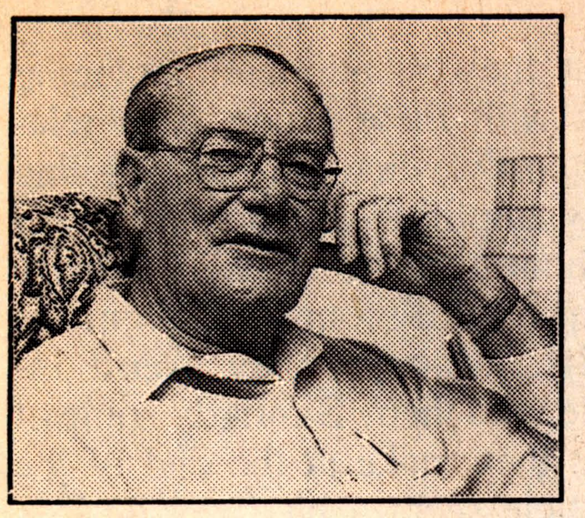

When I Think Back...

by Neville Williams

MAILBAG MONTH: Carrier telephone systems, avionics, 'Smithy' and the 'Knickebeins'

Writing from Wahroongah in NSW, Don Taylor reminds us that progress in electronics has not been confined to radio, video and consumer audio — the topics which have largely dominated these columns. Over much of the same timeframe, telephones have evolved from the primitive 'dynamo' and/or 'candlestick' variety, with manual exchanges, to automated electronic and optical carrier networks offering immediate local, interstate and international communication.

Whether we need to be reminded is another matter, I suppose. I well remember the country village in which I spent my boyhood, where phones of any kind were few and far between. Those that did exist — in the railway office, policeman's cottage, hotel, garage and store — were connected to a switchboard in the 'post office', which was one room in the house where the postmaster lived with his family.

'Ringing up' involved cranking a handle to attract his (or his family's) attention, so that someone could plug your — the caller's — line into the appropriate 'jack' and alert the party at the other end with a further crank handle on the post office switchboard.

When I mentioned as much to Don Taylor, he indicated that he had similar recollections of the exchange in Mona Vale, now a well known seaside suburb of Sydney. Crank handle and all, he said, was installed in one corner of a local store and tended by the storekeeper and/or his family.

These days, most Australians have access to a phone and are encouraged by concessional rates to talk to 'family and friends' here, there and everywhere — from Gundagai to Greece.

Don Taylor's prime purpose in writing was to comment on the late L.P.R. Bean and Stromberg-Carlson (A'sia), as featured in these columns in April and September last. Having done so, he went on to talk about another memorable chief executive and another company which had been set up to manufacture telephone equipment, much of it involving carrier type technology.

One call per pair

For those who are strangers to this subject, I should perhaps explain that telephone wires were originally meant to carry only telegraphic code and/or audio signals, each pair of wires serving, in the latter case, to interconnect the microphones and earphones at either end, along with the call-bell system.

A fair amount of supplementary gadgetry was involved and the number of calls which could be accommodated simultaneously between any two locations was limited to the number of 'pairs' available between them: one conversation at a time per pair. As the demand for phone facilities increased, it became progressively more difficult and/or uneconomic to install and maintain the requisite number of pairs throughout and between the population centres. Photos from the 1920's and 30's show telephone poles festooned with an incredibly complex mass of crossbars, insulators and wires. A typical picture, dated 1912, in the *Macquarie Book of Events* shows a single pole carrying 20 pairs of crossbars, each supporting eight insulators. Twelve workmen were concentrated around it: seven up amongst the wires and five on the ground!

A potential answer to the problem emerged around 1925, with the realisation that phone lines could be made to carry signals in the low-

Fig.1: Any number of readers will remember having saved up 'ten bob' ($1) in the 1930's for a joy flight, but few will have had the privilege of a flight in the 'Southern Cross' with 'Smithy' at the controls. This souvenir is from a 1934 flight...

