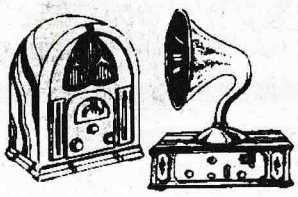
Vintage Radio

by PETER LANKSHEAR



The Hammarlund Super Pro Receivers

Last month we saw how, early in 1932, the Danish born Oscar Hammarlund's New York manufacturing company proved that not only was the shortwave superheterodyne communications receiver a practical proposition, but also it had a superior performance to the then-standard shortwave regenerative TRF receiver.

Domestic shortwave superhets were also appearing, and although they had some features in common with receivers intended for communications work, two quite different classes of equipment developed — and with few external resemblances. Whereas domestic radios were intended to look like furniture, communications receivers had metal front panels, more controls, and usually metal cabinets, were often without internal speakers and no attempt was made to disguise their technical appearance.

There were essential characteristics that defined the classic communications receiver. High quality domestic sets could meet some of these requirements, but by and large the specifications were too stringent for, or were absent from run of the mill receivers. Summarising, these were:

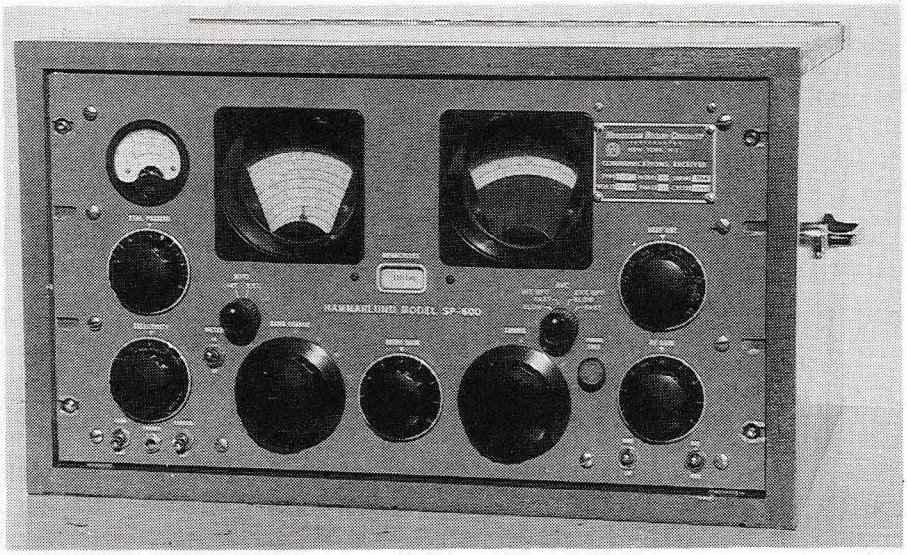
1. High sensitivity, with a good signal to noise ratio together with the ability to handle a wide range of signals without overloading.
2. Good selectivity, preferably variable, with high rejection of adjacent signals.
3. A minimum of images and spurious responses or self-generated signals.
4. Mechanically and electrically very stable. This demanded sturdy and solid construction.
5. Tuning systems had to have easily read dials and accurate resetability to a given frequency, coupled with low tuning ratios to provide accurate tuning of all kinds of signals.
6. An internal beat frequency oscillator was essential.

The Hammarlund 'Comet Pro', described last month, and generally considered to be the first true communications superhet, was able to meet these specifications, with one exception. Lack of an RF stage in front of the mixer created a problem with images. These, at twice the IF frequency, were nearly 1MHz removed from the fundamental, but strong signals could still break through at the higher frequencies. Initially this would not have been a major problem, but as the popularity of the shortwave bands increased, so too did the nuisance factor of images, which have the annoying habit of appearing right on top of a wanted signal.

There are two ways of reducing images in conventional superheterodynes. One is to raise the intermediate frequency; but in practice, for general coverage receivers, there is an upper limit of about 500kHz. (Receivers without broadcast band coverage sometimes had an IF of around 1600kHz, but selectivity then became a problem).

