melbourne, Vic.
Suppliers of:—Dry Batteries.

Wilco Products Pty. Ltd., 568 Lonsdale Street, Melbourne, Vic.
Suppliers of:—Switches; Control Gear.

William, A. J., Electrical Instruments, 361 Lt. Bourke Street, Melbourne, Vic.
Suppliers of:—Meters & Measuring Instruments.

Wilson Electrical Transformer Co. Pty. Ltd., 43 Crockford Street, Port Melbourne, Vic.
Suppliers of:—Transformers & Chokes; Welding Equipment.

Winterbotham, C. W., 229 Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Electrical Apparatus.

Wormald Bros. Pty. Ltd., Young Street, Waterloo, N.S.W.
Suppliers of:—Mounting Racks; Steel Cabinets, etc.

Wright, C., & Co. Pty. Ltd., 209A Castlereagh Street, Sydney, N.S.W.
Suppliers of:—Machine Tools.

Wunderlich Ltd., Baptist Street, Redfern, N.S.W.
Suppliers of:—Aluminium Castings; Welded Aluminium Cases.

Y

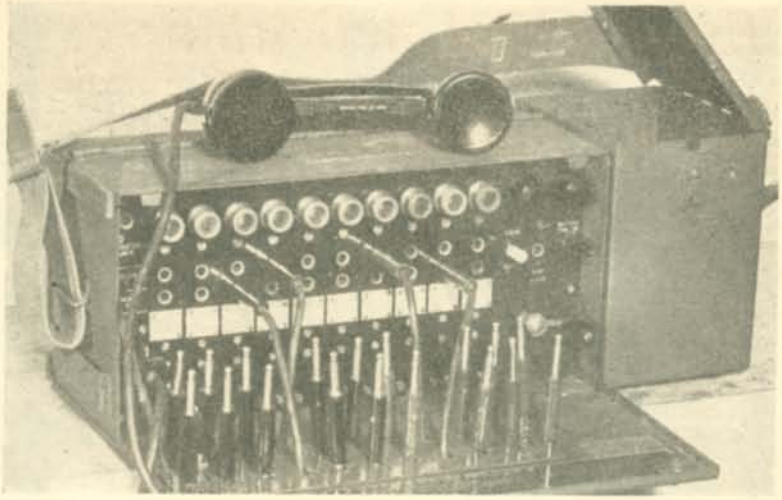
Yott, Fred L., Pty. Ltd., 219 Queensberry Street, Melbourne, N.3, Vic.
Suppliers of:—Fuses; Carbon Brushes.

Z

Zenith Radio Co., 131 Palmer Street, Sydney, N.S.W.
Suppliers of:—VHF Transmitters; Radio Accessories.

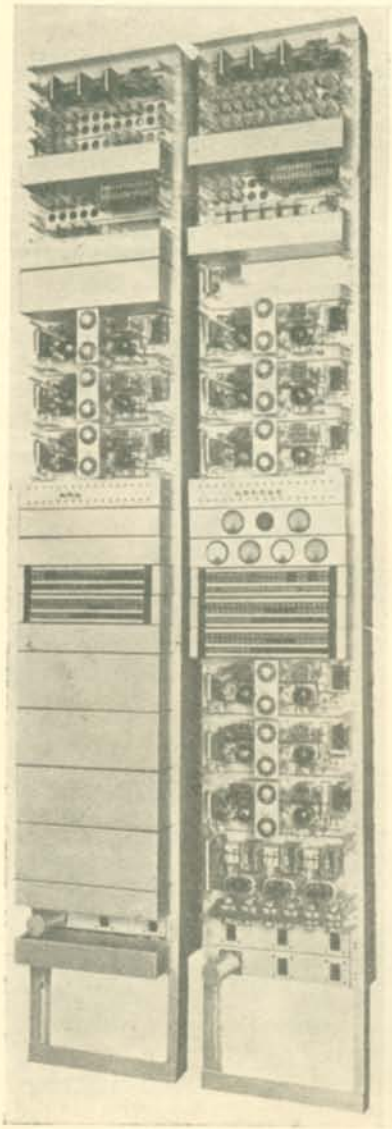
Zevenboom, J., & Co., 335 Elizabeth Street ,Melbourne, Vic.
Suppliers of:—Brushware.

The assembly shown above is a tropicalised high-power telephone produced by Kriesler Radio for the Army. In addition to a magneto-call telephone, the equipment included an amplifier to permit efficient operation over long distances.



The 10-line telephone switchboard illustrated above was Army's standard equipment during most of the war years. Known as the "U-C" (universal call) board, the lamp indicators of this assembly were extremely sensitive and could be used with buzzer or magneto-call telephones. Standard Telephones were responsible for production of this equipment.

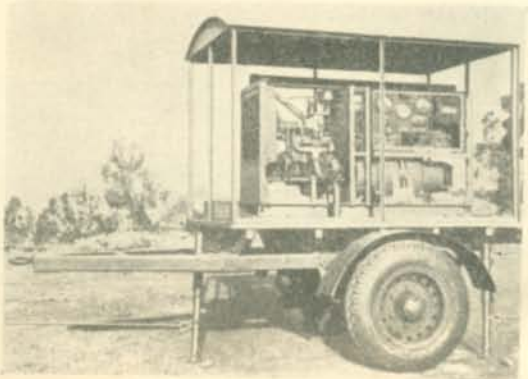
Eclipse Radio of Melbourne were responsible for production of the Army 4-channel fortress telephone amplifier, at right.

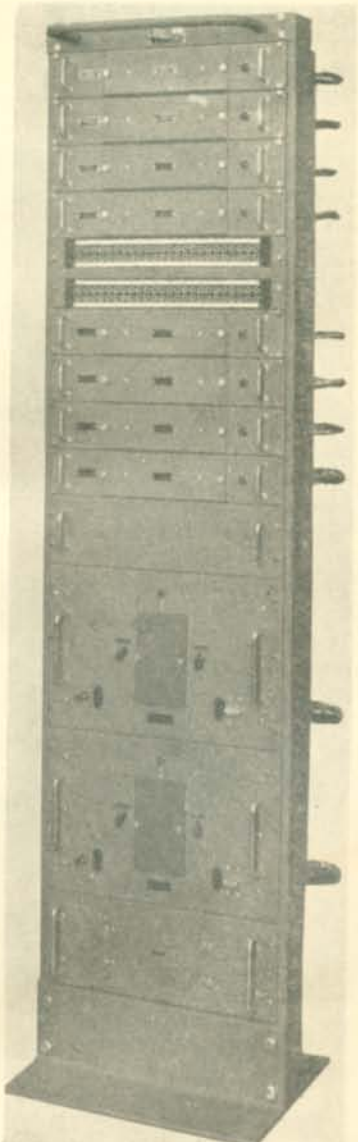


At left is shown a 9-channel VF telegraph terminal equipment rack produced for the PMG's Dept. by STC.

The "Telex" unit shown above, with its covers removed, is typical of a quantity produced by PMG Workshops for the RAAF to permit teleprinter operation over normal line circuits.

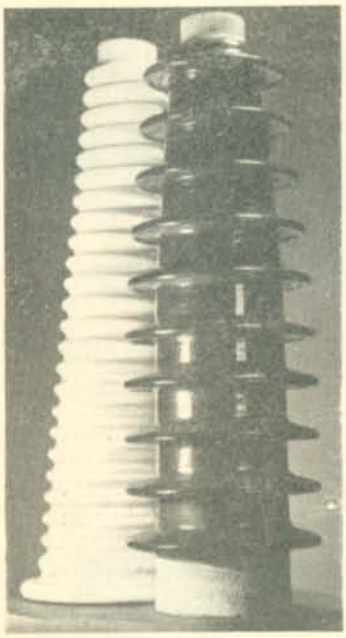
In forward areas, the Services were dependent upon auxiliary power supply sources such as the trailer-mounted Westinghouse-Rosebery 5 KVA generating set shown below.



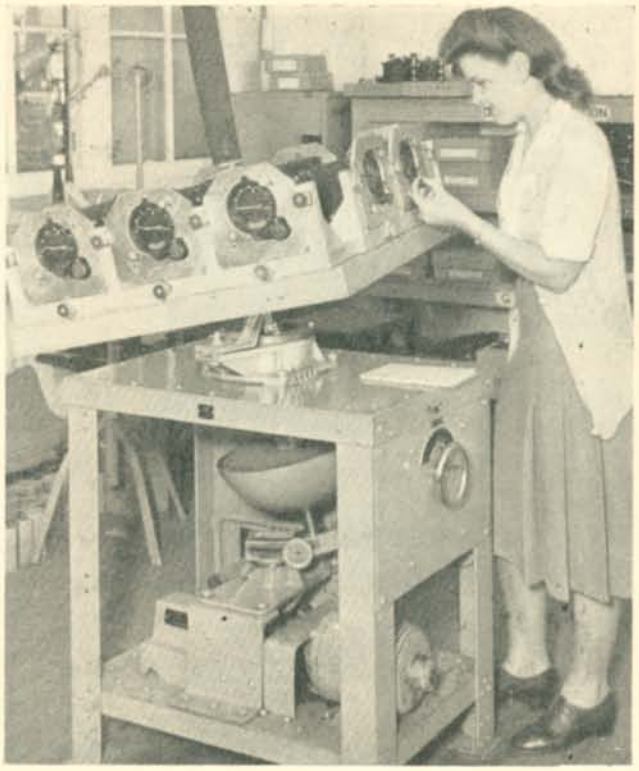


Extra-mural Activities of the Industry

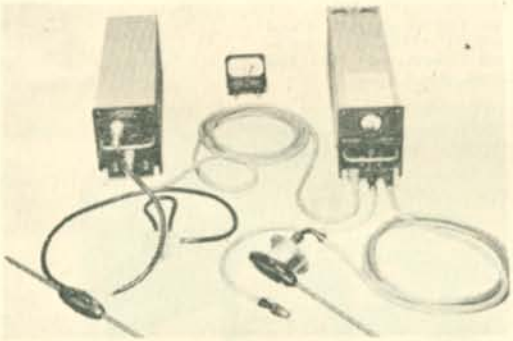
The productive capacity of the Australian Telecommunications Industry was used extensively in the development and manufacture of other than communications equipment. Some typical examples are shown on this page.



In addition to its work on special insulators for radar and other communications equipment, Nilcrom Porcelains produced large quantities of high-tension insulators—an impressionistic view of two typical items is seen above.



Amalgamated Wireless produced about 70,000 aircraft navigational instruments of many types. At right we show a group of instruments undergoing test on a table which simulates the motion of an aircraft.

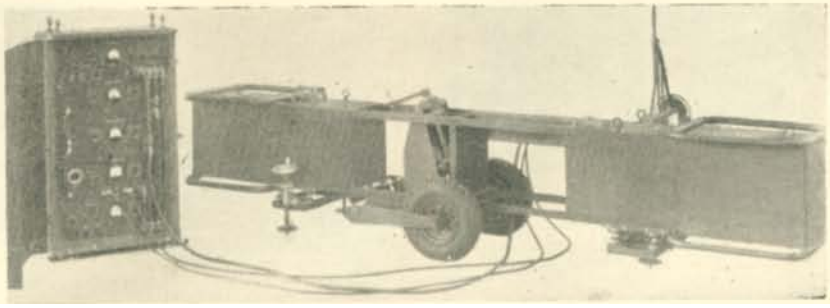


For the RAAF, Standard Telephones produced the electronic height-indicator for torpedo-bombers illustrated at left. Later, an absolute altitude indicator also was produced.

