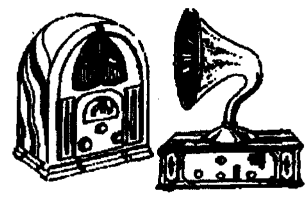
Vintage Radio



by PETER LANKSHEAR

An Australian receiver with metal valves

Last month's column covered the evolution of the first generation of American metal octal valves, released with much fanfare in mid-1935. Some Australian receiver manufacturers were quick to use the new valves and this month we study one of these chassis, the STC model 68.

In the 25 or so years since the manufacture of valve radios gave way to semiconductors, electronics technology has undergone radical changes, a major factor being the reduced cost of amplification. Valves had a high labour content in their manufacture, and their associated circuits were component based, factors which made receivers relatively expensive. One additional valve had a considerable influence on a radio's price.

In contrast, today's receivers can be considered more as systems, assembled largely from IC modules. The addition of a few extra transistors or an IC or two is of little consequence and peripherals such as memories, scanners and readouts — features never dreamed of in valve radio design — can be more complex than the basic receiver they are serving.

Although valve receivers are relatively uncomplicated, they nevertheless require a degree of specialist knowledge and the newcomer, although he may be well versed in electronics, can find vintage technology unfamiliar. As one object of this column is to take some of the mystery out of valve radios, the STC 68 circuit will be described stage by stage, and hopefully the analysis will give some insight as to why some things were done the way they were.

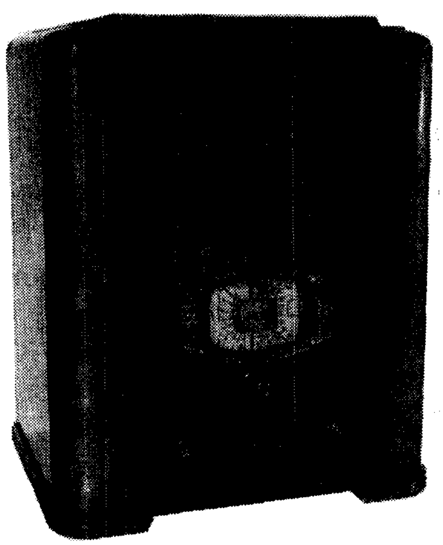
This chassis is a member of what became by far the biggest class of valve receiver, and the equivalent can still be found in today's inexpensive pocket receivers. This is of course the classic '4/5 valve' superheterodyne, comprising a frequency converter, intermediate frequency amplifier, detector and AGC diodes, and a two-stage audio amplifier — plus the usual rectifier.

Yes, I know that the STC 68 actually has *six* valves. But as explained last month, until the metal series combined diode and amplifier valves appeared early in 1936, the detector and first audio stage pair required two valves. Essentially it was still the ubiquitous 'five valver', in a functional sense.

Contrary to some of the contemporary advertising hyperbole, metal valves required no special technology or circuits. Electrically they were interchangeable with their glass predecessors, as comparison with the circuit of the earlier model 50 will show. Even resistor values in most positions were identical. By using an existing design, STC would have been able to commence production of the 68 chassis with a minimum of delay, and were no doubt at an advantage by their being at that time the Australian distributors of Raytheon valves.

Dual wave, PU terminals

By 1935, shortwave broadcasting was well established and dual wave switching was a common feature for any but the most basic receivers. Frequently too, there was provision for the connection of a gramophone pickup — although in many households, just how often recordings were actually played is debateable.



It was common practice to use the one chassis in several different cabinet styles. This cabinet was made in Auckland for the New Zealand market.

Referring to the diagram, the aerial terminal is connected by the three-position wavechange switch to the primary winding of the selected aerial coil. The upper switch position is for shortwave, the centre position for general broadcast and the lower for local station listening. The secondary winding of the selected coil is tuned by the first section of tuning capacitor C1, as well as being connected to the signal grid of 6A8 converter valve V1. The low potential ends of the tuned coils are connected to the AGC line, bypassed with a 0.05uF capacitor and isolated by a 100k resistor.

The second section of the tuning capacitor is switched to the oscillator grid coils. R5, a 20k resistor provides voltage reduction and a load for the oscillator anode, shunt fed to the oscillator feedback windings. (Although drawn as a grid, the 6A8 oscillator anode is actually only a pair of rods).

One feature of the oscillator circuit may not be immediately obvious. As usual, padder capacitors, essential for proper oscillator tracking, are in series with the tuned oscillator windings. In this case, the feedback windings are also connected to their associated padder capacitors. 'Padder feedback' as this configuration is called, improves oscillator low frequency performance. Oscillator grid bias is generated by the grid current flow through the fixed 50k resistor R4.

