The 1949 ADMIRAL 19A11S TELEVISION SET and the most creative deflection circuit ever designed for electrostatic television.

Dr. H. Holden. Nov. 2016.

The image above is advertising paraphernalia for the Admiral 19A11 set from 1949.

Background:

This is a story about a unique circuit that has been sitting under everyone's noses for about 67 years. The circuit concept has not been featured or described in common television technology textbooks such as those by Fink or Grob or Von Ardenne. As far as I am aware the two TV sets which contained this "circuitry masterpiece" were the Admiral 19A11S and Motorola VT71, both use the 7JP4 electrostatic CRT. I have recently found though it appears to be a British invention by Faudell & White (see below).

Perhaps it was overlooked by people servicing the sets because "it worked" and no further thought was put into it, just fix the TV and get it back to the customer. I have asked many veteran TV technicians over the last 35 years if they know about it, nobody has heard of it so far, or is familiar with the technique used here.

Recently I posted this circuit on a vintage TV internet forum, again seen by a good number people with a long history in TV repair, design & construction. Nobody was familiar with it and it surprised most.

Before reading this article, imagine you have studied all there is to know about designing TV sets with vacuum tubes, you walk into an exam room and are confronted with this exam question:

Design a circuit with a single triode tube alone and any other R,C,L components you wish which runs from a 250V DC supply (ignoring the triode's heater). It must produce two anti phase 450V peak to peak amplitude linear sawtooth waveforms (one for each horizontal deflection plate) and be suited to television horizontal scan and flyback timing and be of an adjustable frequency around 15,750 Hz. It must be synchronized to horizontal sync pulses in the usual way. The two 450Vpp sawtooth waves are capacitively coupled to the horizontal deflection plates of an electrostatically deflected television picture tube (CRT) for line or horizontal scanning in the usual manner.

I think most engineers familiar with television scan stage design would find this question too challenging and fail the exam. On the face of it, the challenge seems impossible. Conventional wisdom is that this task requires a separate oscillator and then a two triode para-phase amplifier running from plate supply voltages of 700 or more volts to allow enough linear amplification to allow 450v peak to peak sawtooth waves and have anti-phase outputs.

One of the reasons, argued in some texts, for the fact that electrostatic deflection was abandoned in favour of electromagnetic deflection was that larger electrostatic TV sets with bigger CRT's would require very high voltages for the deflection amplifiers because of the higher EHT's required for larger tubes.

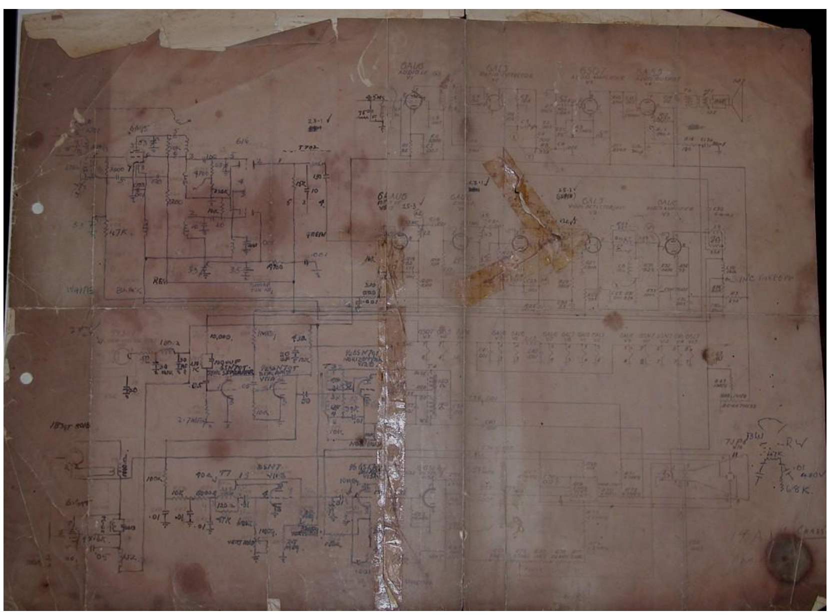
(Of note in electrostatic CRT's the amount of deflection is inversely proportional to the EHT voltage, so if you double the EHT you have to double the deflection sawtooth voltages to get back to the same picture size. On the other hand the amount of deflection, in magnetic deflection, is inversely proportional to the square root of the EHT voltage, so if you double the EHT you only require an increase of 1.41 the deflection current to get back to the same picture size)

How I noticed this unique circuit:

In New Zealand in the very early 1980’s I came into the possession of a "shell" of a vintage television set, an Admiral 19A11S. I had to bargain hard to get it. In the end I think I traded it for a fully working 26 inch colour television monitor.

