THE ADMIRAL 19A11S TV SET. IMPROVING THE VIDEO AMPLIFIER & VIDEO IF ALIGNMENT ISSUES. **H. Holden, June 2024.**

Introduction:

The 19A11 is a very interesting TV set. It is one of the better made post WW2 sets supporting the 7JP4 picture tube. One reason for this is that it has a power transformer. This makes it a much safer proposition than a transformer-less set. Also it had a very attractive Phenolic-Bakelite cabinet and came in Black and Brown models. Possibly, there may have been other colors.

It also sported a fairly advanced Tuner unit, the model 94C8-1. These used a 6AG5 pentode as the RF amplifier and a 6J6 dual triode as the mixer oscillator. Other Tuner types of the time used a 6J6 as the RF amplifier.

One other thing, the 19A11 possessed a very interesting and creative Horizontal scanning system. It derived two anti-phase sawtooth voltages for the Horizontal Deflection plates of the CRT, each of 450Vpp. All with only one active triode, behaving as both the horizontal oscillator and output tube, and being powered only by a 250V B+ supply. This is the subject of another article.

VIDEO AMPLIFIER PROBLEMS:

It had been reported on the Antique Radio Forum that the video amplifier in the 19A11 appeared to have sub-standard performance, with streaking and overshoot on some edges in the image suggestive of a low frequency response issue.

It had been nearly 40 years since I restored my 19A11 set, so I got it out of storage to evaluate and test it.

One point to note is; that there is the video amplifier itself, with its characteristic frequency response issues, but there is also the entire Tuner, Video IF Amplifier and Video Detector, all with their ability to reproduce the Off Air (Channel) signals, with some level of fidelity.

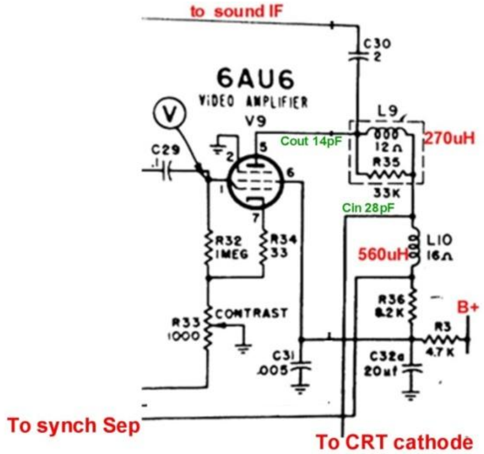
I decided the best move was to look at the video amplifier first, on its own. By driving it with a standard signal from a TV Pattern Generator, to see what the performance was like and if there were any issues to address. It turned out that there were a few issues.

The video amplifier is based on a 6AU6 Pentode, designated V9 on the schematic. Perhaps not an ideal choice, but it should be up to the basic task.

Feeding a 2v pp Test video signal directly into the g1 grid via a coupling capacitor, the 6AU6 anode waveform and drive to the CRT could then be inspected on the scope. The CRT in my set at least, is comfortable with 30 to 35v pp at the Cathode for a reasonable contrast image. The video output stage can deliver 50v pp without difficulty at maximum contrast settings with 2v pp at the grid of the 6AU6.

My set had already been modified, in that the video output amplifier area has a DC restorer and to add a 5.5MHz trap (the purpose is exlained later). These modifications were removed, which confirmed that they were having no effect on the video amplifier's high frequency response and it appeared to be the way Admiral had designed it.

The peaking inductances below are what were found in my set *on measurement*. Also the capcitance values were measured on the capacitance meter after the inductors were disconnected:



Looking in Rider's manual, L9 was listed as 520 millihenrys (must be a typo as it is in the uH range) and L10 not secified for a value just: "Coil Peaking Green Dot". My original shunt coil L10 does indeed have a green dot and reads close to 16 Ohms on the meter matching the schematic.

L9 also read close to 12 Ohms on the meter (agreed with schematic), and was wound on top of a 33k carbon resistor and had a Grey dot too. But it certainly was not 520uH as suggested in Riders (though they said 520 "millihenry"), it measured 270uH on my indctance meter.

There is another inductor in the set that is also wound on a 33k resistor, so could they have been mixed up ? Testing shows the other inductor in the L7 video detector is correct at around 140uH.