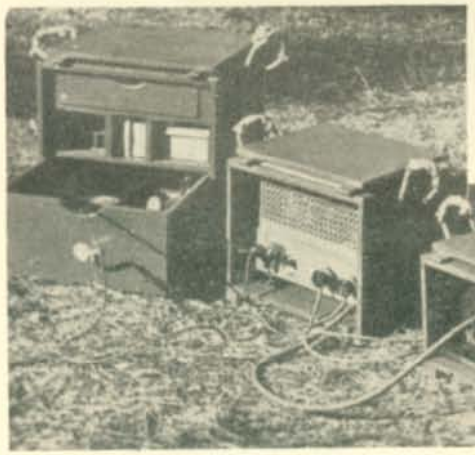
Kriesler Radio were responsible for production of the Reflector Gunsight shown below. Used in fighter aircraft, this device utilised a combination of electronic and optical principles.

Meteorological information was of vital importance to air operations, and the Eclipse division of Electronic Industries produced large quantities of Radiosondes, illustrated at left, for the RAAF.

For the Navy and Army, A. G. Healing produced the CSIR Photo-cell Chronometer, illustrated below, to permit accurate measurement of projectile velocity.



Sound Reproduction Equipment for the Services

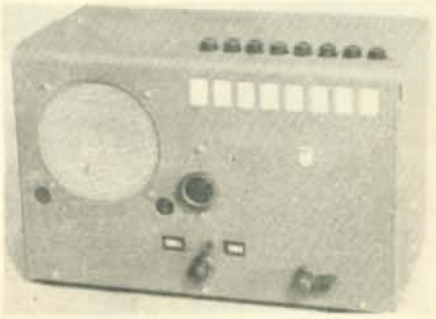


The portable electric megaphone illustrated above was made by AWA and used by the AMF as "Apparatus Loudspeaking No. 2." The equipment has an output of 3 watts and operates from a self-contained motor-cycle battery.

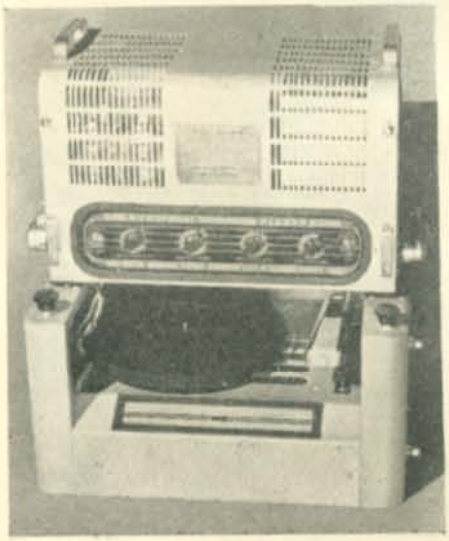
Velco Sound Systems produced the highly-mobile battery-operated 30 watt sound system and demountable projection speakers shown above. Known as "Front Line Broadcasting" units, these equipments were used for propaganda warfare in advanced areas.

Used for gun control in fortress installations, Apparatus Loudspeaking No. 1B shown at right was produced for the Army by Bland Radio of Adelaide.

The radio tuner-gramo. amplifier assembly illustrated below is typical of the equipments produced for Services' Amenities by Australian Sound Systems of Melbourne.



"Philaphone" type 1702 inter-com. units of the type shown above were produced by Philips, Adelaide, for the US Forces.



The elaborate 60-watt amplifier system shown above was produced by Philips Electrical Industries to RAAF specification Y43 and saw active service with all Services for beach control and "loud-hailing" during landing operations.

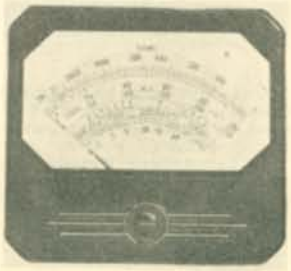
Servicing Equipment for the Services

Illustrated above is a wide - range 5-in. cathode-ray oscillograph produced by Velco Sound Systems for Service workshops.

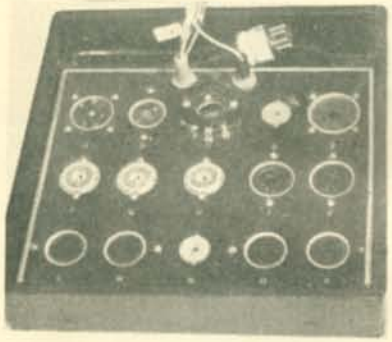
The unit at left is the R6795 100/1000 KC/s. crystal calibrator produced by AWA for the adjustment of Service radio transmitters.

At right is shown a precision wavemeter produced by Radio Corporation for the RAAF. This unit provided 5-band coverage from 125 KC/s. to 16 MC/s.

Resistance measurements down to a thousandth of an ohm were provided by the aircraft bonding tester shown at left. Known as the "D5," this instrument was produced by Radio Equipment Pty. Ltd. of Sydney.

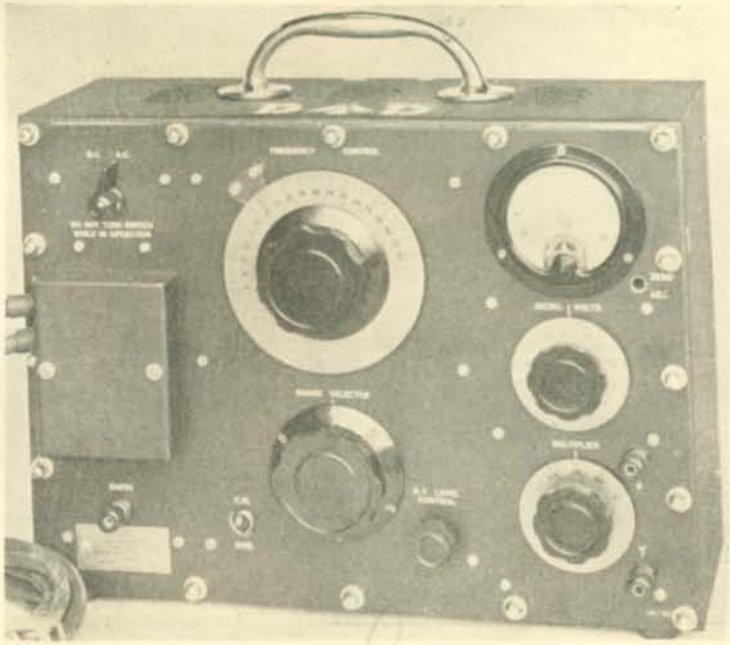


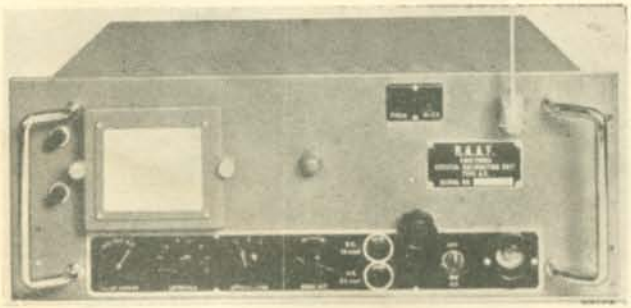
One of the many types of meters produced by the Master Instrument Co., of Sydney, for the Services is illustrated above.



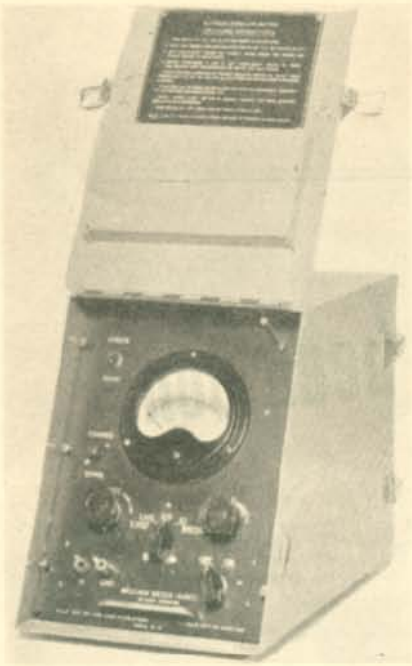
To enable testing of new Service valves with existing instruments, J. H. Magrath, of Melbourne, produced the versatile valve test adaptor shown at left.

Shown below is the "C" version of the "TA101" series of signal generators developed by Philips for Service use.

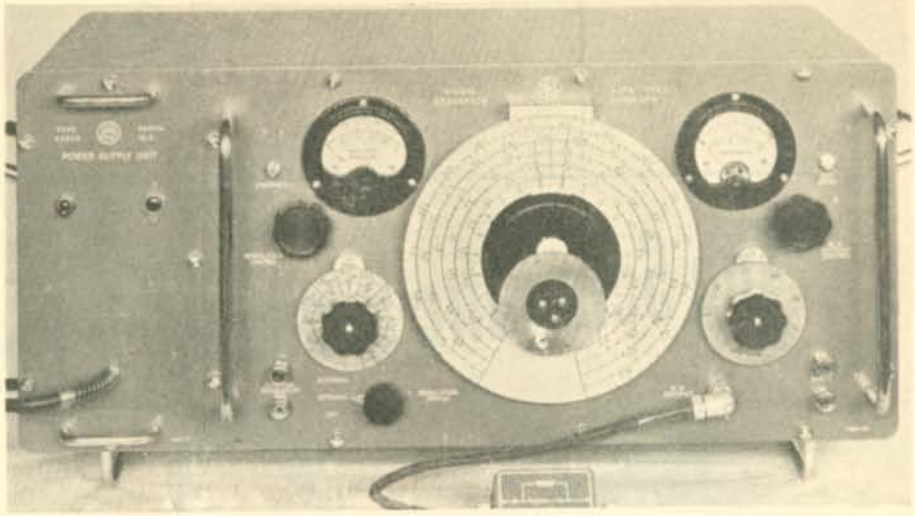




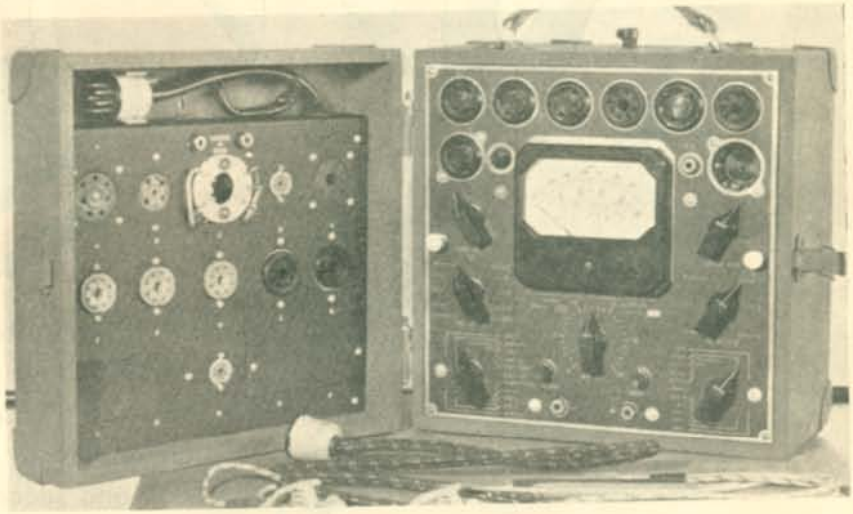
Produced by Radio Corporation for the RAAF, the rack-mounted crystal calibrator unit shown above was used with the AR17 FM-AM receiver as part of the RC73D VHF D/F assembly.