Unfortunately back then I did not see the wisdom in making pre-restoration photographs. There was a rusted chassis with a tuner unit on it. Most of the RF coils were there including the RF power supply. All of the deflection oscillator parts, including two blocking oscillator transformers and one horizontal output transformer were missing. No power transformer was present either.

There was no manual available at the time (no internet either). Due to the fact TV didn’t start in NZ until 1958 to 1959 era, there was no service information on this 1949 model available from TV service shops. Luckily the fellow I got it from had an old copy of the schematic. It looked to me like an old treasure map, at least I thought of it that way:



The schematic shown above was faded and drawn over in biro in places, but enough of it was there. Now days it is simply a matter of searching the net, the entire Rider’s manual for the 19A11S is online which includes everything one could ever want for servicing.

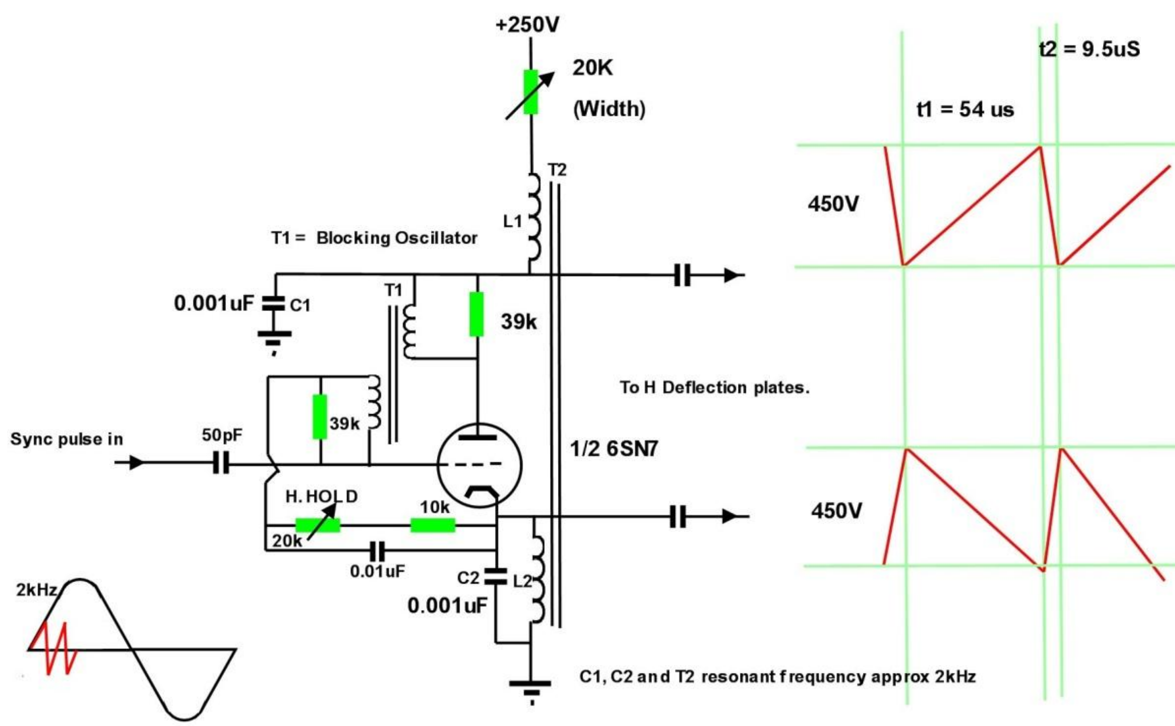
However, perhaps the lack of information did me good. I had to carefully study the design of the frame and line deflection systems to be able to work out how to re-create the missing transformers and make it work again.

It was there that I made a discovery of an ingenious circuit. The line deflection stage or horizontal deflection stage was able to generate 450Vpp, two anti-phase linear sawtooth waves, running from a mere 250V DC supply. But how can a circuit generate this voltage, especially two linear waves of such a high voltage, running from a 250V single DC supply ?

Looking at the circuit documented on the faded schematic (or in the Rider manual) it was drawn in a way that almost concealed how it worked. After re-drawing it I realised what had been done. The designer had nested a blocking oscillator inside a low frequency (2 to 3 kHz) resonant circuit. Due to the high Q nature of the resonant circuit, when it “rings” there is voltage magnification above the applied voltage.