In addition, the Motorola VT-71 set uses 500uH and 360uH inductors as peaking chokes in this postion, for a 6AU6 with a 6.8k plate load.Therefore I concluded from the above data that the shunt and series peaking coils in my set were original as Admiral had put them in there and the colored dots and DC resistances matched up.

Series & Shunt Peaking:

There are two ways in which combined shunt and series peaking coils can be arranged together, depending on the input and output capacitances of the network, from Grob, Basic Television, 2nd Edn:

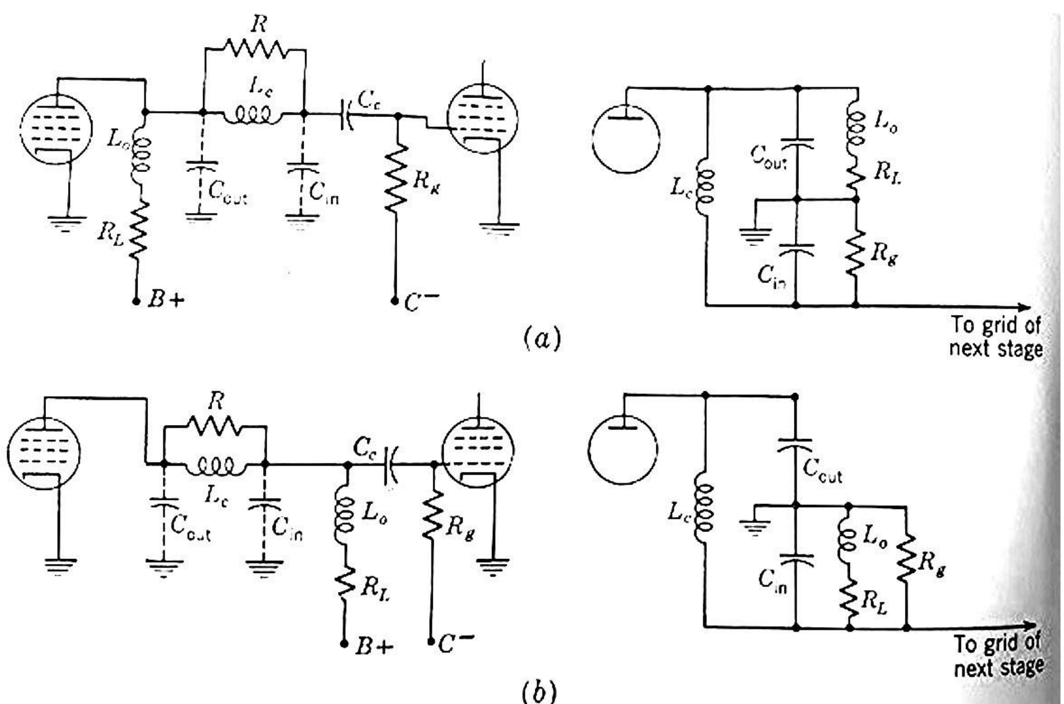


FIG. 12-9. Combination peaking, combining the shunt and series peaking methods. (a) Circuit and equivalent plate load for $C_{in} = 2C_{out}$. (b) Circuit and equivalent plate load for $C_{in} = \frac{1}{2}C_{out}$

Admiral had chosen the basic arrangement shown in (b) when generally, it is chosen when Cin = ½ Cout. Implying that the CRT's wiring and cathode capacitance is lower than the plate capcitance and wiring of the 6AU6.

But this is not the case as shown in the diagram, where measurement shows that the capacitance of Cout in the case of the Admiral V9 plate circuit is close to 14pF and the Value of Cin, in this case, at the CRT cathode is around 28pF.

Another interesting point, in the shunt - series peaking circuits described by Grob, in general, the series peaking inductor Lc is substantially larger in uH value than the shunt inductor Lo.