Designed primarily for radar maintenance work, the battery-operated electronic megohmmeter illustrated above was produced by HMV. An AC-operated version also was produced.



The elaborate signal-generator illustrated above is the R7231 produced by Amalgamated Wireless for use in Service and production design laboratories. Built to a high degree of precision, this instrument provides coverage from 95 KC/s. to 30 MC/s. in ten bands.

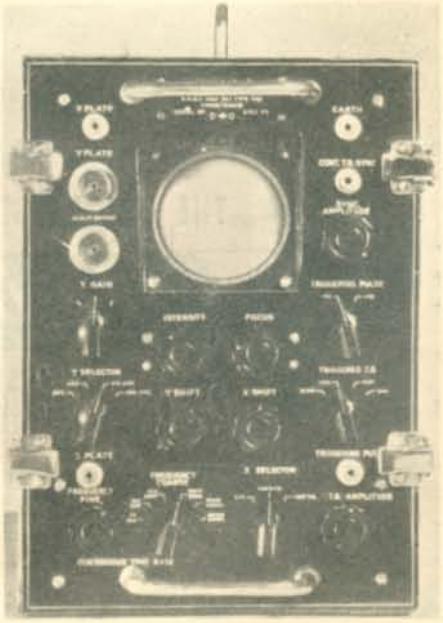


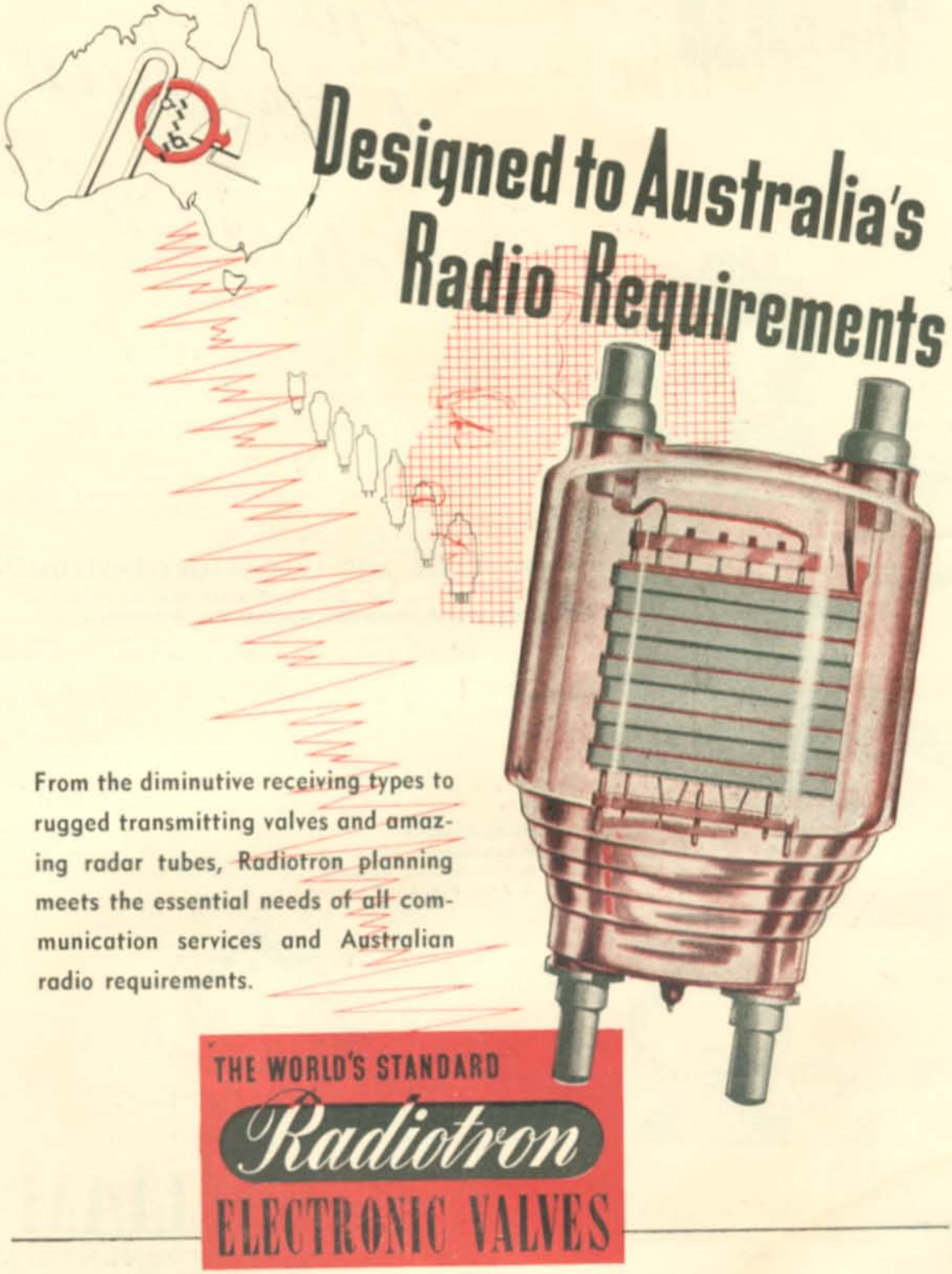
Illustrated above is Transmission Products' type "VCT-V" valve and multi-tester assembly which was produced for Service Workshops.

Radio Equipment, of Sydney, made the versatile multimeter shown above. Known as the "D8," this instrument was specially designed for Service use.

Airzone produced the 5-inch CRO shown at right as part of the radar production programme.

At left is the 415-465 MC/s. coaxial frequency meter, type 76-SU-1B, produced by STC for the RAAF.




Designed to Australia's Radio Requirements
From the diminutive receiving types to rugged transmitting valves and amazing radar tubes, Radiotron planning meets the essential needs of all communication services and Australian radio requirements.
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A. J. William Electrical Measuring Instruments have shown by a unique wartime record that Australian Craftsmanship has no superior anywhere in the world. Productions include:—

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Progress and communications have always been notable for their interdependence, and the many services provided by the Australian Post Office have played an impressive part in the development of the Nation.

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Today the Post Office forms an integral part of the comprehensive international organisation of communications encircling the globe and linking together peoples of all civilised nations.

★

In war years, the Post Office has served the Nation loyally in providing reliable communication facilities both for the fighting forces and on the home front. Throughout these years there has been an unprecedented increase in the volume of traffic handled in all branches of the Department, but with a depleted staff, long hours of duty and the assistance of our women folk, the motto has been "carry on".

★

- THE POSTMASTER-GENERAL'S

- - COMMUNICATIONS

Vast to serve the Nation—Personal to serve you!

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This huge organisation of plant and personnel, affords a practical demonstration of the commercial and social application of modern scientific discoveries to the complex problems of the communication needs of mankind. Keeping in touch . . . in the cities . . . in country towns and settlements . . . in the far outback. Wherever two or three people are gathered together, there also is the Post Office . . . maintaining a communication service; keeping the city in touch with the country and the rural dweller in touch with the town.

★

The Post Office steadfastly pursues a policy ensuring that the latest world advances in communications practice are incorporated in all its technical services for the benefit of the Nation and the individual alike. Modern and progressive are the Australian Airmail, Postal, Telephone, Telegraph and Wireless Services. The watchword is "Speedy, courteous and reliable service."

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DEPARTMENT - AUSTRALIA -

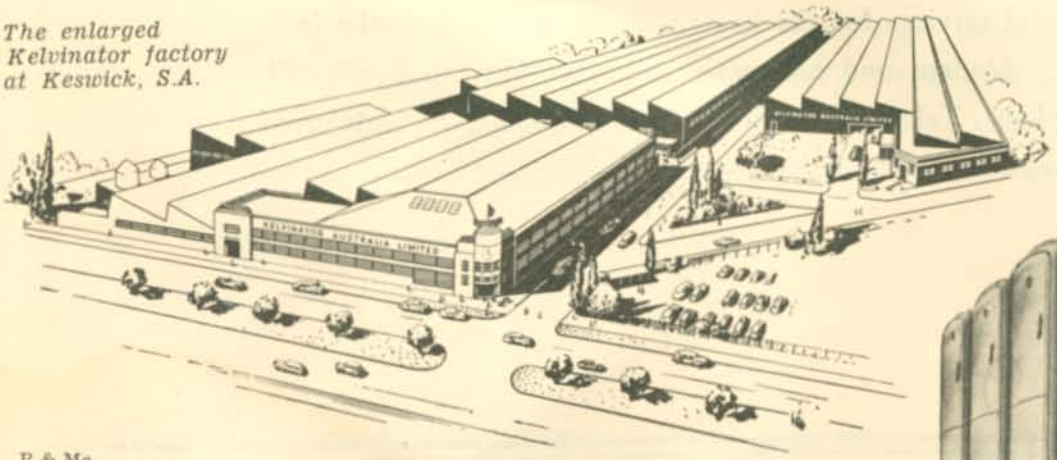
KELVINA

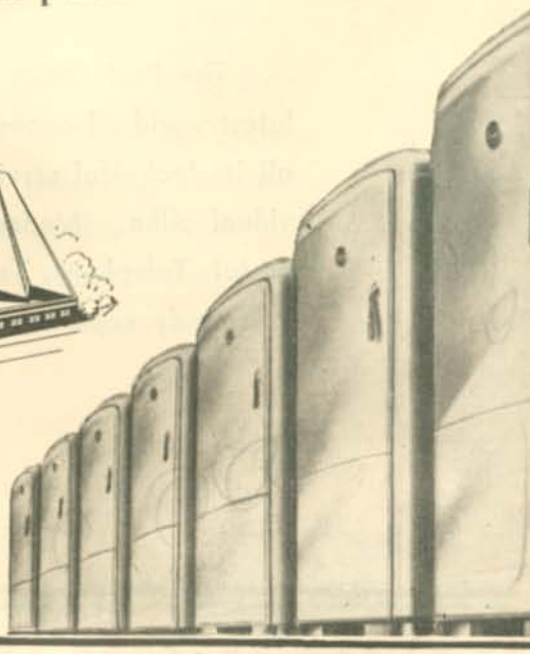
GOES ON TO GREATER VICTORIES IN THE WAR THAT NEVER END

The war against food contamination knows no end, but every domestic Kelvinator buil redoubles the defences of another family. The combination of commercial electri refrigeration at the sources of supply and distribution, and domestic electric refrigeratio in the home is a primary reason for the dramatic drop in many formerly prevale diseases originating in contaminated food.

The greater Kelvinator factory is now in production, turning out domestic refrigerators in the Kelvinator tradition of efficiency with economy. Kelvinator, first in the field of domestic electric refrigeration, has reorganised after its splendid war effort and is again enlisted on the side of health, comfort and happiness in peace.