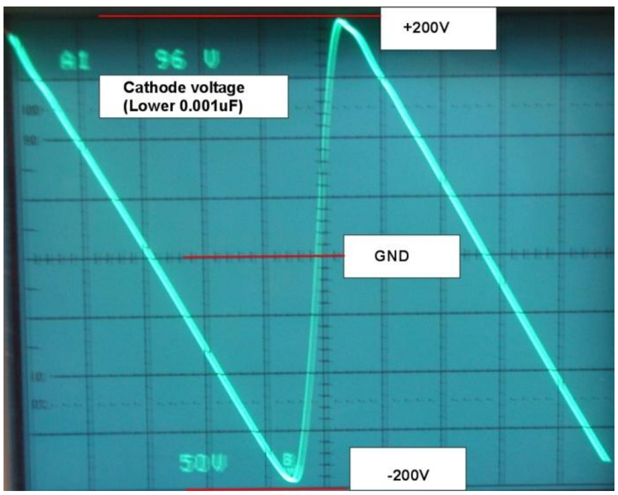
Also the clever part is that since the first 20 to 30 degrees of a sine wave is fairly linear, the blocking oscillator simply chops out about +/- 30 degrees of the oscillation cycle which produces a near perfect linear wave. The circuit, re-drawn, is shown below. And depending on the width adjustment can typically produce 350 to 450V pp saw tooth waves. In use, in the set, they are about 400Vpp but adjusting the control can easily get to 480Vpp:

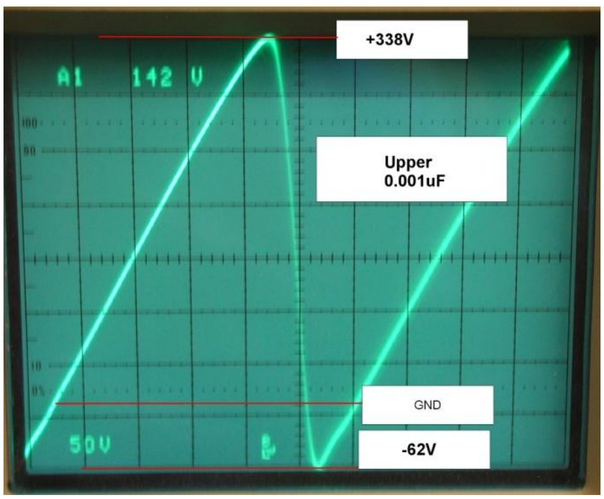
Horizontal osc & output stage Admiral 19A11S TV, 1949.



The circuit is very efficient and calculations show that the 6SN7 is run well inside the maximum plate dissipation. The peak to peak cathode voltage is just on the edge of its maximum rating.

Most of the time, in the blocking oscillator circuit, the tube is not conducting, only at flyback. When the tube conducts it charges C2 to about +200V by flyback's end, by then C1 is discharged to about -62V. The oscillograms below show the voltages on C2 and C1:



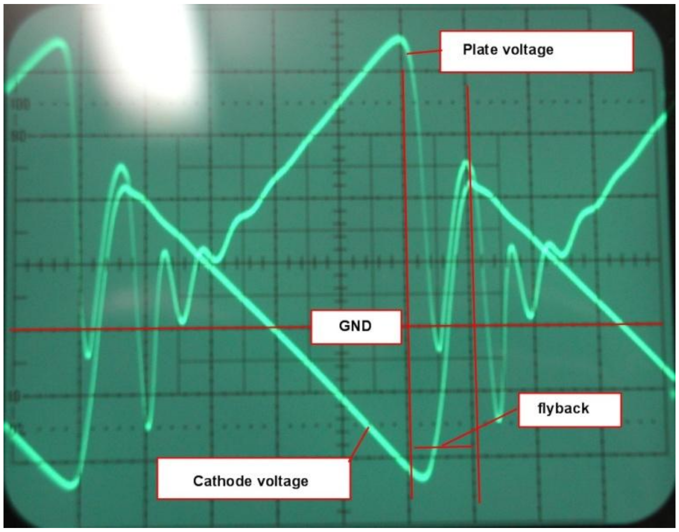


As expected, since there is no average DC of any significance on the transformer the cathode waveform (voltage across C2) straddles zero volts. On the other hand the DC axis of the signal, on C1 is shown on the right above.

Energy is imparted to the transformer's (T2's) magnetic field during the flyback period as well.