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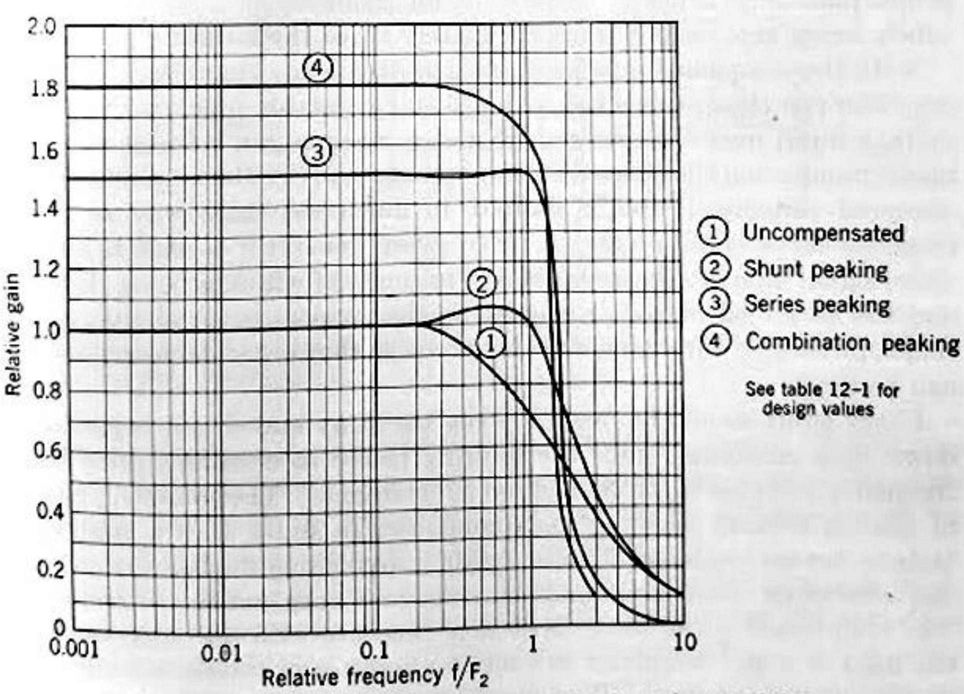
3,960 ohms, L_c 145 μh, L_o 35 μh, approximately, and the gain of the stage 23.8, if combination peaking were used.

TABLE 12-1. COMPARISON OF HIGH-FREQUENCY COMPENSATION METHODS

Type	R_L	L_o	L_c	Relative gain at F_2
Uncompensated	$1/2\pi F_2 C_t$	....	....	0.707
Shunt	$1/2\pi F_2 C_t$	$0.5 C_t R_L^2$	....	1.0
Series ($C_{in}/C_{out} = 2$)	$1.5/2\pi F_2 C_t$	....	$0.67 C_t R_L^2$	1.5
Combination ($C_{in}/C_{out} = 2$)	$1.8/2\pi F_2 C_t$	$0.12 C_t R_L^2$	$0.52 C_t R_L^2$	1.8

12-8. Summary of High-frequency Compensation. The essential design data for the shunt, series, and combination peaking methods are



However, one other thing to note above, the equations in Grob apply when the Cin:Cout ratio is 1:2 or 2:1 and this gives rise to a specific set of inductor values for the series and shunt coils….But only when the load resistor RL has a specific value which depends on the total capcitance Ct and the cut off frequency (F2) or the -3dB down point. *There is no escaping the overall high frequency roll off from the load resistor RL and the accociated total capcitance Ct in the uncompensated case.*