Cathode bias

Cathode bias, created by the anode current flow though a resistor in the cathode lead, is used for the mixer section of V1 and each of the three following amplifying valves V2, V4 and V5. This was regarded as being a superior method to the less expensive 'back biasing' often used at the time.

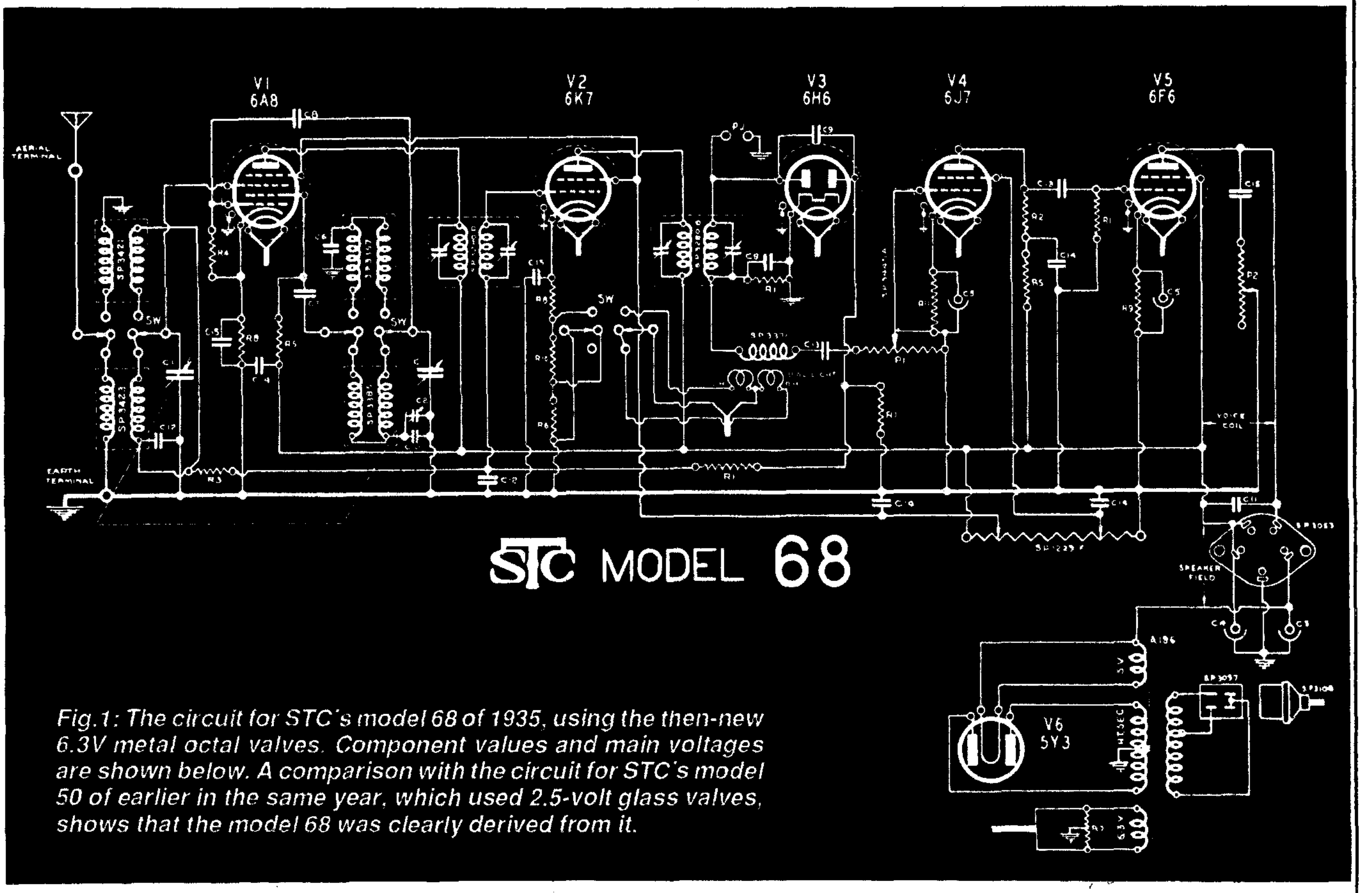


Fig.1: The circuit for STC's model 68 of 1935, using the then-new 6.3V metal octal valves. Component values and main voltages are shown below. A comparison with the circuit for STC's model 50 of earlier in the same year, which used 2.5-volt glass valves, shows that the model 68 was clearly derived from it.