When the 6SN7 comes out of flyback (conduction) T2's field begins to collapse, tuned by both C1 and C2. Due to the circuit Q the voltage across C1 and C2 can rise well above the power supply voltage, which they would do, if the oscillations were not reset by the blocking oscillator conducting again about 25 or 30 degrees or so into the sine wave cycle.

Even though the voltage on C1 falls to -62V, and the cathode voltage on the tube climbs toward +200V at the end of flyback, the tube's anode voltage stays up higher than the cathode during conduction (flyback) because of the voltage on the primary of the blocking oscillator transformer. The scope photo below show this feature:



As noted the plate voltage is always higher than the cathode voltage at any moment in time during flyback. After flyback the tube is cut off but as also can be seen the plate voltage falls below the cathode voltage and the oscillations on the plate from the blocking oscillator transformer do not affect the scan as the tube cannot conduct with its plate voltage below the cathode voltage. Also, because its a blocking oscillator, the grid to cathode voltage is also negative during the active scan time and the tube is not conducting. This is quite unlike magnetic deflection where the output stage tube is conducting during scan time and cut off during flyback. This is possible because the required scan power for electrostatic deflection is very small, only a few milli-Watts. The "load" for electrostatic deflection is merely the deflection plate tie resistors which are in the order of 2 to 5 Meg Ohms.

Since I had no data on the missing transformers I had to guess at the parameters. I wound T2 as two independent windings on a small ferrite core (scavenged from a small transistor TV line output transformer). The inductance turned out to be 4H per winding but at the time I was targeting it to resonate at about 2kHz. Later I measured a transformer from a VT71 set and it was 1.62H per winding. So the resonant frequency of T2 in the original system (tuned by two 0.001uF capacitors) was intended to be about 2797 Hz. Mine resonated at 1780 Hz and it worked fine.

Who was responsible for this circuit ?

Recently browsing the Textbook Time Bases, by O.S Puckle , Chapman Hall 1951 (the first edition was 1943) I came across the circuit by Faudell & White. Clearly this is the same circuit although unlike the Admiral circuit the low frequency resonant circuit is split in two. However the function is the same:

Faudell and White's Time Base

Faudell and White* have developed a time base which gives a push-pull output. It consists of a transformer-coupled blocking oscillator time base in which a large inductance is connected in series with the H.T. supply to the time base. A condenser is connected between the valve side of the inductance and the negative supply rail as shown in Fig. 66.

The inductances L_1 and L_2 are of the same value while the capacitances C_2 and C_3 are of such values that the potentials appearing across them are of equal value and opposite phase. The inductance should have as high a value of Q as is possible in order that the wave-forms appearing at the output terminals may have the highest possible potential. This potential may be many times the value of the H.T. potential and the ratio

$$\frac{\text{rail potential}}{\text{maximum available potential across } L_2}$$

*C. L. Faudell and E. L. C. White: British Patents 479275 and 491934; C. L. Faudell: British Patent 478511. See also W. S. Percival: British Patent 505252.

is proportional to

$$\frac{\text{maximum current in } C_3}{\text{maximum current in } L_2}$$

so that it is advisable to employ for V_1 a valve which is capable of passing a large amount of current and to ensure that the Q values of L_2 and of the transformer are made as high as possible. In these circumstances, the potential available for charging C_3 may be, say, ten times the rail potential and yet the condenser may be allowed to charge only to, say, 75 per cent of the rail potential. Thus, if the rail potential is