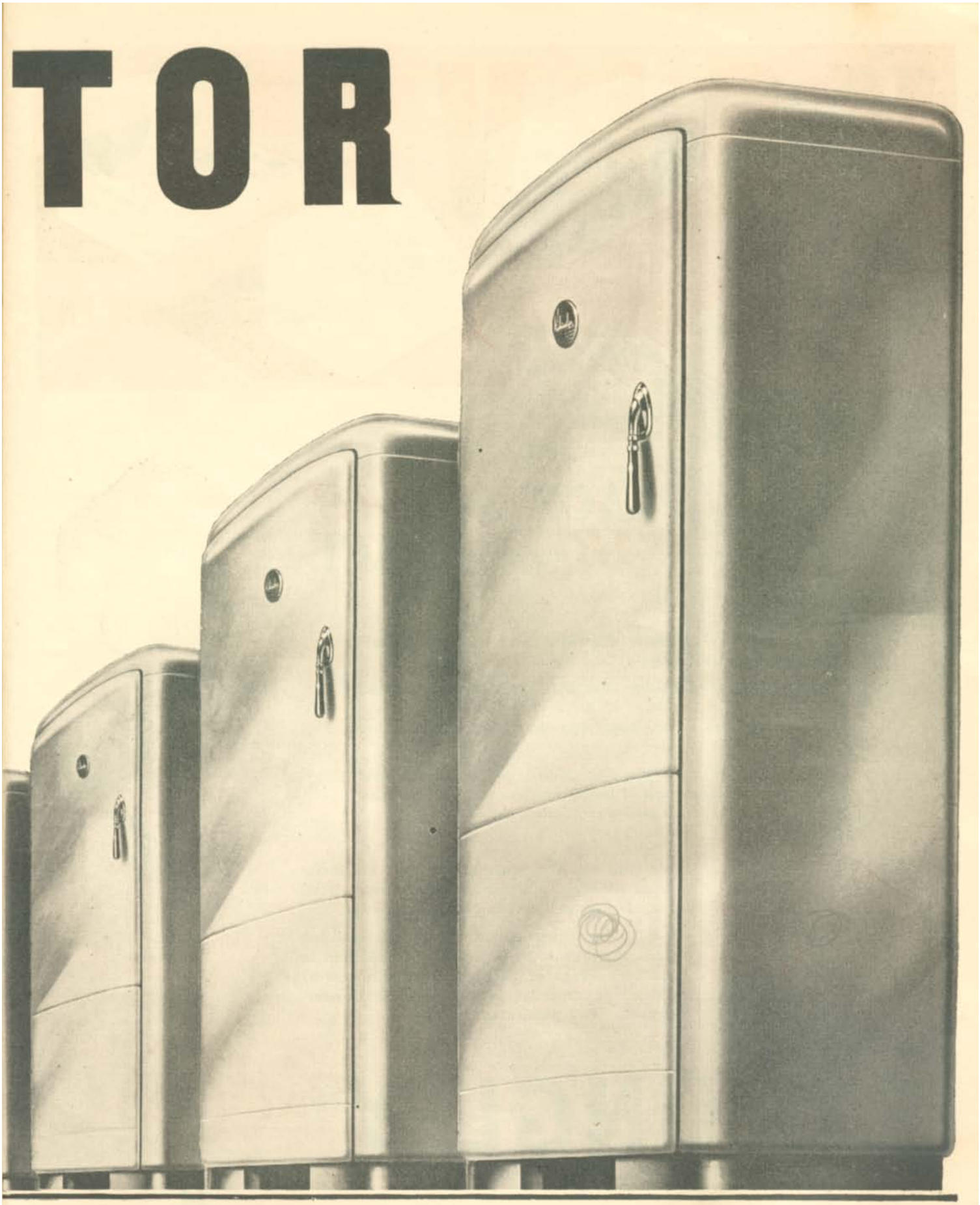
The enlarged Kelvinator factory at Keswick, S.A.



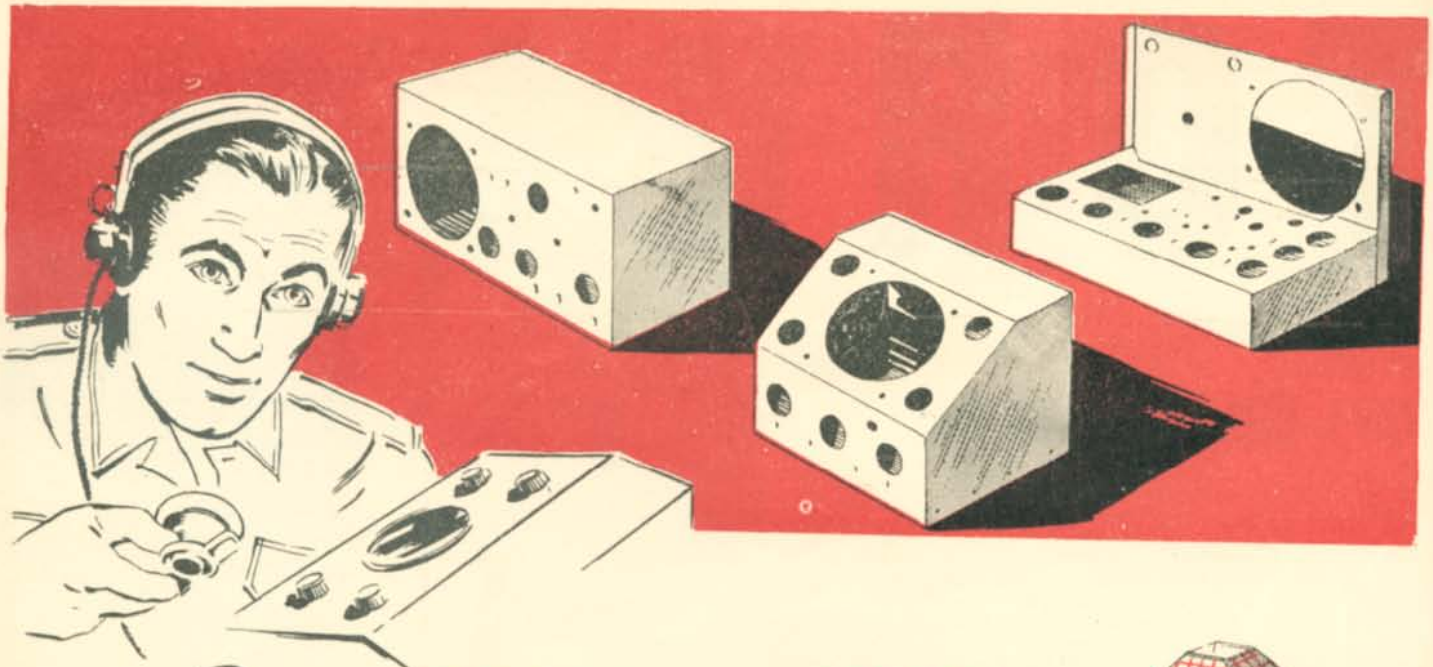


R & Mc

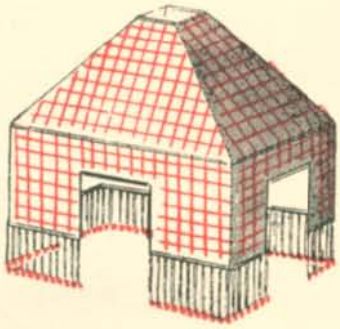
KELVINATOR AUSTRALIA LIMITED, ANZAC HIGHWAY, KESWICK, SOUTH AUSTRALIA and



WILLIAMSTOWN ROAD, PORT MELBOURNE, VICTORIA and EUSTON ROAD, ALEXANDRIA, N.S.W.



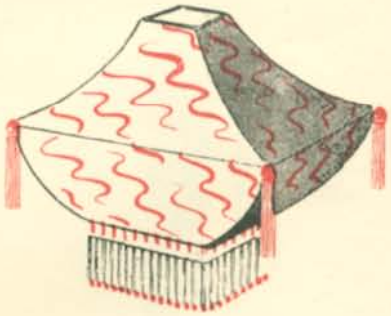
From PEACE *to* WAR
WAR *to* PEACE

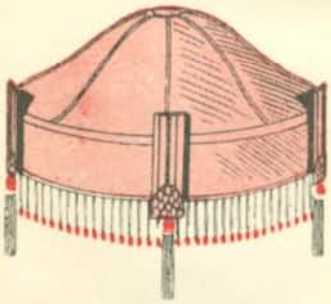


Service and our standard of quality have been maintained both in War and Peace.

During the war, something like £50,000 of vital war material was produced in the form of Radar Targets, Radar Aerials Metal Boxes and Cases, Radio Chassis, and a host of other articles in sheet metal and wire.

Half of our pre-war male staff joined the Services shortly after the commencement of hostilities, and most of them are back again to serve in post-war development.





The firm and the whole of the staff are justly proud of their contribution to the war effort, and are always happy to be at your service.

Our post-war production programme will include the lines mentioned above, in addition to the wide range of goods, the manufacture of which was suspended soon after hostilities commenced. Full particulars from—

S. G. UNGLEY

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——Telephone MA 2460——

EST. LONDON 1884 - - - - SYDNEY 1923

John & the Beanstalk.

"MARVELLOUS!" said our Managing Director, in his rich and vibrant voice, "that so much could grow from so little."

We somehow feel that this remark is not entirely original, but still, he's not far out at that.

From the early days when we pioneered in this country the manufacture of wires and cables with synthetic insulation, we have come a long way and grown a lot bigger. We are naturally inquisitive people, and our experience over the last few years has been broad. This experience is now being applied to the development of more and better products from Nylex Plastics — all of which will be at the service of the Australian radio-electric industry on it s way forward.

Insulated wires and cables, flexible sheet, tubing, and sections — for these and other products bearing the "Nylex" brand, the future is assured.

It just shows what a good gardener can do with good seeds!

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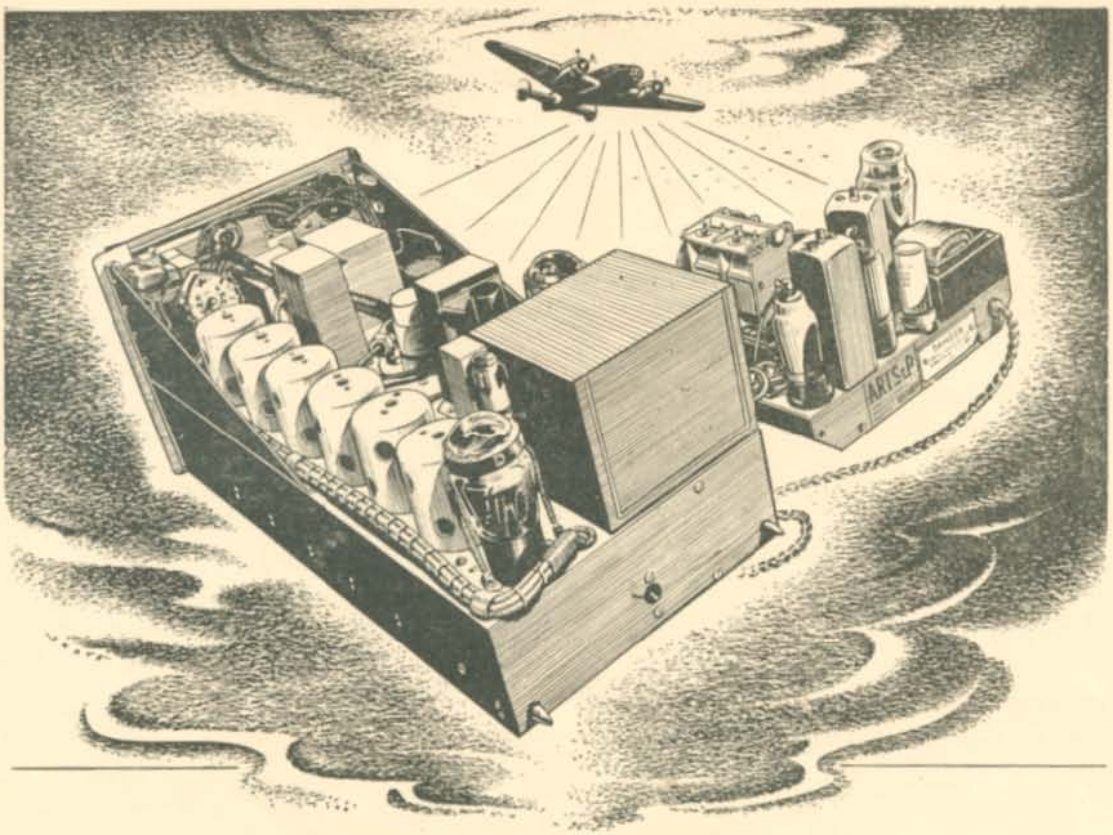
MELBOURNE



The PAST . . .