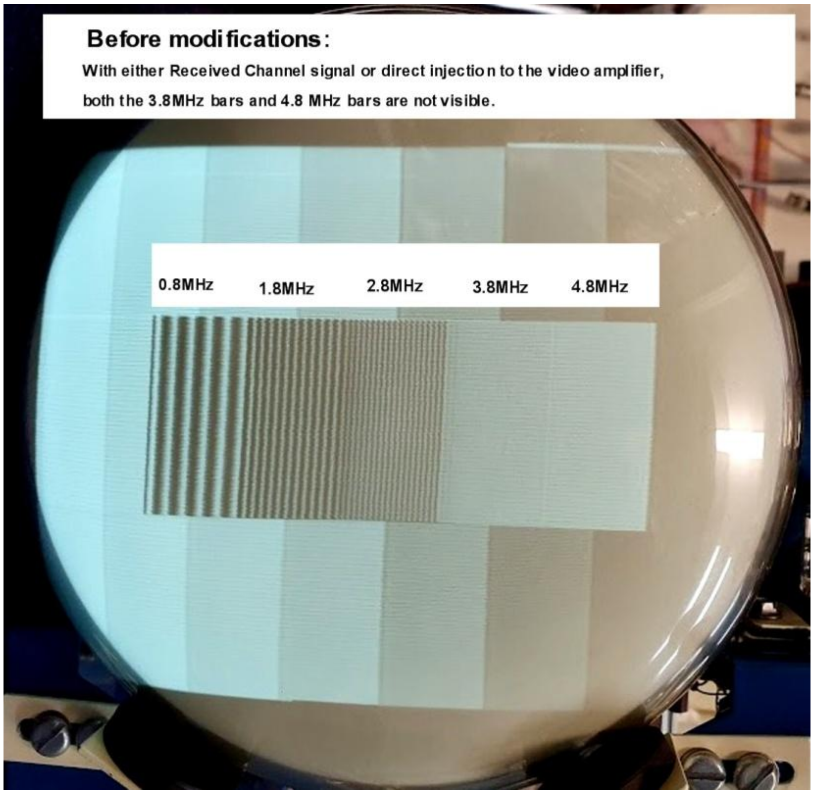
A few calculations indicated that if the cutoff frequency was chosen to be a modest value of 3.5MHz, because the Ct is in the order of 42pF, it would require that the load resistor RL be 2k Ohms. But it is not in the Admiral set it is 8.2k. If it much lower than 6.8k the video gain and contrast would be far too low. They were short on gain in this set . In my Admiral set I lowered the value of RL from 8.2k to 6.8k which helps a little, but doesn't lose too much gain. But this on its own doesn't solve the basic problem.

Unfortunately Grob did not examinine how to frequency compensate a video amplifier when the values of RL and Ct were so high that the frequency response (the -3dB F2 point) rolled off below 1MHz. Fortunately this problem had been solved elsewhere.

Of note, typical shunt and series peaking inductances in CRT cathode drive circuits tend to have a ratio of about 3 to 5 : 1, and the shunt inductor is typically *lower* in the order of 56uH and the series one *higher* in the order 180uH. And the shunt coil is often on the video output or anode side of the series coil, which it should be when Cin = 2Cout. But, this arrangement was not the case in the Admiral circuit where the series coil measured 270uH and the shunt coil around 560uH. However, even if it was more normal in both the ratio's of inductances and the absolute values of the peaking coils, this on its own, would not have solved the major problem that exists with the frequency respose of Admiral's 6AU6 video output stage.

The question then remained: How good is the existing Admiral 6AU6 video output amplifier and can it be improved?

The first thing was to inspect the picture. Looking at the face of the CRT, the following image was observed. In addition, either with direct injection of the video signal to V9's g1 grid (6AU6), or feeding a TV channel signal through from the Tuner, video IF and detector: the 3.8 and 4.8 MHz bars from a Philips PM5519 TV pattern generator were not visible.



Examination of the video output stage:

One method to examine the drive voltage to the CRT's cathode is with a low capacitance probe such as the Tek P6137. These have an input capacitance of around 10.8pF. This has only a small effect to degrade the high frequency response when the probe is connected and causes only just a small noticeable in the image.