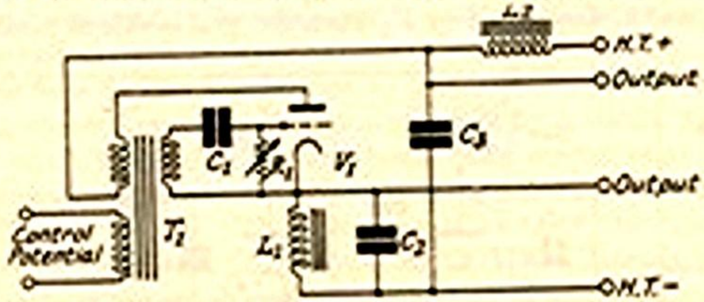


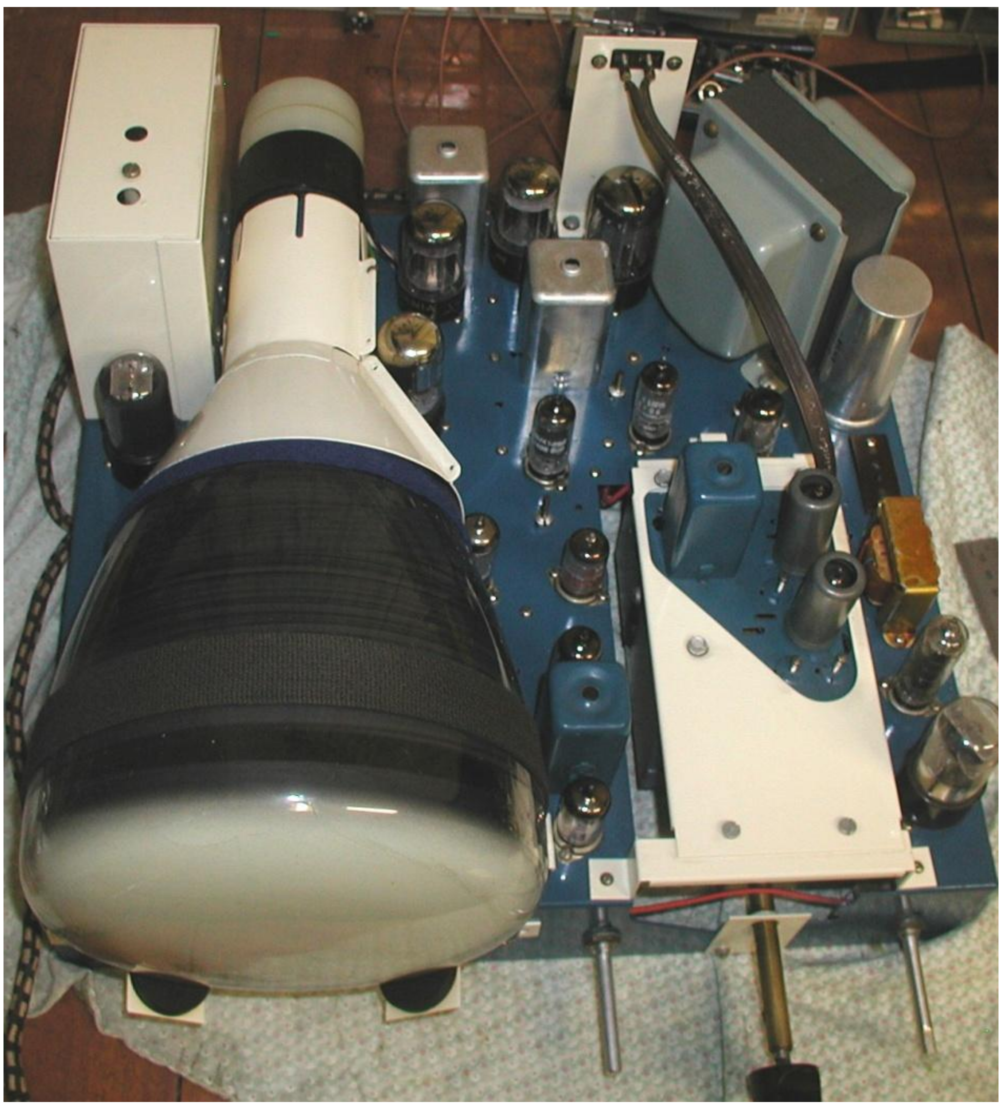
FIG. 66. Faudell and White's time base

200 volts, the available potential for charging C_3 may be 2,000 volts and C_3 may be charged to 150 volts or 7·5 per cent of the total potential whereas, had the normal type of arrangement been employed, the percentage would be 150 in 200 volts or 75 per cent. This is a high-efficiency time base. Faudell and White* also have described a method of reducing the duration of the fly-back in a blocking oscillator.