When our safety depended upon seeking out and destroying enemy convoys and battle fleets, Radar was Australia's most urgent need—a Number 1 priority. In those grim days A. G. Healing Ltd. was Australia's largest manufacturer of Radar Receiving Equipment.

With victory won and production again directed to new Golden Voice Home Receivers, we recall with patriotic pride our wartime achievements in the manufacture of Radar.

The PRESENT .

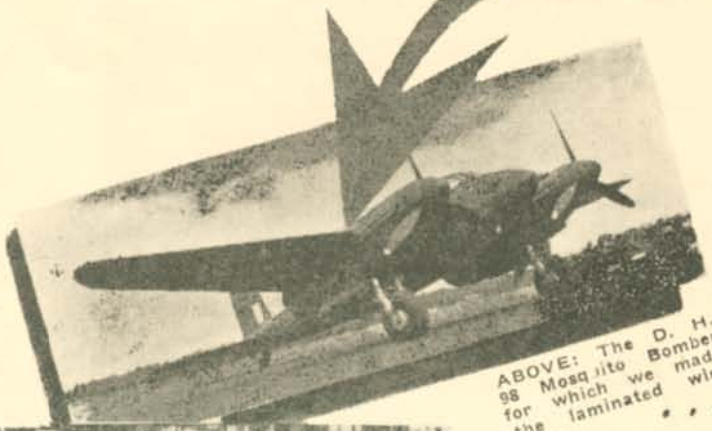
Your Healing dealer is now receiving, certainly in restricted quantities, new Golden Voice Radios engineered with the same skilled precision as the Radar Receivers which were built on the basis, "They must not fail." For quality and range of tone these new Golden Voice Radios are further ahead than ever.

HEALING *Golden Voice* RADIO

Built by the Largest Manufacturer of Radar Receivers

MELBOURNE—SYDNEY—ADELAIDE

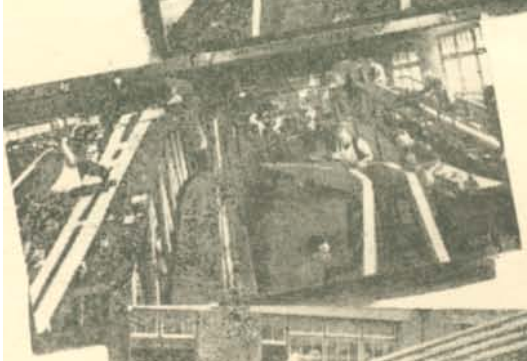
put it there



ABOVE: The D. H. 98 Mosquito Bomber for which we made the laminated wing spars.

... said the R.A.A.F.!

LEFT: Top and bottom boom of spar being made ready for splicing, glueing and clamping.



ABOVE: Fitting bottom boom to jig right and left side. Jigs for fixing rear and front face blocks. Templates on wall indicate block position.

LEFT: First and second operation jigs. Note ramp essential for precision measurements.

ABOVE: Finished spar loaded and ready for delivery. In a power dive at 600 m.p.h., these laminated spars were proved to retract as far as 24 inches without any structural fault developing.

ONCE upon a time a great artist downed his brush to plan the arsenals and siege guns of war. He was Leonardo da Vinci whose genius lives in the smile of a lovely lady—Mona Lisa, whose portrait hangs in the Louvre. Over and over in our world's history the arts of peace have been abandoned to make way for the crafts of war. Something like this happened to us. In 1940 we put aside our job of peace. Our craftsmen went to war—with the R.A.A.F.—and performed miracles.

With justifiable pride, this company and every employee can now look back upon a war job well done.

We illustrate here the part we played when the curtain of secrecy was thrown around our activities. The R.A.A.F. wanted laminated wing spars for Mosquito bombers—they wanted them quickly. Invasion was at hand. They got them through sweat and tears—but they got them—in hundreds.

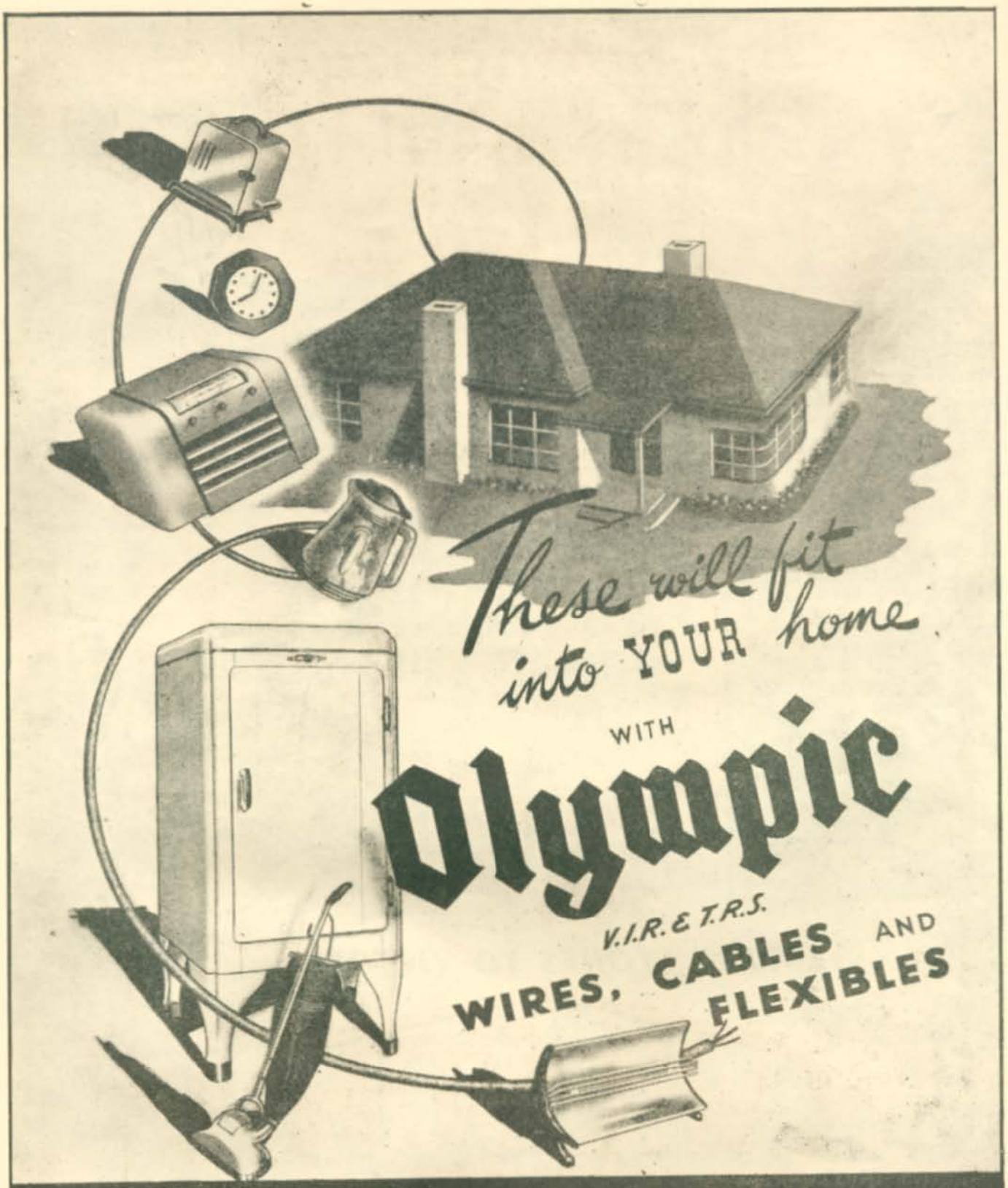
As our war post was one that called for untiring energy and precision workmanship, so our post-war production will keep in tune with the standard set in times of emergency.

We rest content on our war effort and now with renewed vigor have geared our wheels to the industrial plan for peace.

F. DICKIN
PTY. LIMITED

18 LORDS RD., LEICHHARDT, N.S.W.

Telephone: LM 4431



Quality Sound Equipment

AT KEEN PRICES

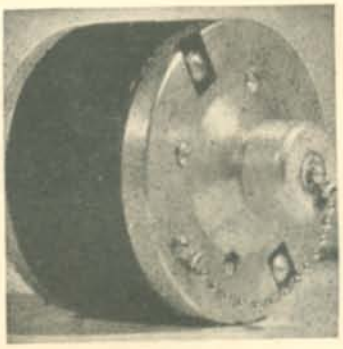
Torpedo studio model microphone. Sensational Realism is obtained with these microphones. Ideal for Theatres, Night-clubs, Broadcasting Stations and Sound-reinforcing systems.

These professional mikes flatter vocal or instrumental reproduction and are very popular for all indoor P/A work. Distinctive, with an amazing frequency response, these units are available at a commen-sense price.

"DYNAMIKE," the popular moving-coil, acoustic compensated microphone 50 ohms, or with transformer 42,000 ohms impedance. Mounting thread 27-5/8". Output—52 db below 1 volt per bar, 40-10,000 cps. Tilted satin chrome head allows unobstructed view of artist's face. Floating generator ensures immunity to vibration. This inexpensive rugged all purpose microphone is ideal for "smashing clear speech." Can also be used for musical reproduction. Owing to its low impedance the microphone cable can be a hundred feet or more in length, if necessary. Supplied with 9' twin shielded cable.

"DYNASTAND" streamlined desk-stand, incorporating "Dynamike" microphone generator and multi-contact spring-loaded " press-to-talk" switch. Ideal for Paging Systems—telephonist can press button which automatically silences music and opens microphone. Finished in brown crackled duco and oxy-metal work and supplied with standard 9' cable.

"DYNAPHON" Loudspeaker unit. This driver sound-motor has been designed for TROPICAL OPERATION and has proved very popular with the Services. It handles up to 15 watts and, owing to its high electro-acoustic efficiency and scientific design, PRODUCES MORE SOUND THAN ANY OTHER SPEAKER IN AUSTRALIA. The plastic self centred diaphragm gives an excellent frequency response and ensures permanent voice-coil alignment. When used with a 6' "Dynaflare" exponential horn acoustic coupling, "feedback" is reduced to a minimum. 12.5 ohm voice-coil impedance. 500 or 1,000 ohm matching transformers are available.



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STEANE'S SOUND SYSTEMS

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10 DIXON STREET
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The high quality of Ferrocart Vibrators is well known to service men everywhere. That high quality has characterised all Ferrocart Products, taking into consideration every operating essential such as frequency, current-carrying capacity, points and reeds properly tuned for transformer circuit requirements.

Ferrocart Vibrators are available in a range of type to suit every requirement—Synchronous, Split Reed, and non-Synchronous. They assure minimum R.F. interference, low level mechanical noise and starting, under adverse battery conditions.