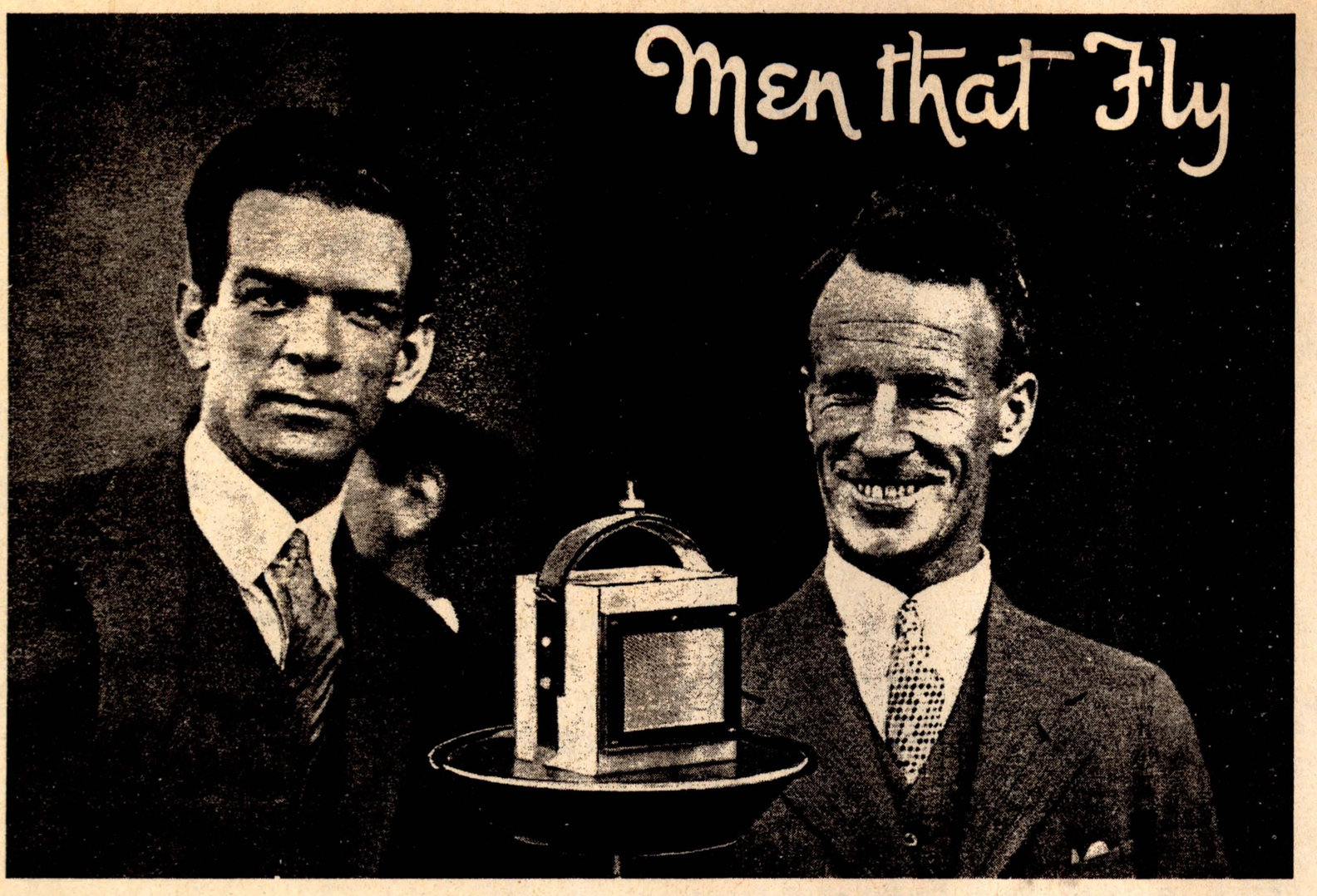

Fig.2: From the June 22, 1928 issue of 'Wireless Weekly', this picture shows Ulm (left) and 'Smithy' fronting up to a 1920's style transverse current carbon (Reisz) microphone. An 18-hour unbroken coverage of their trans-Pacific flight by 2BL set what was an Australian — and probably a world — record at the time.

RF (supersonic) range which could be modulated with audio, speech or tone, in the manner of ordinary radio signals. By relying on filters to limit their individual bandwidth, multiple modulated 'carriers' could presumably be carried by each pair without mutual interference. The idea was sound, but implementing it proved to be a long drawn-out process.