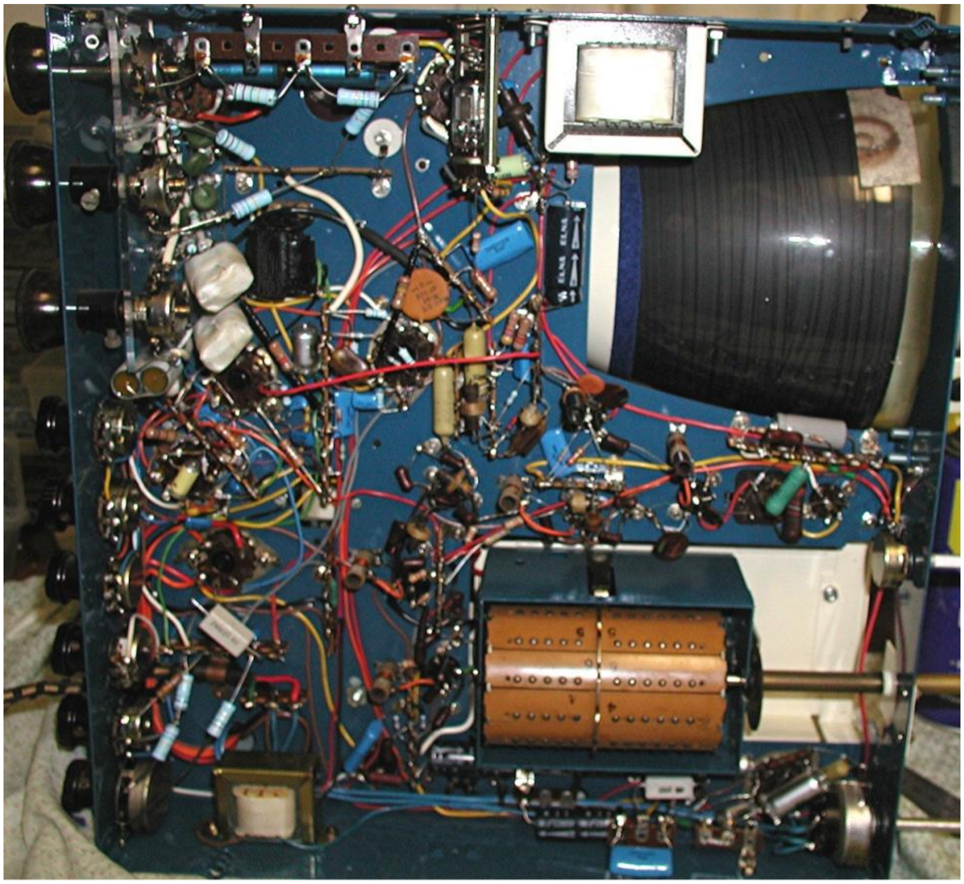
Restoring the rusty chassis:

At the time in the early 80’s there was no electroplater in my locality I could trust it with. So the next best move was to have it painted after I had removed the rust. Later my preferred method for chassis restoration was to fine glass bead off the rust and have it plated with electro-less nickel. I have completed a number of TV sets with this method, Andrea KTE-5, RCA621TS, HMV904 which can be seen on this website.

Looking retrospectively I chose an interesting colour scheme of blue and white, the chassis photos are shown below. The paint is two pack epoxy that was oven baked so its extremely tough:



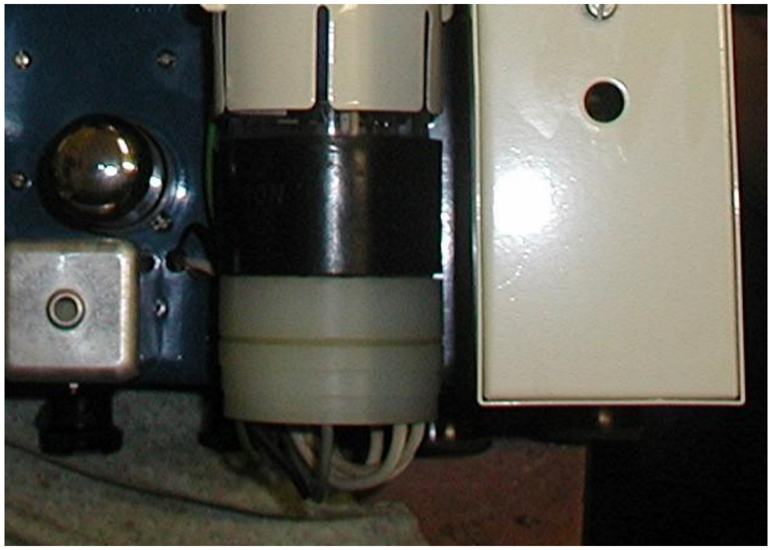
1980's Vintage Chassis Restoration.



The two aluminium rectangular cans on the chassis top contain T1 and T2. Notice how on the centre top of the under chassis, to the left of a smoothing choke nearby, there is a tube added (a 6AL5 acting as a DC restorer) mounted in a socket on two metal posts and held in place by a coil spring so it can't fall out (see below).

The Turret tuner assembly in these sets is quite sophisticated for 1949, although the 1946 RCA 621TS set had a very sophisticated turret tuner using three 6J6 tubes.