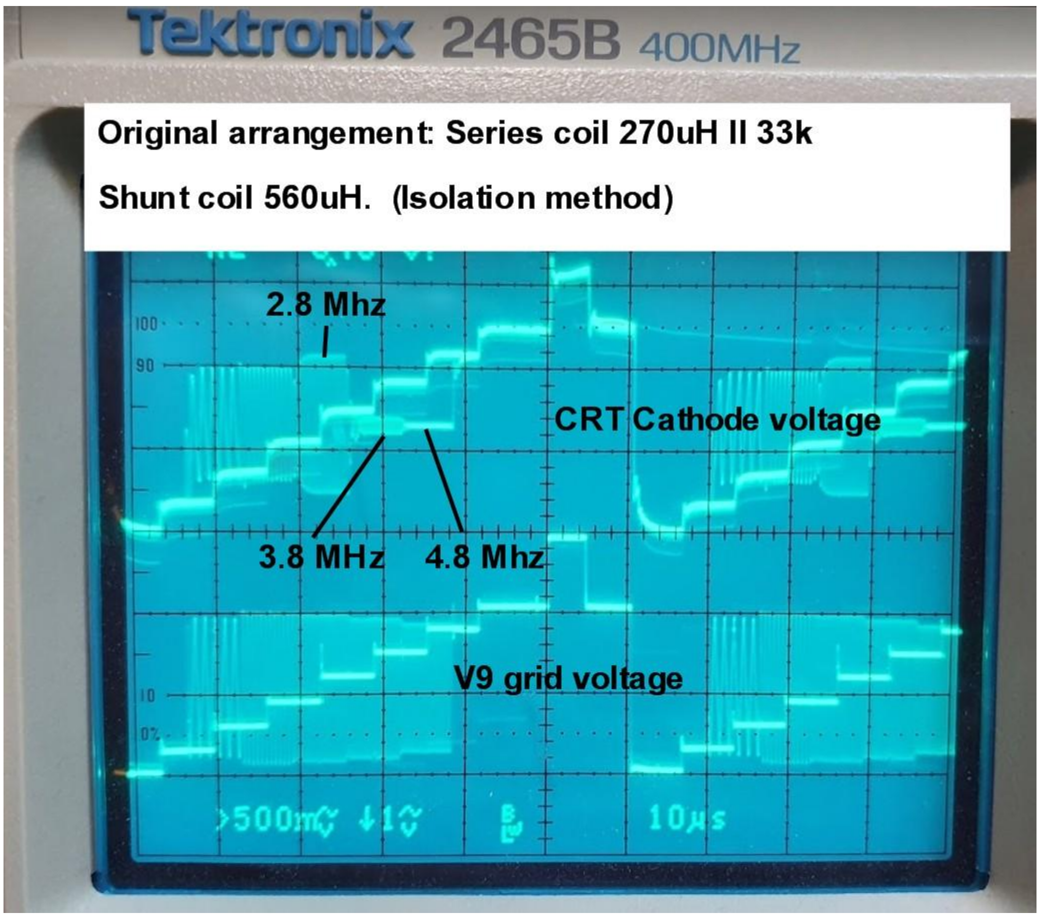
One way to avoid this additional capacitive loading of the scope probe, while examining the high frequency parts of the signal, is to couple the probe tip in with a low pF value capacitor. This forms a voltage divider with the probe's input capacitance. While this corrupts low frequency AC and DC measurements and also corrupts any calibrated amplitude measurements, it does allow visualisation of the higher frequency components of the signal for relative level comparisons, with less of a loading effect by the probe itself. (This is referred to here as the isolation method).

Examining the the cathode voltage waveform of the CRT directly, or with the isolation method, it was clear why the 3.8MHz and 4.8MHz bars were not visible. In this recording below, the Grid voltage of the 6AU6 V9, applied by the generator, has been inverted on the scope display and the CRT's cathode voltage has been gain scaled to match, so the two waveforms can be compared:

Of note in Admiral's original circuit, with the peaking coil values in my set at least, the video amplifier frequency response cuts off very sharply above 2.8MHz, and there is negligible signal at 3.8 MHz and 4.8 MHz, explaining why these bars are not seen on the CRT's face.

Also there is a peak in the response around, or nearby, 2.8MHz.

But also the relative amplitudes of the 0.8MHz and 1.8MHz bursts are only about 75% of what they should be:



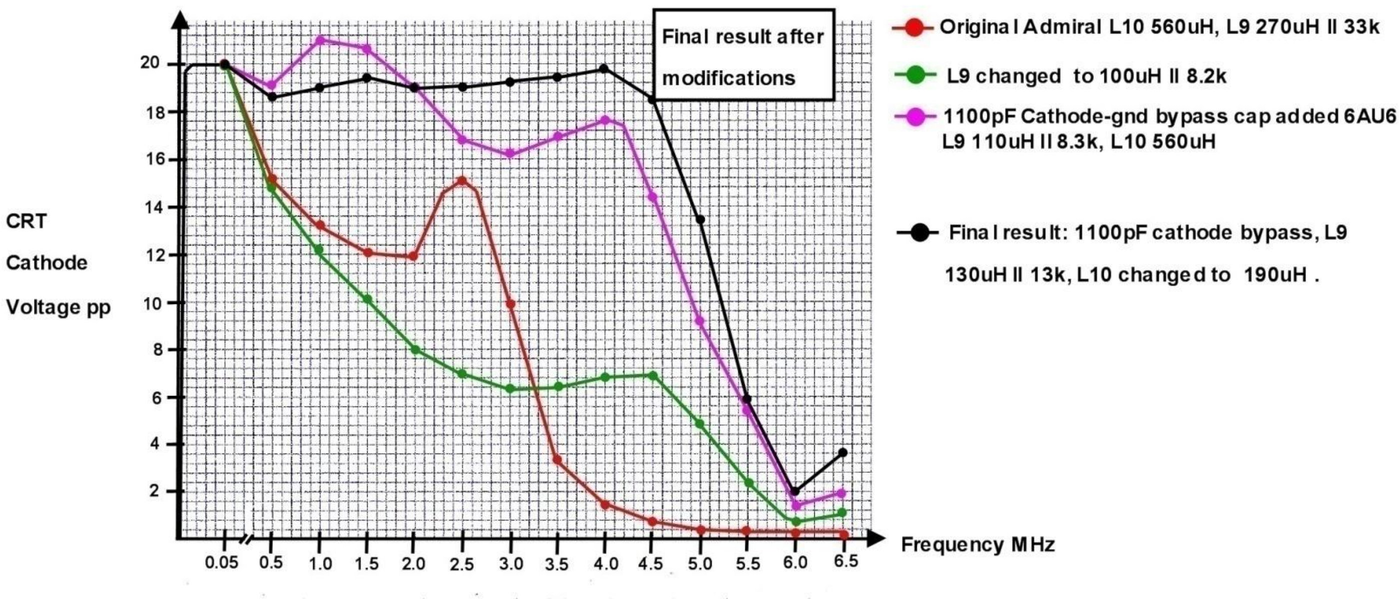
To examine this further, a levelled sine wave generator (Tek SG503) was used to inject an amplitude levelled sine wave into the g1 grid of the 6AU6.

The result is the Red plot on the graph below and it explains the multi-burst recording above and the absence of any bars seen at 3.8 and 4.8 MHz:

Admiral 19A11 6AU6 **video output stage frequency response testing. (H.Holden 2014)**

Data acquired with Tek SG503 leveled sine wave generator , coupled to 6AU6 grid with 2uF coupling capacitor, and Tek 2465B scope with P6137 pobe (10.8pF input capacitance) applied to CRT cathode, & using amplitude cursors for measurements.

(final data acquired with coupling reduced to 2.5pF to avoid de- tuning)



Grid drive voltage 2vpp, contrast control set for 20vpp at CRT cathode, at signal frequency 50kHz

Below 50kHz and down to a low frequency of a few Hz (tested with a function generator) the response was flat at 20v pp down to a very low frequency. The lower end -3dB frequency roll off point at the LF end is determined by the 0.1uF coupling capacitor to the CRT's cathode circuit and is a few Hz. The video amplifier performance was far from ideal as the Red graph indicates.

The level had dropped to around 50% by 3MHz, it was essentially flat only below 50kHz.

And perhaps -3dB down point at around 0.75MHz on the red graph, but this made sense; given the 6.8k anode resistor and the total loading of 42pF in the anode circuit, that is not surprising as the -3dB roll of for that alone (ignoring peaking chokes) is 0.56 MHz.

Apart from the progressive roll off above 50 kHz caused by the 6.8K load resistor and 42pF capacitive loading being easily explained, I determined that L9 was responsible for the peak around 2.5 MHz mark.

As an initial experiment I changed L9 to a 100uH with a parallel 8.2k. The response then was shown in the Green graph. This was better and the high frequency peak up-shifted somewhat broadening the bandwidth. However the video amplifier was still left with a gain reduced high frequency response, or an excessive low frequency response, relatively. The latter is known to cause a broad smearing effect and the former a soft image.

How to make the response flatter out to a higher frequency?

One clue to fixing this problem is that in the same way the effects of high frequency roll off, in an anode (or collector) circuit, is caused by the anode load resistance and capacitive loading there, it is possible to counteract that effect in the tube's cathode circuit (or transistor's emitter circuit), with a similar RC arrangement that boosts the gain as the frequency increases.