Nowadays, the 'multiplexing' of encoded information over cables is a science in itself involving speech, music, video and all manner of data over telephone pairs, coaxial cables, fibre-optic cables and satellite links — separately or in combination. Right now, the Federal Government is agonising over the various options as a basis for Pay TV.

But 50 years ago, engineers were still sorting out basic technology the hard way — how best to go about it, and how to create the specialised circuits and components that would be required. That's the background against which Don Taylor's letter should be read. What follows is largely Don's original text, with a minimum of editing on my part:

Don Taylor thinks back

The other remarkable character I recall from the 1950's was Thomas Samuel Skillman. He was an Englishman, a Cambridge graduate who, in the 1950's, was employed by Philips in Holland...

Not long before the start of World War II, Philips secured a contract with the Australian Post Office for the development and installation of a 17 channel carrier-on-a-cable duplex system to provide a telephone link between Sydney and Maitland, 150km or so to the north. A similar system was later to link Sydney and Orange, in the west.

Work on the system was still in the early stages when Germany invaded Holland. Skillman, together with some of his associate engineers, managed to escape with the complete design data and, after complex negotiations, came to Australia.

Here, with financial assistance from the Government, Skillman formed a company, Communication Engineering Pty Ltd, built a factory in a disused sandstone quarry in the Sydney suburb of Cammeray, and set about producing the entire system on the spot.

According to Don Taylor, it was extraordinarily sophisticated equipment for the time. The requisite coaxial cables were laid underground, in a special conduit which was filled with an inert gas (probably nitrogen) at slightly above atmospheric pressure. This provided an environment which promised greatly extended life for the cables.

Designated channel spacing was 4kHz which, with SSB (single-sideband) technology, provided an effective audio channel bandwidth from about 400Hz to 3.8kHz. The top frequency transmitted would be about 75kHz.

It was an enormous advance on anything that the Australian Post Office had in service. Up to that time, their only carrier systems consisted of some fairly primitive three-channel installations using existing open-wire circuits and (Don thinks) both sidebands.

Quality control problems

Skillman, with extraordinary drive and engineering ability, established his manufacturing enterprise in the face of enormous difficulties. Although the general idea of the equipment was fairly conventional, components such as inductors, capacitors, resistors and transformers all had to conform to the most exacting specifications.

Conventional, locally made components, as used in the radio industry, were totally inadequate — as, indeed, they proved to be a few years later, when TV receiver production got under way.

The carrier telephone system required large numbers of band-pass, low-pass and high-pass filters, as well as modulation and demodulation oscillators. Not only did these have to be manufactured and adjusted to fine tolerances but they also had to exhibit a very high degree of stability.

(Don should know. Questioned by telephone during the preparation of this article he said that, as a graduate in mechanical-cum-electrical engineering, his job at Communication Engineering Pty Ltd had been to supervise the production and later the testing of filter modules).

The tolerances were far tighter than for anything needed or even imagined for the production of domestic radio receivers.

To achieve such standards, all components had to be specially manufactured on the spot. For example, all capacitors used mica as the dielectric. The mica came in blocks and hand-picked operators were trained in splitting the mica down to the specified thickness, each piece being carefully checked with a micrometer.

The mica sheets were then blanked into squares in a press to form individual plates. Half the number underwent a vacuum deposition process to provide a thin film of aluminium. They were then assembled, using uncoated squares to serve as dielectric spacers. Duly clamped and tested, they were vacuum wax impregnated and pitch dipped.

Some of the inductors were wound on toroid cores, others in so-called 'pots', which were adjustable.

Complete filters were normally assembled in steel cans, tested, pitch filled, aged at high temperature, tested again, then closed by soldering a lid in place.

As such, they left little scope for subsequent internal servicing!

Local design, technology

On site support facilities included a machine shop, plating, painting, bakelite moulding, etc., along with the usual infrastructure of engineering, drafting, purchasing, sales and accounts.

Last but not least, the complete carrier systems were wired and critically performance checked by Post Office inspectors. Significantly, the technology for all this was put in place during the war.