In addition I needed a new CRT socket as the one in the set was crumbling away. These are currently available on Ebay, but back in NZ in the early 1980's no such part was available. So as shown in the photo below I machined one out of Nylon. The pin retainer in it is a round section of fibreglass PCB material with the copper removed and countersunk holes with sharp edges so that when the socket is assembled it rotates into place and locks all of the pins into position :



One failing of the design of this set is that the video output stage is AC coupled to the CRT. This loses the video signal's DC component. And the effect that this causes on changing picture scenes is well known to every television engineer. To remedy this I came up with two methods:

1) Modify the circuit for direct coupling from the detector-video output stage to the CRT.

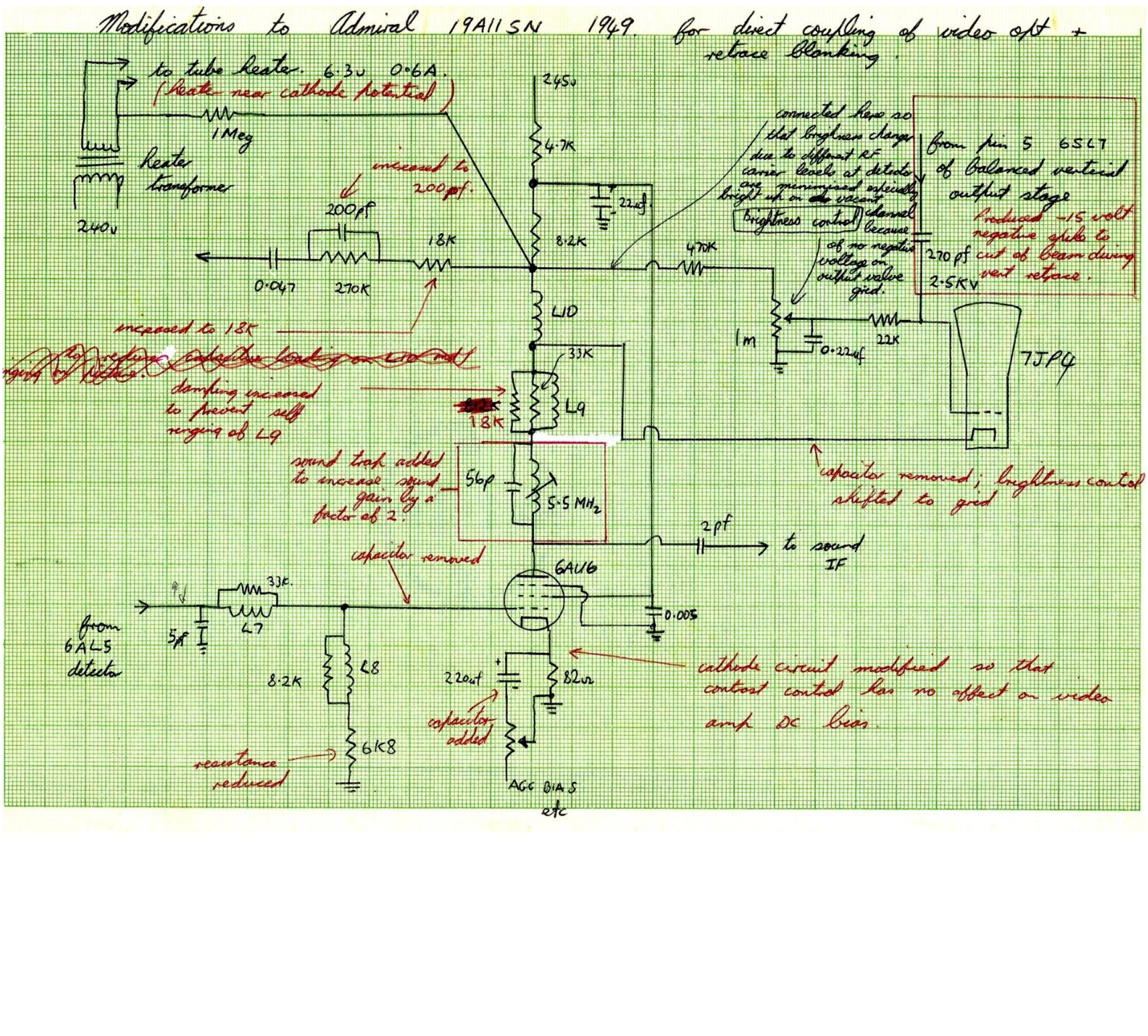
2) OR add a DC restorer.

3) In addition I added vertical retrace blanking.