The other approach is to improve rejection before the frequency converter, by providing extra tuning for the incoming signal, usually in the form of one or more RF stages. As frequency converters tend to be very noisy, RF stages also have the important benefit of improving the signal to noise ratio.

Although band changing would become more complicated, the obvious way to improve the Comet would have been the addition of an RF stage.

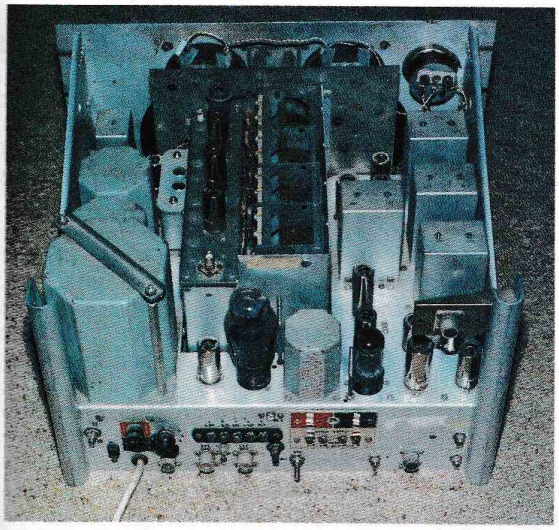


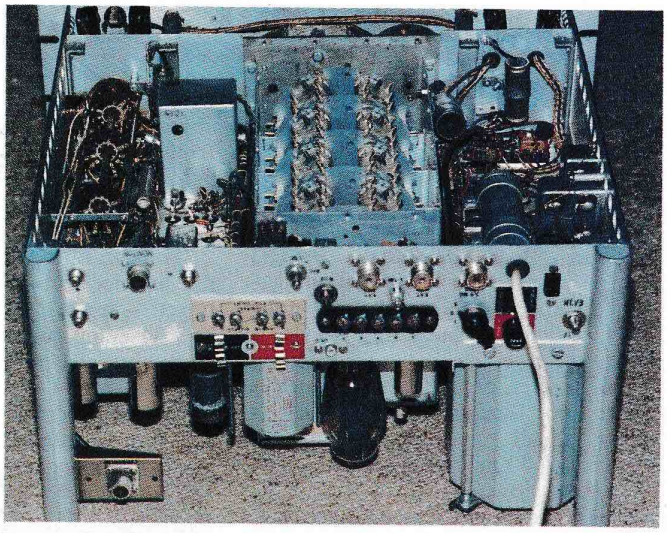
During its nearly 20 years of production, the Hammarlund SP600 was available in several versions. The set above has a home made wooden cabinet and was originally one of a dual diversity pair in a northern radio company's frequency shift telegraph terminal.

A new generation

Meanwhile, the competition had been busy, and by 1935 the new generation of communications receivers had appeared, led by the legendary National HRO fitted with an unprecedented *two* RF stages. Good as it had been, Hammarlund's Comet Pro was no match for these new models.

Of course, as any progressive manufacturer would have done, Hammarlund foresaw the eventual obsolescence of the Comet and had been developing an improved model. Mid-1935, they announced a new receiver to





Left: The rear view, with the tuning capacitor cover removed, revealing the four split stator and rotor sections. Note the massive cast case for the power transformer and chokes. Right: With the underside covers removed, the turret, heart of the tuning system can be seen to dominate the interior of the chassis. Note the silver plate contact pegs projecting from each module base. Between each group of pegs are the air spaced trimmer and slug adjusting screws. The wafer switch to the left is the variable selectivity control.

be called their 'Super Pro'; but it was March 1936 before the first examples were released.

Just as 18 months previously, the National HRO had revolutionised receiver performance, so the Super Pro in its turn set still higher standards. Its appearance and specification were impressive. Like the HRO, there were two RF stages, but the Super Pro, with five switched bands covering from 550kHz to 20MHz had a directly calibrated main dial and a second dial for the mechanical bandspread, together with precision geared drive. One considerable advance was efficient bandswitching.

The front panel was the standard width for rack mounting, as an alternative option to a metal cabinet, and the large, tightly packed chassis was practically square. Fig.1, reproduced from a 1936 advertisement in *QST*, shows some of the outstanding features.