A 6K7 variable-mu RF pentode is used for the intermediate frequency amplifier, operating at 450kHz, and is coupled to the converter by a double-tuned IF transformer. One segment of the wavechange switch controls resistors in the 6K7 cathode bias circuit. In the shortwave position, the two lower resistors are shorted out and the IF stage operates at maximum gain. During broadcast reception, with its greater signal strengths, an additional 1200 ohms is added to reduce gain. For quieter operation in strong signal or noisy areas, a 10k third resistor is switched in, further reducing gain.

Another switch segment selects the dial lamp illuminating the appropriate tuning scale. The 6A8 and 6K7 screen grids operate at about 100 volts positive, and STC practice was to derive this from adjustable tappings on a large HT 'voltage divider' resistor.

Detection and AGC voltage are provided by the 6H6 double diode, operating with the detector load of a 0.5M resistor and a 100pF capacitor connected between the lower end of the second IF transformer secondary and the earthed cathode. The audio signal is coupled to the volume control via an RF choke and 0.01uF capacitor.

The use of an RF choke for keeping IF voltages out of the audio amplifier was

THE FOLLOWING VOLTAGES ARE TO BE SET WHEN THE TRANSFORMER IS CONNECTED TO 240 VOLTS 50 ~ THROUGH THE 240 V TAPPING ON THE TRANSFMR.

V.1. 6A8.	
SCREEN GRID	90 V.
OSC. PLATE.	260 V.
PLATE	185 V.
BIAS	1·2 V
FILAMENT	6·2 V
V.2. 6K7	
SCREEN GRID	90 V
PLATE	260 V.
BIAS	4·8 V
FILAMENT.	6·2 V
V.3. 6H6.	
V.4. 6J7.	
SCREEN GRID.	30 V
PLATE.	40 V
BIAS.	·6 V
FILAMENT.	6·2 V.
V.5 6F6.	
SCREEN GRID.	260 V.
PLATE.	235 V.
BIAS.	16 V.
FILAMENT.	6·2 V.
V.6. 5Y3	
RECTIFIER AC.	400 V
RECTIFIER DC.	400 V
FILAMENT.	5 V.

ALL READINGS TO BE TAKEN WITH 1000Ω P/VOLT VOLTMETER VOLUME CONTROL SET AT MAXIMUM.

STC MODEL 68

S.P. Nº	CODE	NAME	S.P. Nº	CODE	NAME	S.P. Nº	CODE	NAME
3366	C1	2. GANG COND. & DIAL ASS'Y		R.3	100,000 Ω RESISTOR	3280-B		I.F. TRANSFORMER ASSY
3082	C.2	PADDER CONDENSER		R.4	50,000 Ω "	" -D		" " "
	C.3	8 μF ELECTROLYTIC COND.		R.5	20,000 Ω "	3371		R.F. CHOKE.
	C.4	16 μF " "		R.6	10,000 Ω "	1229.F.		16,000 Ω POT. DIVIDER.
	C.5	25 μF " "	3103-S	R.7.	100 Ω C.T. "	3086-A	P.1	500,000 Ω POT.R
	C.6	·0039–·0041 μF MICA COND.	" -F	R.8	110 Ω "	" -E	P.2	50,000 Ω "
	C.7	·001 μF " "	" -B	R.9	400 Ω "			DIAL LIGHT LEAD ASS'Y.
	C.8	·0001 μF " "	" -R	R.10	1,200 Ω "	3105.		P.U. PLATE.
	C.9	·0002 μF " "	" -T.	R.11	600 Ω "	3053.		SPEAKER SOCKET.
	C.10	·00029–·00031 μF " "		R.12			SW.	YAXLEY SWITCH PLATE.
	C.11	·006 μF PAPER COND.						
	C.12	·05 μF " "						
	C.13	·01 μF " "	A.196		POWER TRANSFORMER			
	C.14	·5 μF " "	3106		POWER LEAD ASS'Y.			
	C.15	·1 μF " "	3097		TERMINAL PLATE.			
			3423		M.W. AERIAL COIL ASS'Y			
			3385		M.W. OSC. " "			
			3421		S.W. AERIAL " "			
	R1	500,000 Ω RESISTOR.	3357		S.W. OSC. " "			
	R2	200,000 Ω "	3445-A		SHIELDED GRID LEAD.			

Component values for the STC model 68, along with the main circuit voltages.

not common. In fact it is hard to understand why a choke was used at all; at 450kHz, a 10mH choke has a reactance of less than 30k ohms. Most designers instead used a 50k resistor, which was cheaper and more reliable, and the extra attenuation is negligible.