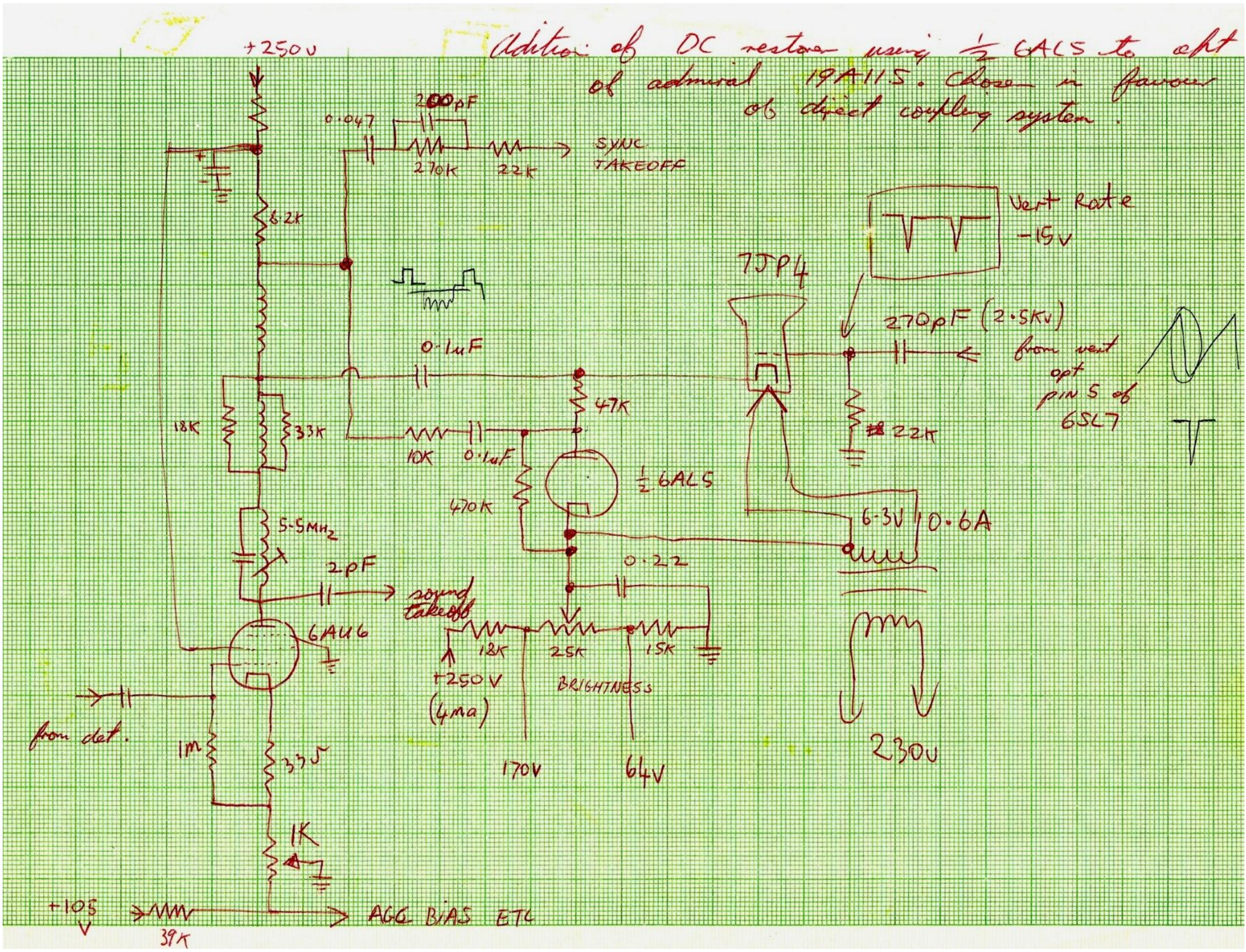
4) An additional 5.5MHz sound trap (suited to NZ TV reception) was added to improve the sound take off gain from the video output stage.

The circuits below from my original notes from the early 1980's. After trying the two methods I elected to use the one with the added 6AL5 DC restorer. With this circuit the raster is black or near blacked out with no received signal.

Direct coupled method from detector to CRT :



I settled on the DC Restorer method for the final result. This method of wiring in the DC restorer uses typical techniques developed by RCA to minimize loss of high frequencies in the video output:



It was interesting to look at these notes I made with the neat hand writing I had back in the early 1980's. Shortly after this I finished my career in TV and VCR servicing and went to Medical School. After that I became an Ophthalmologist specialising in cataract surgery which is my current line of work.