After the war, Skillman formed a new company, T.S. Skillman & Co Pty Ltd and embarked on new projects connected with long-line telephone equipment. These included custom built line filters, program channel equipment for the transmission of radio programs and specialised equipment for the Department of Civil Aviation, which provided multi-channel telephone circuits for onward transmission by radio link. But that was not all.

In the 10 years or so following the war, one of the basic bottlenecks impeding the provision of telephone services was overload of the 'junction' cables linking the various suburban exchanges. Working with Post Office engineers, Skillman and his team found that many pairs already in the junction cables could transmit the higher frequencies required for a carrier system, without crosstalk or compromising audio quality. Out of this came a highly innovative but practical design for the so-called 1+4 'junction carrier' system.

Another innovative development was the design and manufacture of a three-channel carrier system for use on open wire lines in the outback. This was the first design in which crystal-controlled oscillators were used for modulation

Fig.3: Built by Jack Duffy of Sydney, for a projected 1933 Trans-Tasman flight, this 50 watts transmitter/-receiver could handle both voice and Morse code. Featured by 'Wireless Weekly' in October 1932, it was apparently one of a number that John Stannage ultimately rejected.

and demodulation. With the earlier L/C oscillator technology, temperature effects had posed a problem, on occasions necessitating resort to temperature controlled crystal ovens.

A still further refinement was the option of using two carrier frequencies for each channel, enabling the use of either lower or upper sideband. The development made it easier to achieve the specified tolerances for audio frequency response and crosstalk.

Finally overwhelmed

Despite such initiatives, Skillman's business eventually fell victim to the enormous advances in technology and the difficulty of competing with the large multi-national corporations which dominate the telecommunications industry.

Don Taylor says that Skillman was always conscious of his firm's vulnerability and frequently referred, with a degree of paranoia, to 'the ring' which, he said, the international cartel maintained in order to drive smaller competitors like him out of business!

But Skillman himself was a larger-than-life character. He was a huge man physically, well over six feet (183cm) tall, weighing 20 stone (127kg) or more:

I will never forget my first meeting with him. It was a hot summer's day and he sat in his office with his sleeves rolled up. As my eyes fell on this huge man I thought: that's what it means to have arms like hams!

It was not only physical size which made Skillman such a formidable character. His dominant personality, powerful cultivated English voice and enormous intellectual talent made him a person to be reckoned with. He also had the ability to surround himself with loyal, talented and hard-working people. His staff included scientists, engineers, a lawyer (Laurie McGinty, who later became Mayor of Willoughby and a member of State Parliament) a patents expert and many others. He was a demanding person to work for, and sometimes unpredictable but most who did so found the experience rewarding.

Don Taylor concludes:

To my regret, I have lost touch with the people at Skillman's, but I still remember many of them. When the business closed in about 1961, those remaining were scattered to the wind.

Harry Stewart, I know, went to STC. Others who come to mind were Jimmy Stuart MSc, a gentle and talented scientist; Bruce Veitch, Frank Melvan, Barry Boden, David Goldby, Ken Stanton, Vince Power, Bill Fowler, Ross Littlemore, Truxtan Cooper, Herman Kanters, Allen Webster and others. Most of these people would almost certainly have continued their career in some part of the electronics industry, and would have their own stories to tell.

Skillman himself remained in Australia, living in Mosman, NSW. He interested himself in various esoteric activities — including, I think, the Mensa Society, a group of neo-eccentrics claiming to have inordinately high IQ's. To the best of my knowledge, he died about 10 years ago, survived by his wife and two daughters.

(For former workmates who may want to contact Don Taylor, his address, published with his permission, is 96 Burns