There is no switching for gramophone pickup operation. Instead, a couple of sockets are provided for connecting a pickup directly across the volume control, and incidentally, the detector diode. Presumably the magnetic pickups in use at the time were considered to have a sufficiently low impedance not to be affected by a parallel diode — but would need to be unplugged for normal reception, of course.

With modern transmissions having modulation percentages often exceeding 100% in the positive direction, the original detector design has shortcomings in common with many older receivers. To achieve low distortion at high modulation levels, the ratio between the diode load and the following grid resistor should be as high as possible.

With STC's unity ratio, serious distortion commences at only about 60% modulation. A common solution is to make the volume control the diode load. At normal listening levels, the grid resistor is in effect tapped well down the load, making the ratio much higher and distortion is improved.

The catch is that volume adjustment will generate noise if the volume control is not of very good quality.

Undelayed automatic gain control voltage is generated by the second 6H6 diode. Delay could easily have been provided by connecting the cathode of the AGC diode to the cathode of the 6J7.

High gain audio

In common with the great majority of similar receivers, there is a two stage resistance-coupled audio amplifier. The combination of 6J7 and 6F6 pentode valves provides plenty of gain and several watts output.

A series resistor, typically of about 1M ohm, was used by many manufacturers to supply the correct voltage to the screen grid of resistance-coupled pentodes. These carbon resistors were very prone to increase in value, and STC practice was to use instead a tapping on the main voltage divider resistor. A 20k resistor bypassed with a 0.5uF capacitor provides additional hum filtering for the 6J7 anode supply.

The 6F6 output stage is standard, with a 50k pot and a 0.1uF capacitor 'tone control'. Similar tone controls were to be found on many receivers, and made listening to the combination of a pentode valve and a loudspeaker whose impedance rose with frequency — often with noisy reception conditions — a bit more tolerable. The output transformer is mounted on the electromagnetic field loudspeaker and the two are connected to the chassis by a plug and standard 5-pin valve socket.

Another socket is provided for the mains supply lead and incorporates 220/240V voltage selection by the position of the plug. The power supply is quite standard, with a centre-tapped HT winding connected to the anodes of a 5Y3 rectifier. As explained last month, the 5Z4 of the original metal valve series was unreliable and the glass 5Y3 quickly took over.

The rectified HT energises the loudspeaker field magnet winding. One advantage of the EM (electromagnetic) speaker was the ability of the field winding to substitute for a filter choke for hum filtering; but to obtain the necessary number of ampere-turns, the field was wound with a lot of fine wire.

Australian receivers frequently used speakers with fields of 2500 ohms resistance. With 60mA of HT current, there was 150V dropped in the field, and associated power transformers were required to supply 380 - 400 volts to each rectifier plate.

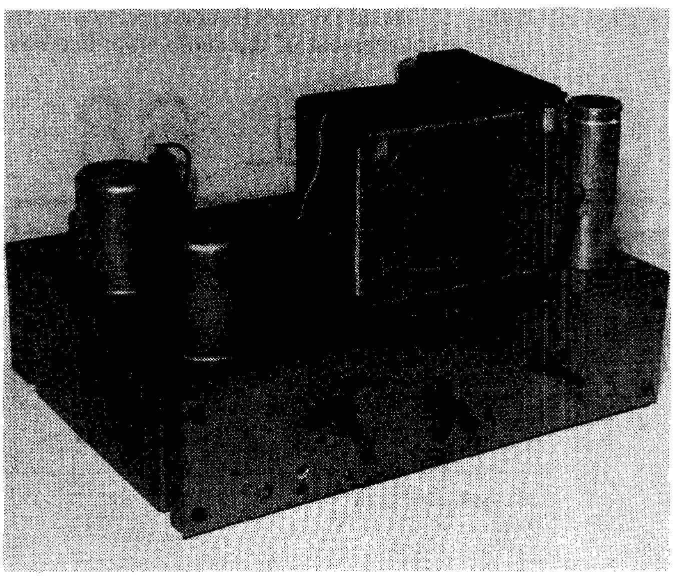
Obviously then, with mains voltage and that order of HT voltages present, work on live chassis should be done with care. The old rule of keeping one hand in a pocket is still a good one!

STC receivers are easy to work on, and so are a good introduction to valve radio servicing. Their spacious chassis and extensive use of tagboards assist in location and identification of components.

Servicing hints

First check the power cable and plugs and if there is the slightest doubt, renew the cable and check too that the connections are to the correct terminals. Some nasty shocks have resulted from the active lead being inadvertently connected to the chassis.