Much of the success was due to the quality of the mechanical construction, and generally, the electrical design of the Super Pro was conservative and conventional. A unique feature was fitting the aerial coils with Faraday electrostatic shields, made from woven thread and wire, to reduce the transfer of man-made noise from the aerial.

Four IF stages

Although by 1936 metal valves were fashionable, all 16 valves in the Super Pro were, like those in National's HRO, the older and proven glass types. In the front end, two type 6D6 were used as RF amplifiers, and a 6A7 was paired with an electron-coupled 6C6 oscillator for frequency conversion. There followed an optional crystal filter and an unprecedented *four* 465kHz IF stages, with continuously variable selectivity, the spacing of the windings being adjusted by means of cams controllable from the front panel.

Four IF stages were not necessary to obtain sufficient amplification. The prime reason was to obtain an IF bandpass response with very steep sides, and by running each stage conservatively, this was achieved with considerable stability. The IF amplifier valves used were three 6D6's and a 6B7 diode- pentode, which served also as a diode detector. There was yet a further IF stage using a 6B7 as a separate AGC amplifier and rectifier. In all, the original Super Pro had no fewer than *seven* IF transformers! Another sharp cutoff 6C6 was used as an electron-coupled BFO.

High power audio

The audio amplifier had an element of overkill! A type 76 general purpose triode fed a triode-connected standard 42 output pentode.

This combination would have been adequate for most communications work. But Hammarlund obviously considered this to be unworthy of a premium receiver, and fitted an extra transformer coupled push-pull triode connected pair of class AB 42's, capable of a nominal 15 watts! This configuration, by the way, had been used a couple of years previously by Philco in some of their very popular cathedral and console receivers.

There was a separate cabinet for the power supply, with dimensions in keeping with the massive receiver. A 5Z3 was used for the HT rectifier, and a type 1V for the bias rectifier.

The Super Pro lived up to its promise of providing a superior performance. It was primarily a professional receiver, as the name implied. The price put it out of reach of all but the most affluent amateurs and shortwave enthusiasts. Major users were government and large commercial organisations, and military versions were soon being made.

Amateurs were not denied possession of Hammarlund receivers, however. In 1938 the HQ120 became available, a top performing model, but only half the price of a Super Pro and with calibrated amateur bandspread and reviving the HQ prefix.

By now, the SP100 had replaced the original Super Pro, but the only change was the substitution of half the valve complement with their octal-based metal equivalents.

The Super Pro 200 series followed. These were basically the original model, but with 18 octal valves and with a noise limiter as a new feature — but now with only three IF stages.

With the outbreak of World War II, there was a huge and initially unsatisfied demand for communications receivers, and in the USA large numbers were made, including the National HRO, the RCA AR-77 and AR-88 and of course, the Hammarlund SP200.

Hammarlund design and quality came to the fore during this period. It has been claimed that their 'APC' variable capacitors were at one stage being produced by 10 different manufacturers, at the rate of one million a month!

It was with an SP200 that I first had 'hands on' experience with a Hammarlund Super Pro. This was in 1950 at the New Zealand Broadcasting Service's shortwave receiving station, situated on a remote area of the hills 300 metres above Cook Straight and with a DXer's dream aerial 'farm' populated with numerous 600-metre long rhombic and V aerials, covering all points of the compass and all on 20 metre high poles.

There was a wide choice of top-line receivers, including Eddystone, STC, Canadian Marconi, HRO clones and RCA models. But when reception conditions were bad, a Hammarlund SP200 was unquestionably the best performer, and the universal favourite. It says much for Hammarlund engineering that this was in spite of the receiver being basically the 1936 design, with the RF stages using the already obsolete 6K7 valve.

At the conclusion of hostilities in 1946, Hammarlund were able to put into production the SP400. Basically, it was the proven old SP200, but with some minor valve changes.