"Ferrocart"

FERROCART (AUST.) PTY. LTD.

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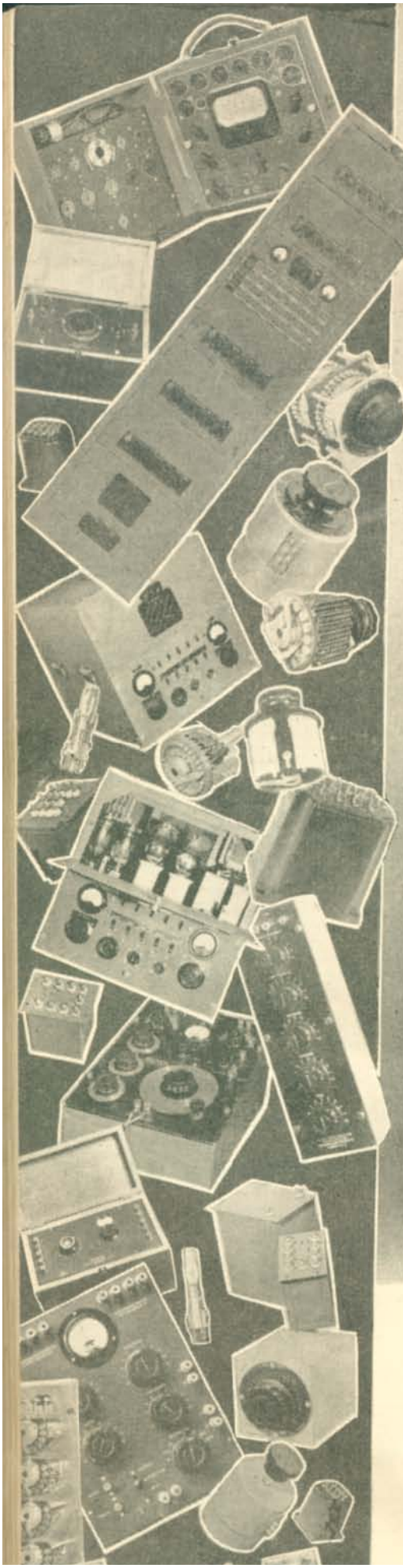

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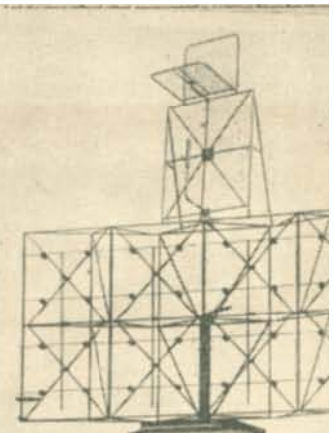

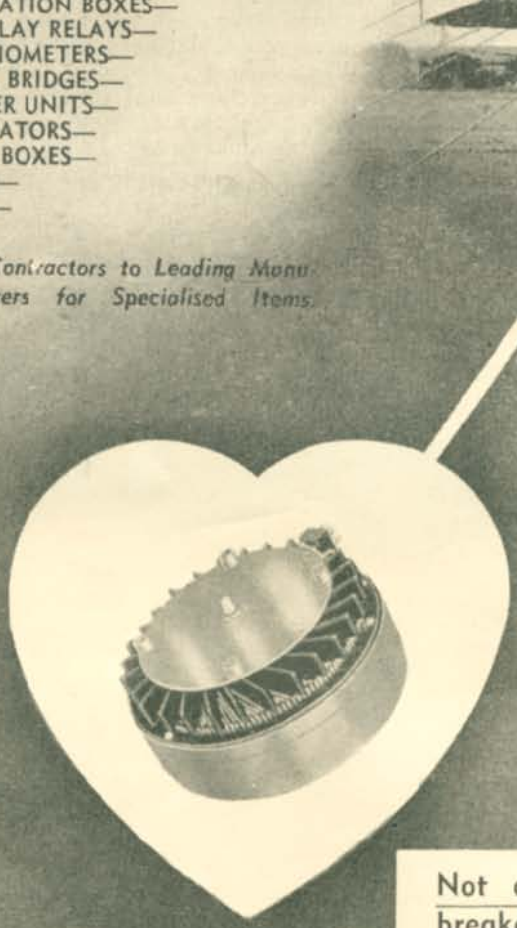

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THAT BECAME T
VERY BACKBONE
THE JOINT R.A.A
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● *PRECISION RAN POTENTIOMETE WITH A W RECORD—*

Not one recorded instance breakdown during years of hour operation under the m gruelling conditions!

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Demands the Very Highest Quality PRECISION EQUIPMENT

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Communication *Engineers*

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AUSTRALIAN SOUND SYSTEMS

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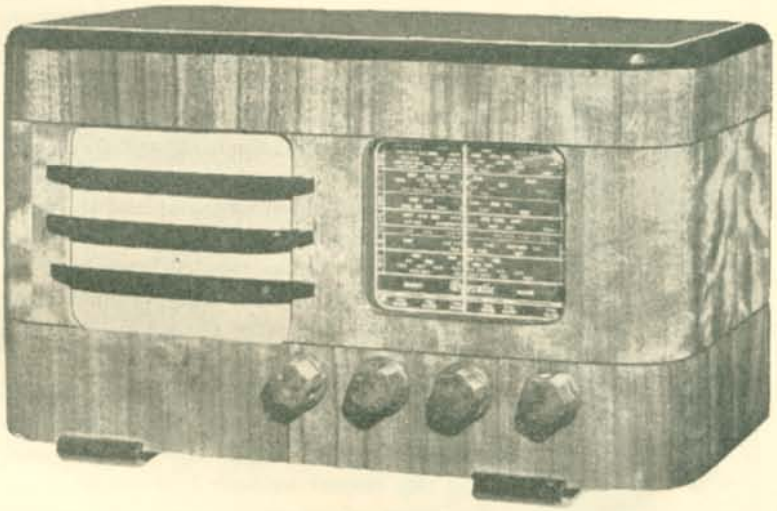
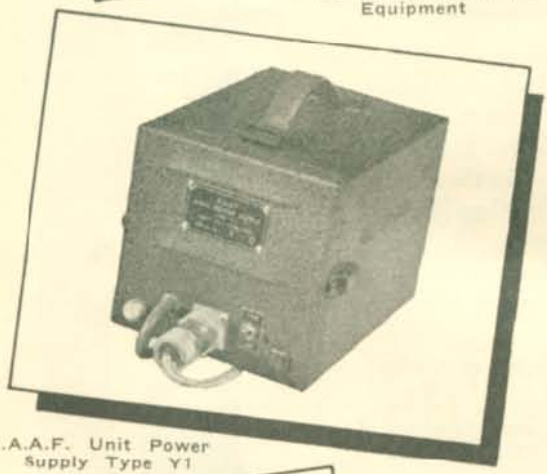
BLAND RADIO AT WAR

Sound Reinforcement Equipment

During the war Bland Radio Ltd. gave their very best in Radio and Electrical Equipment for the Armed Forces. On the Bland assembly benches, technical equipment was designed and built in ever-increasing numbers for the Army, Navy and Air Force. When peace was declared, Bland Radio had no doubts that they had made their fullest contribution to the victory that was ours.

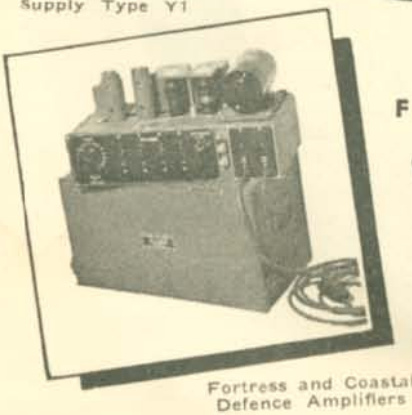
BLAND RADIO IN PEACE





R.A.A.F. Unit Power Supply Type Y1

The wheels of wartime industry are slow in turning back to peacetime production and the full range of post-war "OPERATIC" Receivers is not yet available. Only one—the 45M 5-valve Mantel model—has made its appearance so far, but its undoubted quality and high standard of performance presages a brilliant future for its companion sets. You can be sure that the experience gained during the war years is being put to good use and the makers of "OPERATIC" Radio Receivers are confident that their product will always occupy a leading place in the radio field.



Fortress and Coastal Defence Amplifiers

FOR

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BLAND RADIO LTD

Manufacturers of Radio and Electrical Equipment of all Types

COROMANDEL PLACE, ADELAIDE, SOUTH AUST.

WAR CRY

With Australia's security threatened in those dark days of 1941-42, the warning cry of the factory whistles summoned the workers to herculean efforts in war-time industry. That they responded nobly and well is evidenced by the smashing defeat that was inflicted on the Axis powers. Now the cry of the factory whistle is a neighbourly sound once again, calling the men and women to peace-time labour as of pre-war days . . . the comfort and welfare of man their premier mission.

RADIO WHOLESALERS LTD

"South Australia's leading Wholesale Distributing House."

are proud to be distributors for those Associated Manufacturers who, after their splendid war efforts, are now finalising for full Civil Production:—

EVEREADY (AUST.) PTY. LTD.
"Eveready" Batteries

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"Tecnico" Vacuum Cleaners

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"BRIMAR" VALVES
"FERRIS" CAR RADIOS
"TADCO" LIGHTING PLANTS
"RADELECT" HOME LIGHTING BATTERIES
"UNIVERSITY" TEST EQUIPMENT
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"RADIANT" TABLE LAMPS