STC used reliable resistors, and unless



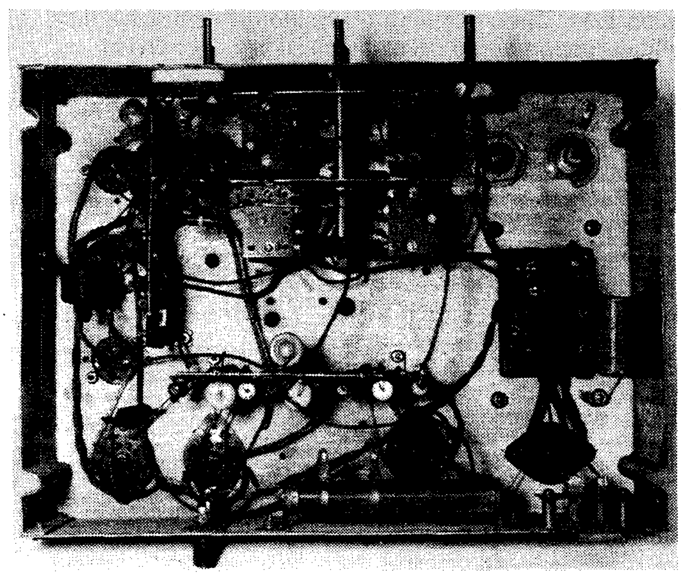


Fig.2 (left): The relatively small size of the metal valves and lack of shields gave the large chassis an uncluttered appearance. In a modern restoration the original wet electrolytic capacitors can be left for appearance, but should be disconnected and functionally replaced by modern components. Fig.3 (right): Component mounting boards and a roomy chassis make STC receivers ideal for the vintage radio novice to work on.

there has been an accidental overload, few are likely to need attention. Their cathode resistors were quite distinctive and wire wound on fibre forms.

Another STC specialty was the main voltage divider, a fibre cylinder wound with fine resistance wire and with adjustable tapping clips. Normally there should be no need to alter the clip settings and as the wire is very fine and easily damaged, it is unwise to touch them. An open-circuited section can be replaced by connecting the clips on either side with a 5W resistor whose value can be easily calculated. The total resistance of the divider is 16k and the resistance of any section is proportional to its length. Thus if the distance between two tappings is 1/5 the total, a suitable bridging resistor would be 3.3k.

The paper capacitors may not have lasted well. After more than half a century, moisture is likely to have penetrated their seals to the detriment of the insulation resistance. This is not too important in the case of the 6A8 and 6K8 cathode bypass and the voltage divider tapping bypass capacitors, but the remaining paper capacitors should be checked carefully and replaced if their resistance is lower than about 50 megohms.

As any leakage in the 0.01uF capacitor coupling the anode of the 6J7 to the control grid of the 6F6 is very serious, it should be replaced regardless. Suitable modern capacitors are polyesters or polycarbonates. For HT bypassing and the 6J7 anode coupling capacitor, use 630VW polyesters.

The original electrolytic capacitors will have long since dried up. Modern 22uF/25VW types are suitable as replacements for the 6J7 and 6F6 cathode bypass capacitors, but there are traps in replacing the HT filter capacitors. Originally these were wet electrolytics — literally, in tall liquid-filled aluminium cans. Replacements can be standard dry types, but as peak HT voltages — especially during warmup of the indirectly heated valves — can be very high, replacement input filters should have a peak rating of at least 525 volts. These are now hard to find, and it may be necessary to use a pair of equal capacitance 350-volt capacitors in series. Bridge each capacitor with a 270k 1W resistor, to equalise leakage currents and balance their voltage drops.

Another point to watch is that the value of the input filter capacitors is not too great, or rectifier damage and excess voltage may result. This is not so important for the output filter, but for the input, a pair of series-connected 33uF capacitors should be the maximum value.

Mechanical problems

STC dial drives of the mid-1930's used a dual-speed planetary system assembly, mounted on the tuning capacitor frame and driving the edge of a semicircular brass disk by means of the grip of a pair of small friction wheels. Unfortunately the edge of the disk is likely to have worn, causing slipping.

If the wear is too great, the only remedy is to cut a new disc from sheet brass. Gentle peening of the hollow rivet holding the two friction wheels may tighten the drive sufficiently to cure slipping.

The volume control may be a bit scratchy. This can come from dust and dirt on the carbon track, and a squirt from a contact cleaner aerosol spray may cure the problem. Often the spray can be directed through the terminal openings. If this fails, wear is the problem and a new control will be needed.

Finally, replacement metal valves may be hard to come by, but there are glass equivalents for all types — although for the IF stage a 6K7G may be unstable without a shield. This is not likely to be a problem with a 6K7GT. ❖