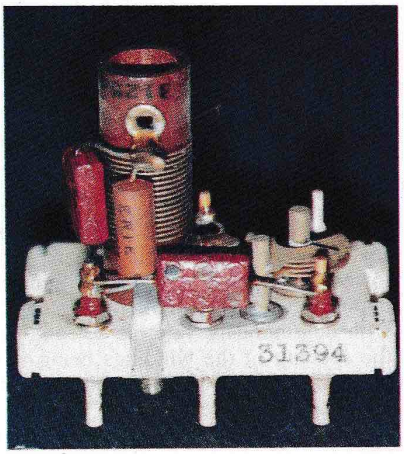
Meanwhile, however, significant developments were under way. A new Super Pro was taking shape. Using their experience of a decade of Super Pro production and wartime developments, Hammarlund's SP600 receiver was a completely new design, but it was not until 1952 that it was finally released.

An historic anomaly

It is here that one of those situations occurred that can mislead historians. Four years earlier, the 1948 *Radio Amateur's Handbook* had included a full-page Hammarlund advertisement with technical details and even a drawing of the SP600. The problem is that it bore little resemblance to the production model SP600.

The real SP600, with no fewer than 20 valves, was certainly worth waiting for. Oscar Hammarlund, who died in 1945, would have approved. It bristled with interesting features, and has been referred to by several writers as the finest conventional superheterodyne communications receiver ever made — capable of holding its own even with later specialist receivers, including the Wadley-Loop Racal RA17. Frequency coverage of the standard model was from 540kHz to a remarkably high 54MHz, in six bands. A low frequency version, the SP600-LF, covered from 15kHz to 540kHz.

The heart of the front end, and key to the superior performance, was the coil turret — a large rotary drum divided into 24 compartments, each for a coil assembly with its associated capacitors mounted on an isolantite base. These bases had silver plated pegs which, as the drum was turned, mated with silver



Individual coil modules are complete sub-assemblies and are readily unclipped from the turret. This is the oscillator coil unit for the 7.4 to 14.8MHz band.

plated spring contacts located between the tuning capacitor and the associated RF and oscillator valve sockets.

There was therefore no wavechange switch, and lead lengths were sufficiently short for efficient 50MHz operation. The turret effectively combined the efficiency of the HRO coil boxes with the convenience of the wavechange switch. Some years later, Philips used a turret successfully for their TV tuners.

Ceramic shaft

The split-stator four gang tuning capacitor can be seen in Photo 2. What may not be obvious from the photo is that the brass vanes are gold plated and to minimise coupling between stages, the shaft is made not of metal, but Isolantite!

The manufacture of a component like this demands extreme precision and skill. Ceramics such as Steatite and Isolantite shrink considerably during firing, and cannot be turned to an exact size afterwards. Isolantite manufacture was a Hammarlund specialty and their standard insulation, and their receivers have little of the usual bakelite and fibre used extensively in conventional radios.

The SP600 circuit is significantly more complex than that of the earlier Super Pros. As an indication, the parts list specifies 129 resistors and 184 capacitors. Many domestic receivers would have had only one-tenth this number.

The RF stages are choke/resistor coupled, with the circuit constants chosen to provide increased gain at the higher frequencies, where it is most needed. As was standard communications receiver practice, the high frequency oscillator was a separate valve, and in the set illustrated, which was half of a pair for diversity reception, it is a double triode arranged so that, if required, an external master oscillator can be used.

Then follows the first mixer, a standard pentagrid 6BE6, the anode of which is connected to a double frequency IF transformer T1. Some models had the option for fixed frequency operation using V3 with up to six switched crystals.