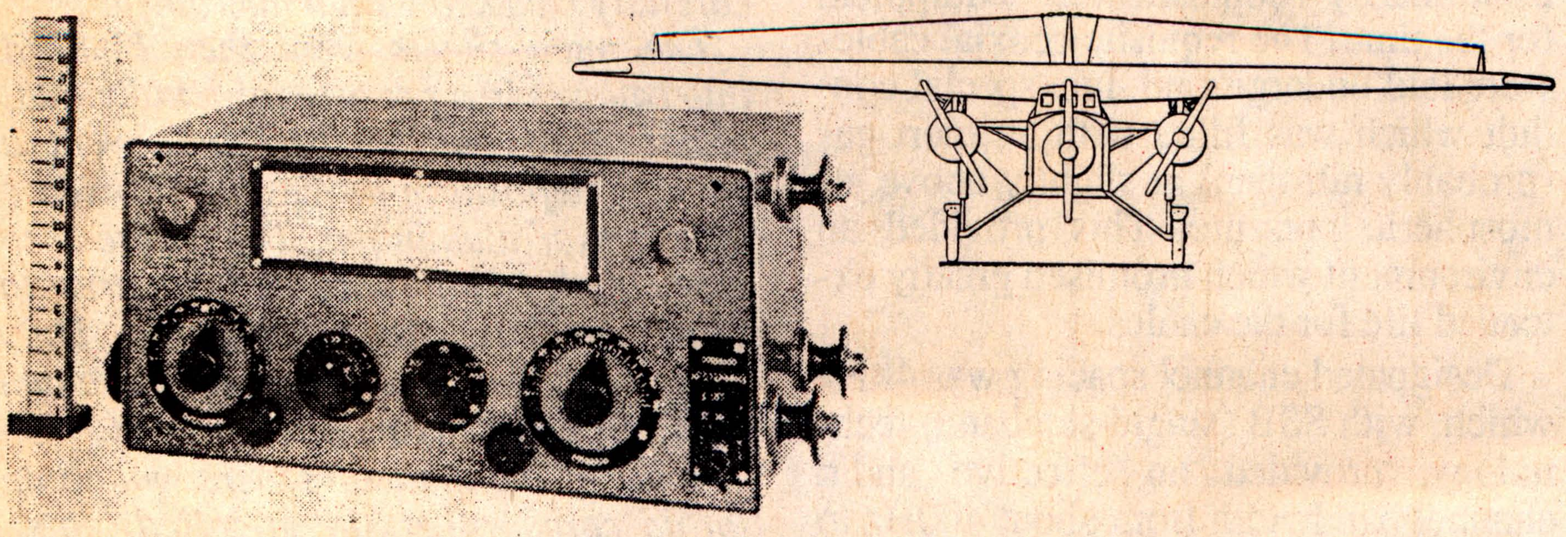

Fig.4: Produced by Philips of Holland for the Dutch KLM Aerial Mail Service, this receiver was designed for use with a V-antenna strung between the wing tips and tail, as shown. Mated with an equally modern looking crystal-locked voice/code transmitter, it was described in Wireless Weekly for December 9, 1932 as the 'Last Word in Radio for Smithy".

Rd, Wahroongah, NSW 2076. Telephone (02) 489 2534.)

So much for carrier type telephony. Now for a complete change of subject:

More about 'Smithy'

In June and July 1992, I recounted the exploits of (Sir) Charles Kingsford-Smith and his associates, with particular emphasis on the 'Old Bus' — the *Southern Cross* — and the relevance of two-way radio to his pioneering flights.

Mention of his incidental barnstorming tours around the countryside stirred the memory of Fred Whitehouse of Muswellbrook, NSW, and of a former *EA* staff member Jim Yalden, who currently operates an electronics service business in Milton, NSW. Both recalled having had a joyflight in the *Southern Cross* in the early 1930's and having kept the ticket against the day when it might become a fragment of Australian history.

It so happens that Fred's ticket was the better preserved of the two, and it's the one which Editor Jim Rowe has done his best to reproduce in the accompanying Fig.1.

By chance, Jim Rowe also came across several more articles about Smithy in old copies of *EA*'s ancestor *Wireless Weekly* and, while I do not propose to discuss them at length, they are certainly worthy of mention.

In the issue for June 15, 1928, a *WW* staff writer asks and answers the question: "Would the (recent) trans-Pacific flight have been successful without radio?" He concludes "It is doubtful".

He stresses that, under less than ideal flying conditions, a plane could not navigate safely over open ocean using only the resources (then) applicable to shipping. Deprived of reliable sightings, a pilot did not have the ultimate option of waiting around until conditions improved. In 10 hours aloft, a 30mph cross wind, undetected, could carry a plane like the *Southern Cross* 300 miles off course — sufficient to miss an island destination altogether.