STROMBERG-CARLSON (AUST.) PTY. LTD.
Radio Receivers and Air Circulators

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Domestic Refrigerators

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Amplifiers and Receivers

ETHERTONE MANUFACTURING CO.
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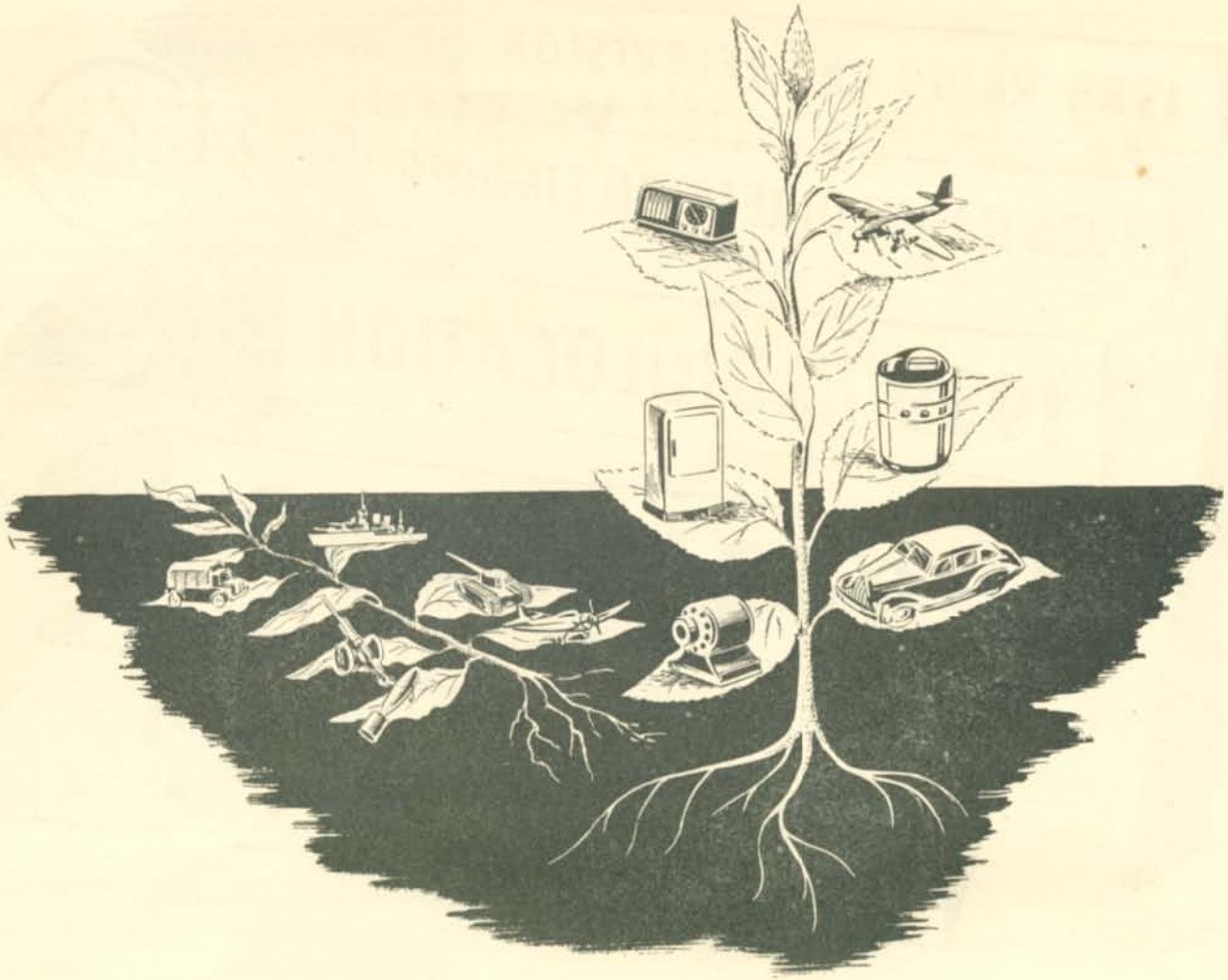

TURNING WAR PLANTS INTO PEACE PLANTS!

The Australian Radio and Electrical Manufacturers' Performance for War will be matched only by its tremendous production for peace. R. E. JEFFRIES PTY. LTD. served faithfully and efficiently during the critical demands of war, and now, with the easing of trade restrictions, look forward to supplying Quality Insulation Materials to peacetime Manufacturers from their large stocks of:—

Cotton Tapes.
Presspahn.
Fibre Sheet, Rod and Tube.
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Ebonite Sheet and Rod.
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QUEENSLAND, N.S.W. AND VICTORIAN REPRESENTATIVE FOR LEWIS BERGER ELECTRICAL INSULATING VARNISHES AND COMPOUNDS

QUEENSLAND, N.S.W. REPRESENTATIVE FOR HAIGH AND MEGA RESISTANCES AND ELEMENTS

'Phone MA 2200 or MA 7257 for our Representative to call.

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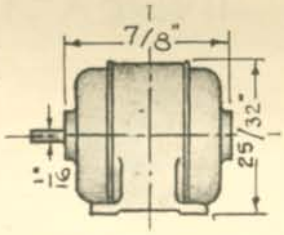
BESIDES designing and producing

little Midget A.C. Motors such as this



Made like the big brothers

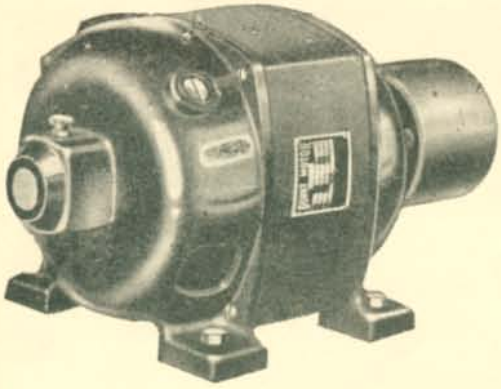
&

Specials like this

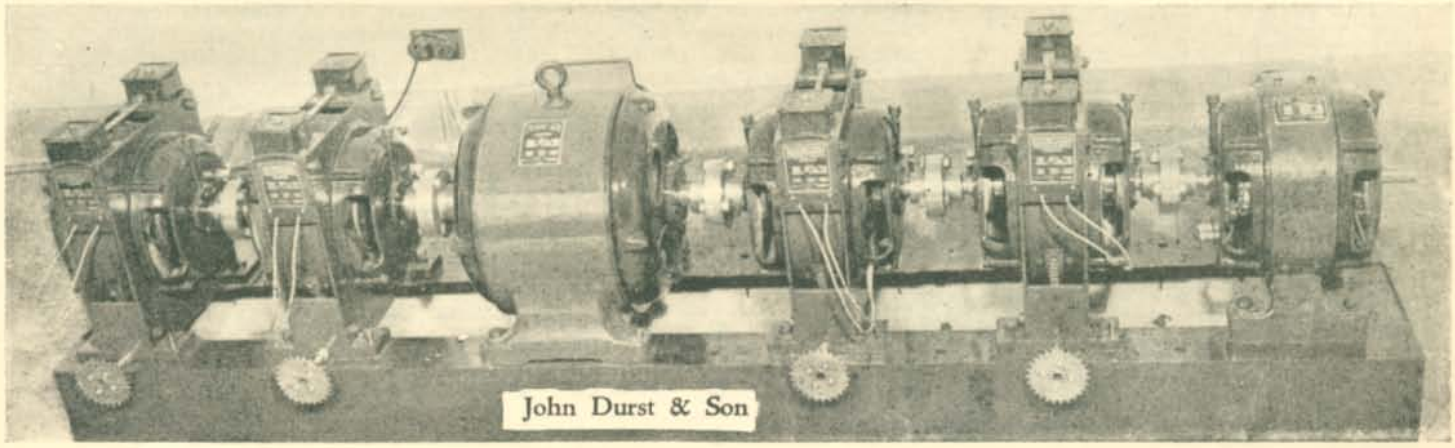
We manufacture Standardised Motors:

3 Phase 1/20 to 15 H.P., 500-3000 r.p.m.
" " Two speed pole changing
" " Synchronous 1/6 - 10 H.P.
Single Phase Capacitor Start 1/6 - 1 H.P.
" " Capacitor Run 1/20 - 1 H.P.
" " Repulsion Induction 1/4 - 10 H.P.
" " Explosion proof 1/3 - 1 H.P.
" " C.R. Variable speed 1/2 - 3 H.P.
" " Synchronous 1/20 - 1 H.P.
" " Compensated Series 1/6 - 1 H.P.
D.C. Series, Shunt and Compound 1/6 - 3 H.P.
D.C. Generators to 10 KW.
Alternators to 10 KVA 50 to 500 cycles
Bench Grinders and Polishers
Geared Motors AC - DC - to 5 RPM
Special Motors to operate at —40° below zero.
Temperature Bearings sealed against 30 lb. air pressure.

AND HIGHLY-SPECIALISED SINE WAVE ALTERNATORS FOR SCIENTIFIC RESEARCH.



STANDARD R.I. MOTOR
240-480 V. 1/6-10 H.P.



8 KVA, 50-150 c.p.s., 1.01% 3rd Harmonic, Full Load. 2% Regulation. Free of any Magnetic Ripples.

DURST PATENT

Sine wave synchronous multi alternator for the solution of problems in connection with the transmission and distribution of electricity for the Sydney County Council Electricity Undertaking. Completely designed and manufactured by Durst Motors, this complex machine is the first of its kind in connection with a calculating table for the Sydney County Council in working out the most difficult problems encountered in this large electricity undertaking.

DURST MOTORS

189 ST. JOHN'S ROAD, FOREST LODGE, SYDNEY

ELECTRIC MOTOR & GENERATOR MANUFACTURERS

AGENTS IN S.A. AND W.A.: BRITISH TUBE MILLS (AUSTRALIA) PTY. LTD.

Telegrams: "DURST," SYDNEY. Telephone: MW 1755, MW 1470.

SINCE 1918

INDEX TO ADVERTISERS

HONOUR ROLL OF INDUSTRY

Schedule of Apparatus, Materials & Services

A

Adhesives.

Supplied by:—Stapleton & Lewis Pty. Ltd.; Taubmans Pty. Limited.

Aerial Equipment (Insulators, Wire, Hardware, etc.)

Supplied by:—Kosters Premier Pottery; Lindberg, Foster & Co.; Nilcrom Porcelains (Aust.) Ltd.; New Brunswick Brick & Pottery Co. Pty. Ltd.; Wm. Bedford Pty. Ltd.; British Insulated Cables; Brunswick Springs Pty. Ltd.; H. Brearley; R. S. Calder Pty. Ltd.; A. Challingsworth; Gladwell & Barlow Pty. Ltd.; F. W. Green; Reeve & Marshall; Sunshine Potteries.

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Supplied by:—British Tube Mills (Aust.) Pty. Ltd.; A. Challingsworth; Chubb's Australian Co. Ltd.; K. L. Engines & Tractors Pty. Ltd.; Metters Limited; Plated Products.

Air-circulating & Compression Equipment.

Supplied by:—F. W. Davey & Co. Pty. Ltd.; Elcon Pty. Ltd.; Ferrier & Dickenson; McPherson's Pty. Ltd.; Malley's Ltd.; Toowoomba Foundry Ltd.

Aircraft Electrical Gear.

Supplied by:—Airzone (1931) Ltd.; Kriesler (A'sia) Pty. Ltd.; Philips Electrical Industries of Aust. Pty. Ltd.; Tecnico Ltd.

Aircraft Instruments.

Supplied by:—Amalgamated Wireless (A'sia) Ltd.; Warburton Franki (Melb.) Ltd.

Aluminium & Aluminium Alloys.

Supplied by:—Australian Aluminium Co. Pty. Ltd.; Sellers Pty. Ltd.; Wunderlich Ltd.

Amplifiers, Audio.

Supplied by:—Amalgamated Wireless (A'sia) Ltd.; Australian Sound Systems; Crammond Radio; Eclipse Radio Pty. Ltd.; Philips Electrical Industries of Aust. Pty. Ltd.; Raycophone Pty. Ltd.; Steane's Sound Systems Pty. Ltd.; Universal Mayer Sound Systems; Velco Sound Systems Pty. Ltd.

Amplifiers, Radio.

Supplied by:—Colville Wireless Equipment Co. Pty. Ltd.; Bland Radio Ltd.

Anti-corrosion Treatments.

Supplied by:—Anchor Electroplating Works; Burrows Plating; Efco Manufacturing Co. Pty. Ltd.; Galvanisers (Aust.) Pty. Ltd.; Harvey, Shaw, Successors; Mellozing Pty. Ltd.; Metal Coatings Pty. Ltd.; Modern Plating Works; Metalsprayers Pty. Ltd.; Renown Plate Co. Pty. Ltd.; Rustproofers Pty. Ltd.

Anti-Submarine Equipment (Asdic).

Supplied by:—Airzone (1931) Ltd.; Casper Precision Engineering Pty. Ltd.; Raycophone Pty. Ltd.

Anti-Vibration Materials & Mountings.

Supplied by:—Dunlop Rubber Co. (Aust.) Pty. Ltd.; Federal Felters Pty. Ltd.; Felt & Textiles of Aust. Ltd.; Kenny Charlesworth Rubber Co.; Leggetts Products Pty. Ltd.; Mackay Silentruba Products Pty. Ltd.; Southern Panel Beating Works.