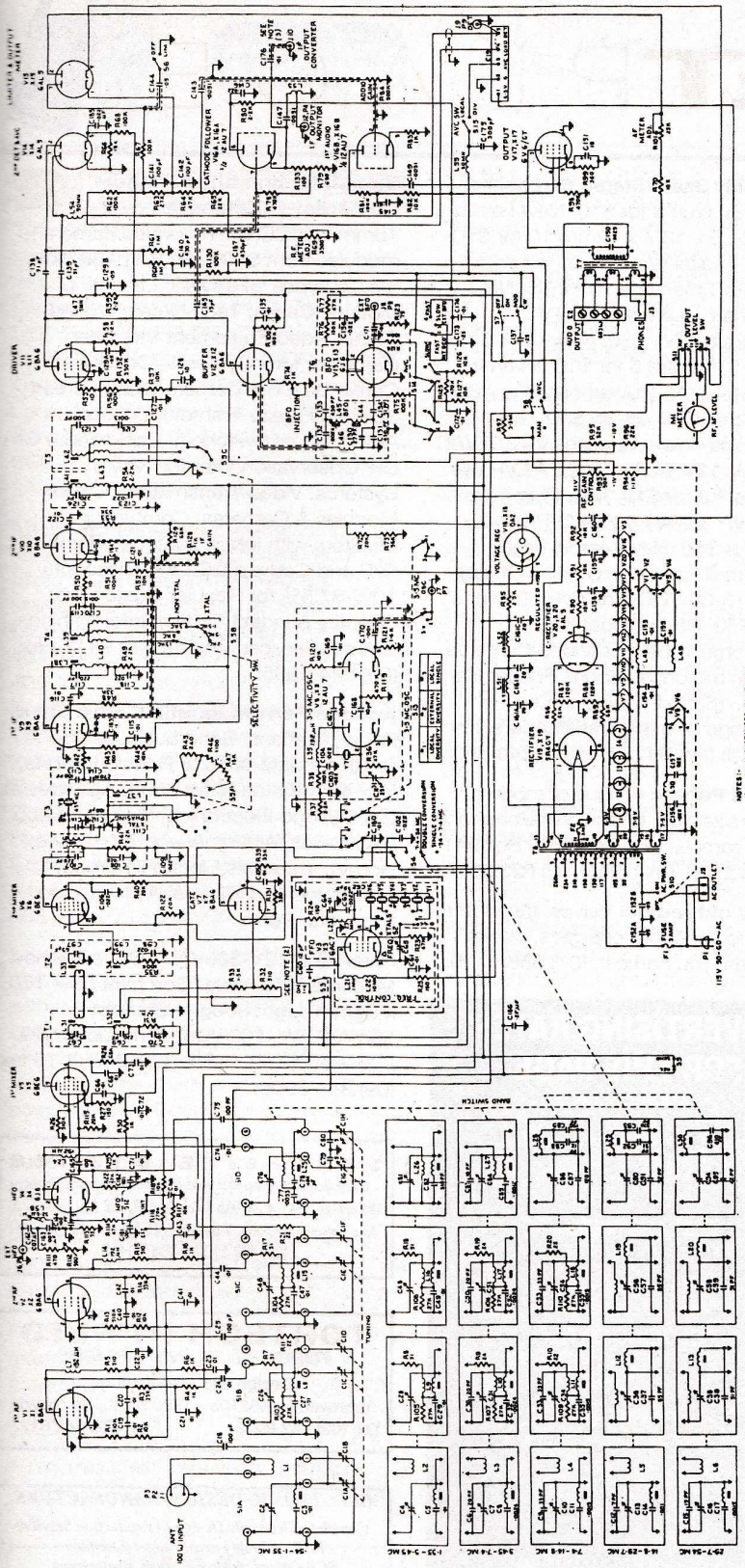
Double conversion

At the highest frequencies covered by the SP600, with the standard 455kHz IF necessary for good selectivity, and despite the use of two RF amplifiers, images would be a problem. The ingenious solution adopted by Hammarlund was to use double conversion for the top three bands.

These signals were first converted to an IF of 3955kHz before being coupled via T2 to the second mixer V6, another 6BE6. Here signals were mixed with the output of the 3.5MHz crystal oscillator V8 to produce the main IF signal of 455kHz.

Signals for the three lower bands left the first mixer already converted to 455kHz, and were automatically directed to a straight amplifier V7, called a 'gate', operating in parallel with the second mixer. All IF signals appeared at the anodes of the V6 and V7 to be passed on to the crystal filter and the IF system with six switched positions, rather than the continuously variable selectivity of the earlier models.