Readers were also reminded that Marconi and Fisk/AWA had recently demonstrated the properties of directional high frequency wireless beams between the UK and Australia, and that Smithy had flown the 2400-mile (3900km) leg from San Francisco to Honolulu along just such a beam.

The writer envisaged more ambitious systems spanning the Atlantic and Pacific oceans, with the main beam being intercepted every 300 miles or so by transverse beams, acting as markers, each modulated with its own distinctive code letter. 'Invisible lighthouses in the sky' he called them. (More about them later).

Broadcast coverage

Although more than 60 years have passed since that first historic flight across the Pacific, I can still remember the drama of the live radio coverage. Only now, however, do I realise how little of it I could really have heard, because of the need to conserve batteries.

It was a case of switching on at intervals to verify that signals from the *Southern Cross* were still being received, then switching off again.

Among the items unearthed by Jim Rowe was a detailed contemporary account of the broadcast coverage, published in *Wireless Weekly* for June 22, 1928, in an article entitled 'How 2BL Broadcast the Good News'. The station had been the first in Australia to announce the plane's arrival in Hawaii, and had kept in touch with it throughout the entire next leg from Hawaii to Fiji.

En route, the *Southern Cross* passed through a storm so violent that Lieut.

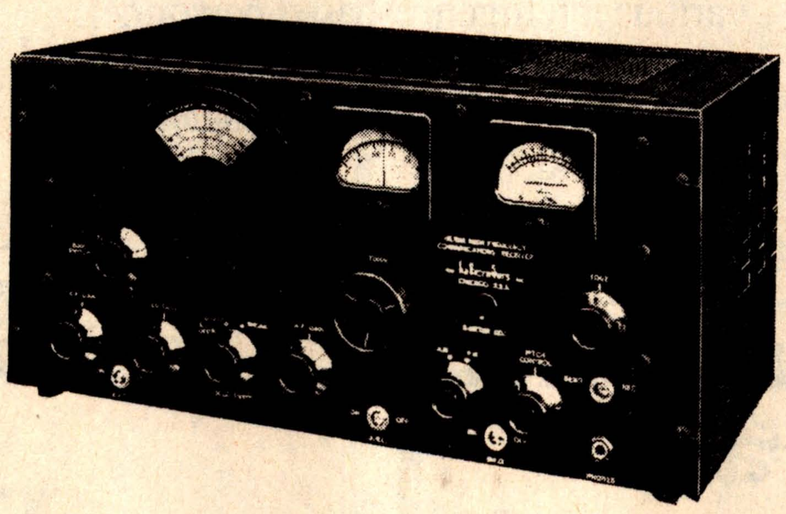

Fig.5: Made by Hallicrafters Incorporated of Chicago, the S-27 receiver had 15 valves and tuned from 27MHz to 145MHz in three ranges. It also demodulated FM, and allowed the British to finally detect the German Knickebein beams.

Warner found it difficult to operate the Morse key. He had kept the key switch closed, however, so that his listeners would be reassured by the wavering buzz of the carrier, as the trailing antenna whipped around in the gale — varying the transmitter frequency as it did so.

At the receiving end, the entire episode was monitored by 2BL's Chief Engineer Raymond Allsop, and his assistant, both experienced operators. Throughout the long hours, they relayed the sound of the incoming carrier to the studio, interspersed with actual Morse Code transmissions and the transcribed text, as jotted down on a note pad.

In the studio, the coverage was intermixed spontaneously with back-up program material, with a summary of the plane's progress every hour, on the hour.

When the plane took off, a few days later, on the final leg from Fiji to Sydney, 2BL broadcast the news within four minutes. It then stayed on air for an unbroken 18 hours, mixing messages from the plane with phone-in messages from the aviators' families and comments from studio staff plotting the plane's progress on Admiralty charts (Fig.2).

Radio's vital role

As the plane approached Mascot, Sydney, and a welcome by a reported half-million people, 2FC took up the coverage, providing a supplementary channel on 28.5 metres.

In all, the broadcast went to air through A-class stations Australia-wide, through 5SW in England, WGY Schenectady (USA) and WMAK Buffalo.