A.S.V. Equipment.

Supplied by:—Airzone (1931) Ltd.; Breville Radio Pty. Ltd.; Thom & Smith Pty. Ltd.

B

Battery Charging Equipment.

Supplied by:—Amplion (Aust.) Pty. Ltd.; Challenge Electric Co.; Don Electric Co. Pty. Ltd.; J. Flood Pty. Ltd.; Gloria Light Co. Pty. Ltd.; T. Kiernan; Masse Batteries Pty. Ltd.; McKenzie & Holland (Aust.) Pty. Ltd.; Overseas Electric Distributors; O'Donnell & Griffin Pty. Ltd.; Precision Engineering Co. Pty. Ltd.; Parsons & Robertson Ltd.; Quirk's Victory Light Co.; Rural Lighting Co.; Standard Telephones & Cables Pty. Ltd.; Thorne & Deane Pty. Ltd.; Toowoomba Foundry Ltd.; Vesta Battery Co. Pty. Ltd.; Webb Industries Pty. Ltd.

Batteries, Dry.

Supplied by:—Eveready (Aust.) Pty. Ltd.; Stan-Mor Battery Company; Widdis Diamond Dry Cells Pty. Ltd.

Batteries, Wet.

Supplied by:—Masse Batteries Pty. Ltd.; R. & S. Batteries Pty. Ltd.; Vesta Battery Co.

Brass & Bronze Materials & Castings.

Supplied by:—Austral Bronze Co. Pty. Ltd.; Extruded Metals Pty. Ltd.; Knox, Schlapp & Co.; Melbourne Wire Works.

Brushware.

Supplied by:—J. Zevenboom & Co.

C

Cable Connectors.

Supplied by:—H.M.V.; Repetition Engineering Co. Pty. Ltd.; International Radio Co. Pty. Ltd.

Cable Laying Equipment & Accessories.

Supplied by:—A.R.C. Engineering Pty. Ltd.; R. S. Don Pty. Ltd.; K. L. Engines & Tractors Pty. Ltd.; D. Provan & Sons.

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Supplied by:—Braided Products Pty. Ltd.; Cable Makers (Aust.) Ltd.; Gilbert Lodge & Co. Pty. Ltd.; Johnston & Phillips Ltd.; Liverpool Electric Cable Co. Ltd.; Moulded Products (A'sia) Ltd.; Ormiston Rubber Co.; Olympic Tyre & Rubber Co. Ltd.; Rylands Bros. (Aust.) Pty. Ltd.; Sun Electric Co. Pty. Ltd.

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Supplied by:—A.W.A. Telcon; Moulded Products (A'sia) Ltd.

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Ceramic Insulators & Mouldings.

Supplied by:—Australian Porcelain Insulator Co. Pty. Ltd.; Adelaide Potteries; Ducon Condenser Pty. Ltd.; H. Hecht & Co.; Kosters Premier Pottery; Nilcrom Porcelains (Aust.) Pty. Ltd.; New Brunswick Brick & Pottery Co. Pty. Ltd.; Sunshine Potteries; Southern Cross Porcelain Co.; Simplex Products Pty. Ltd.

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D

Depth Sounding Equipment.

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G

Gaskets.

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H

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I

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Supplied by:—Amplion (Aust.) Pty. Ltd.; Rola (Aust.) Pty. Ltd.; Steane's Sound Systems.

M

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Supplied by:—Commonwealth Aircraft Corporation; Dominion Radio; McKenzie & Holland (Aust.) Pty. Ltd.; Rola (Aust.) Pty. Ltd.; Steane's Sound Systems.

Mine Detectors.

Supplied by:—Breville Radio Pty. Ltd.

Morse Keys.

Supplied by:—Gerard Industries Ltd.

Motor-Generator Brushes.

Supplied by:—Morgan Crucible Co. (Aust.) Pty. Ltd.; Fred L. Yott Pty. Ltd.

Motor-Generators.

Supplied by:—Airzone (1931) Ltd.; Durst Motors; F. W. Davey & Co. Pty. Ltd.; Elcon Pty. Ltd.; Services Elevator & Electric Co. Pty. Ltd.

N

Name Plates.

Supplied by:—Adverts Pty. Ltd.; Apex Engineering Co.; Angus & Coote Pty. Ltd.; British Xylonite (Aust.) Pty. Ltd.; Crusader Plate Co. Pty. Ltd.; A. H. Enticott Pty. Ltd.; A. E. Patrick Ltd.; Raynor's Pty. Ltd.; E. H. Stewart.

P

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Supplied by:—Australian General Electric Pty. Ltd.; British-Australian Lead Mfrs. Ltd.; Lewis Berger & Sons; Brolite Pty. Ltd.; Duco-Dulux Pty. Ltd.; A. C. Hatrick Pty. Ltd.; Lusteroid Lacquers; Mica & Insulating Supplies Co.; Sherwin, Williams Co. (Aust.) Pty. Ltd.; Sterling Varnish Co.; Taubmans Pty. Ltd.

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Supplied by:—H. B. Chalmers; International Radio Co. Pty. Ltd.; Gramophone Co. Ltd.; Gerard Industries Ltd.; Repetition Engineering Co. Pty. Ltd.; Telephone & Electrical Industries Pty. Ltd.

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Supplied by:—Australian Sound Systems; Broadcast Recording Supplies.

Phono Turntables.

Supplied by:—Broadcast Recording Supplies.

Photo-Cell Chronometers.

Supplied by:—A. G. Healing Ltd.

Power Supply Units.

Supplied by:—Amalgamated Wireless (A'sia) Ltd.; Airzone (1931) Ltd.; Bland Radio Ltd.; F. W. Davey & Co. Pty. Ltd.; Elcon Pty. Ltd.; EMMCO; Radio Corporation Pty. Ltd.; Transmission Products Pty. Ltd.

R

Radar Accessories.

Supplied by:—Amalgamated Wireless (A'sia) Ltd.; A. W. Valve Co. Pty. Ltd.; A.W.A. Telcon; Breville Radio Pty. Ltd.; Chubb's Australian Co. Ltd.; The Gramophone Co. Ltd.; A. G. Healing Ltd.; Kingsley Radio Pty. Ltd.; Kriesler (A'sia) Pty. Ltd.; Radio Corporation Pty. Ltd.; Standard Telephones & Cables Pty. Ltd.

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Supplied by:—Amalgamated Wireless (A'sia) Ltd.; Casper Precision Engineering Pty. Ltd.; Cliff & Bunting Pty. Ltd.; Ducon Condenser Pty. Ltd.; The Gramophone Co. Ltd.; Hilco Transformers Pty. Ltd.; Moulded Products (A'sia) Ltd.; New-Air Pty. Ltd.; Nilcrom Porcelains (Aust.) Pty. Ltd.; Radio Corporation Pty. Ltd.; Standard Telephones & Cables Pty. Ltd.; Swales & Swann; Simplex Products Pty. Ltd.; G. H. Sample & Son; Transmission Products Pty. Ltd.; Tecnico Ltd.

Radar Equipment.

Supplied by:—Airzone (1931) Ltd.; Amalgamated Wireless (A'sia) Ltd.; Eclipse Radio Pty. Ltd.; Gramophone Co. Ltd.; A. G. Healing Pty. Ltd.; Kriesler (A'sia) Pty. Ltd.; Standard Telephones & Cables Pty. Ltd.; Thom & Smith Pty. Ltd.

Radar Reflectors & Targets.

Supplied by:—Wm. Bedford Pty. Ltd.; Morris & Walker Pty. Ltd.; Frederick Rose Ltd.; S. G. Ungley.

Radio Accessories.

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THURSDAY, May 2, 1946

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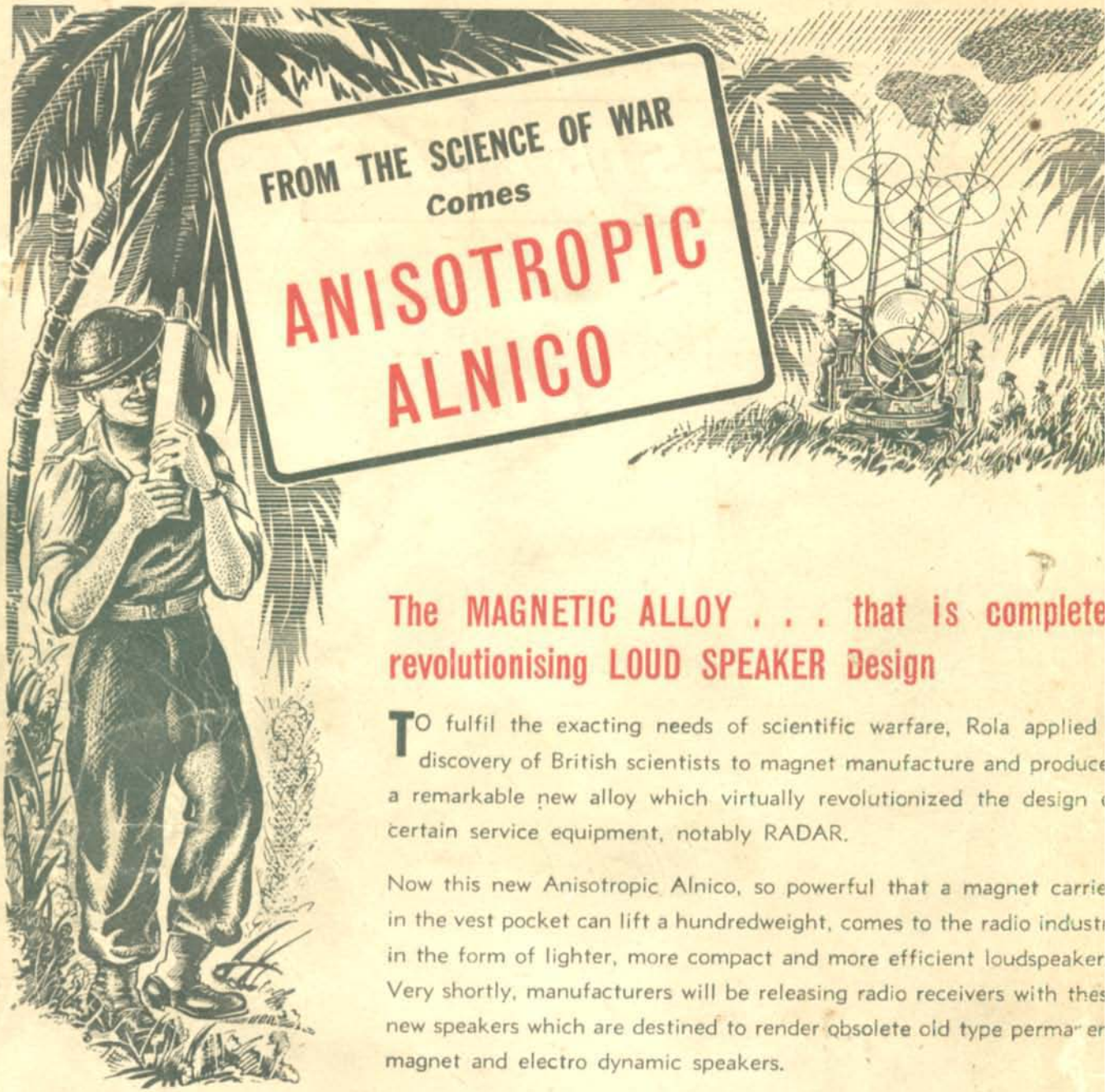

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