Valves 9, 10 and 11 comprised the traditional three-stage IF amplifier, providing considerable amplification and drive to the AGC and detector



The circuit of the SP600 is well worth tracing out as it reveals many innovations and unusual features. There were several variations of the receiver for specialist applications, this version being adapted for diversity reception using two receivers connected to widely spaced aerials and with inter-connected oscillators and AGC systems.

diodes V14. There was actually sufficient detector current for direct reading by the signal strength meter, calibrated in dB above one microvolt.

With several volts of audio from the detector, minimal amplification was needed from V16B before the signal passed on to the single 6V6GT audio output stage. In contrast with the earlier Super Pro powerhouse audio systems, the SP600 provided only a couple of watts at 600 ohms, primarily intended for feeding an audio line which can be monitored by the signal strength meter.

Associated with the detector are two unusual facilities. V16A is a cathode follower, providing an output of the IF signal for connection to external equipment. To ensure complete stability and eliminate any possibility of 'pulling', the BFO (V13) had a buffer amplifier, V12.

A high tension and a bias rectifier, together with a voltage regulator are needed for the power supply. The power and audio transformers and filter chokes are in keeping with the rest of the engineering of the SP600, being sealed in octagonal cast cases with ceramic terminals.

The SP600 is a handsome receiver, with the controls located in just the right places for prolonged periods of operation. Naturally, accuracy and resetability of dials was paramount. Each band had 6000 readable divisions with very precise drives and no backlash. As one old time 'sparkie' commented after a session with mine, "That is an operator's receiver!"

One development that caught up with

Continued on page 104

MARKETPLACE

FOR SALE

68HC705 Development Systen: Editor, assembler, In Circuit Simulator and Programmer board. Oztechnics, PO Box 38, Illawong NSW 2234, Phone (02) 541 0310, Fax (02) 541 0734, email:OZTEC@OZEMAIL.COM.AU.

Plotter Houston DMP42 A1 plotter: RS232 Interface, as new $1500 Ph (03) 9803 0376.

WANTED

500V Electronic insulation tester: Also main PCB No.42262 433800 for Teac compact disc player PD35. W.Linton 7/26 Grasspan St. Zillmere QLD 4034.

Any early valve hifi: Quad, Leak Garrard 301/401, SME, Ortofon, KT66, KT88, 300B or similar. Cash paid (074) 491 601.

VINTAGE RADIO

Continued from page 101

the SP600 after it went into production was the increase in single sideband traffic. While the stable and flexible BFO is ideal for CW and RTTY transmissions, there is insufficient injection and the diode detector is not suitable for single sideband operation. Hammarlund overcame this problem with the SPC-10 SSB converter, which can be driven from the SP600 IF cathode follower.

If space permitted, there are still more details of interest that could be mentioned; but I think that sufficient has already been written to show that the SP600 is quite a receiver. It is only recently that solid state technology has been able to match the performance of the great communications receivers of the valve era. The Super Pro 600 was specified to resolve a 1uV CW signal with a 10dB signal to noise ratio.

The major advance in modern receivers has probably been frequency synthesis, eliminating the huge dials and the need for the complexity and precision of the drive mechanisms of the classic receivers.

At one stage, the US military released a large number of SP600 receivers for sale to the public, and examples regularly appear in the American amateur and vintage radio magazines 'for sale' columns at reasonable prices, and to make a purchase is a practical proposition. There is one catch however — although the major metalwork is aluminium, the weight with cabinet is over 40 kilos. Hardly 'carry on board' luggage!

The SP600 was the last of the Super Pro line, and remained in production until at least 1970. For a receiver to remain in production for 18 years without major modification, it had to be an outstanding design.

Odd spot

By far the most frequently used valve of the 1920's was the 201A, and it was the subject of this column for April 1991. Nine years ago, the US-based Antique Wireless Association reported on a project initiated by renowned valve historian Bro. Patrick Dowd, identifying just how many different brands of 201A could be identified.

In their May 1995 Bulletin is an update, listing a staggering 513 brands, including Australia's AWA. No wonder the '01A is claimed to be the most popular and duplicated valve of all time! ❖