Remembering also the drama of 'Coffee Royal', the loss of the *Southern Cloud* and the abortive mail flight to New Zealand, it is difficult to escape the conviction that broadcast coverage of such events did much to generate a public — and political — perception that planes used for anything but local flights must have adequate radio back-up for both communication and guidance.

But what did 'adequate' signify? In practical terms, and in Smithy's day, it could mean airborne transmitters and receivers assembled on a one-off basis by earnest amateurs or experimenters. Their handiwork would be reported in the press as having been installed and tested in flight, leading to uncertainty as to which planes were carrying what at any given time.

As a notable example, *Wireless Weekly* for October 28, 1932 carried a picture of two-way radio, custom built for a trans-Tasman flight scheduled for early 1933. Typical of hand-made 1920's-style equipment, housed in a stout wooden carrying case, it offered a power output in the range 10-50 watts, depending on the power source, and could transmit either voice or Morse Code.

It was to be installed in a special sound-proofed wireless cabin in the *Southern Cross*, and would feed a V-antenna strung between the wing tips and tail — ostensibly a foregone conclusion.

Yet a few weeks later on December 9, 1932, *Wireless Weekly* ran a follow-up story commenting on the continuing uncertainty surrounding the choice of wireless equiment for the *Southern Cross* and explaining that: 'several transmitters had been built in Australia for use on the trip, but none of them appeared to be what was wanted'.

WHEN I THINK BACK

It went on to picture a commercial receiver and transmitter which Philips in Holland had designed and produced for similar tri-motor Fokkers, flown by the KLM Air Mail Service. Described as 'the last word in radio for Smithy' and priced at £900, they were due on the *Narkunda* later in the month — December 29.

Also feeding a V-antenna atop the plane, the new Philips 10-watt transmitter was said to be crystal controlled, with back-up tuneable coverage between 25 and 90 metres. Special headgear for the crew carried in-built headphones and an optional microphone.

The equipment was purpose-built, of thoroughly professional appearance, and capable of remote control by means of Bowden cables (Fig.4). It was presumably used for what proved to be an uneventful flight on January 11, 1933, followed by a barnstorming tour of New Zealand.

Now for another up-date:

Beams for bombers

The 1928 forecast of 'invisible lighthouses in the sky' proved spot-on during WWII, when the Germans set up secret primary and intersecting beams ('Knicke- beins') to guide their night-time bombers to strategic targets in the UK. We covered the story in the August 1992 issue.

The Brits suspected the existence of the Knickebein beams, but could not be sure because:

1. No such beams showed up on available British equipment.
2. Crashed German bombers did not appear to be fitted with any special receiver. (The Germans had cleverly adapted their Lorenz type blind landing receivers to perform the extra function).
3. The Germans had also installed steerable, high-gain, highly directional antenna arrays at key airbases, ostensibly as blind landing aids but able, in conjunction with a high power transmitter, to project very narrow beams across Britain.

As we explained in the abovementioned issue, the impasse caused all sorts of ructions in the British High Command, as recorded in the writings of various intelligence-based personnel.

It was due largely to prompting by service personnel with an amateur radio background, that a specially fitted British Anson bomber detected intersecting German guidance beams focussed above a Rolls Royce engine factory at Derby!

An Australian amateur, Mr K.G. England (VK1KGE), writes to say that, having perused much of the literature on the subject, it would seem to him that a prime reason for the Brits' inability to discern the intruding beams was the fact that the carriers were frequency rather than amplitude modulated.

Unlike available British VHF receivers, which were limited to AM and CW, the imported US-made Hallicrafters receivers installed in the Ansons not only provided coverage from 27 to about 150MHz but were switchable to FM. He suggests that they were as advertised in the 1941 edition of the *ARRL Handbook* and priced at US$175. I quote:

A junior officer, who was an amateur, knew of several of these Hallicrafters sets in a London radio shop, so he went out and bought the whole stock. When installed in aircraft, the sets revealed how the navigation system then in use by the Axis worked.

The 1930's have been described as 'the golden years' of consumer radio. They were obviously very fertile years for avionics, as well! ❖