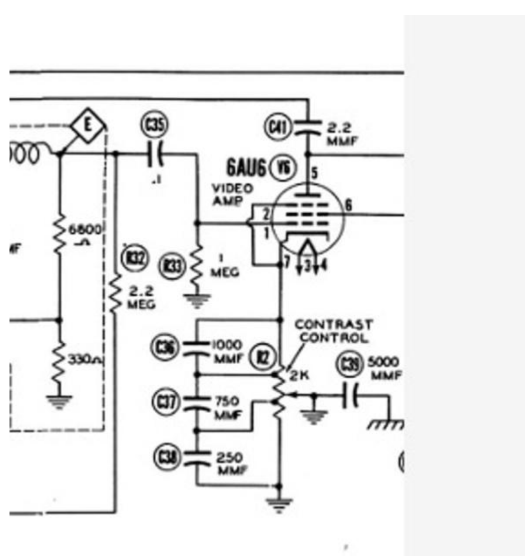
This is not a new idea, many TV designers did this with video output stages. It is also done in oscilloscope vertical amplifiers, but often with reactive elements between the cathodes or emitters of Paraphase amplifiers, but the principle of it remains the same.

A good example would be in the English Bush model TV-22 where a 0.002uF capacitor was used to bypass a 270 Ohm cathode resistor in a video output stage with an 8.2k anode load, to boost the HF response of the video output stage and compensate for the roll off in the anode circuit because of the relatively large anode resistor, compared with the associated load capacitances there.

In the Motorola VT-73 chassis, the designers for this one had also decided there was a problem with the 6AU6 video output stage and created an elaborate cathode potentiometer with taps and high frequency bypass capacitors so that the HF boost would remain stable with different contrast settings. However the VT-71 did not have this. I think with the VT-73 model they had concluded, just as I have, that despite the small CRT size, there was an improvement to be had in picture detail and video amplifier performance.

MOTOROLA VT-73

Video Output Stage.



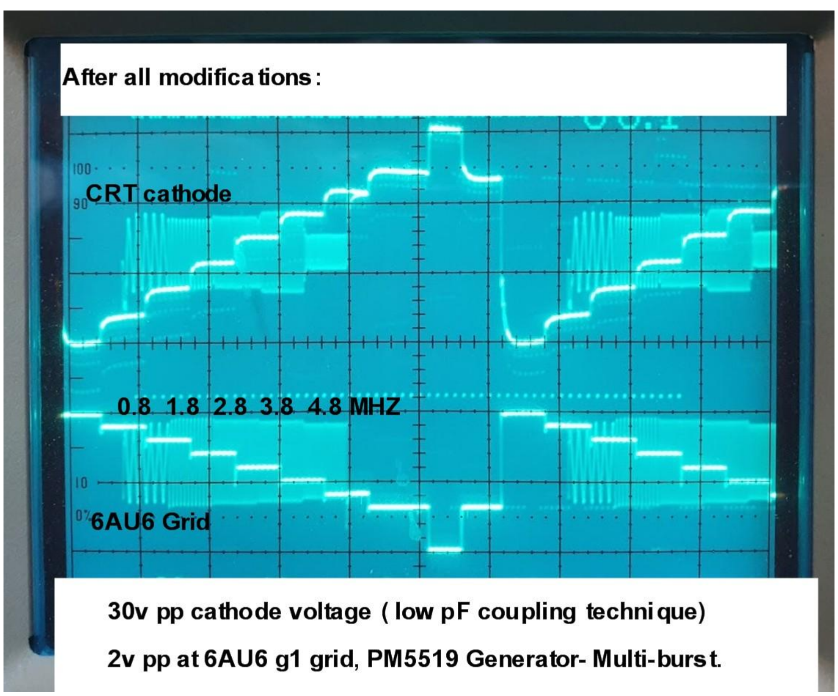
The result of adding a capacitor of a suitable value to the 19A11 set's 6AU6 cathode circuit is shown in the Pink graph above. This substantially improved the high frequency roll off issue. The response was still a little bumpy though.

Ultimately, after a lot of experimenting I settled on an L9 of 130uH shunted with a 13k resistor, an L10 of 190uH , as measured on my inductance meter (120uH and 180uH standard values would be fine) and the cathode bypass capacitor of 1100pF (or 1000pF would be ok). The final result is plotted on the graph in Black.

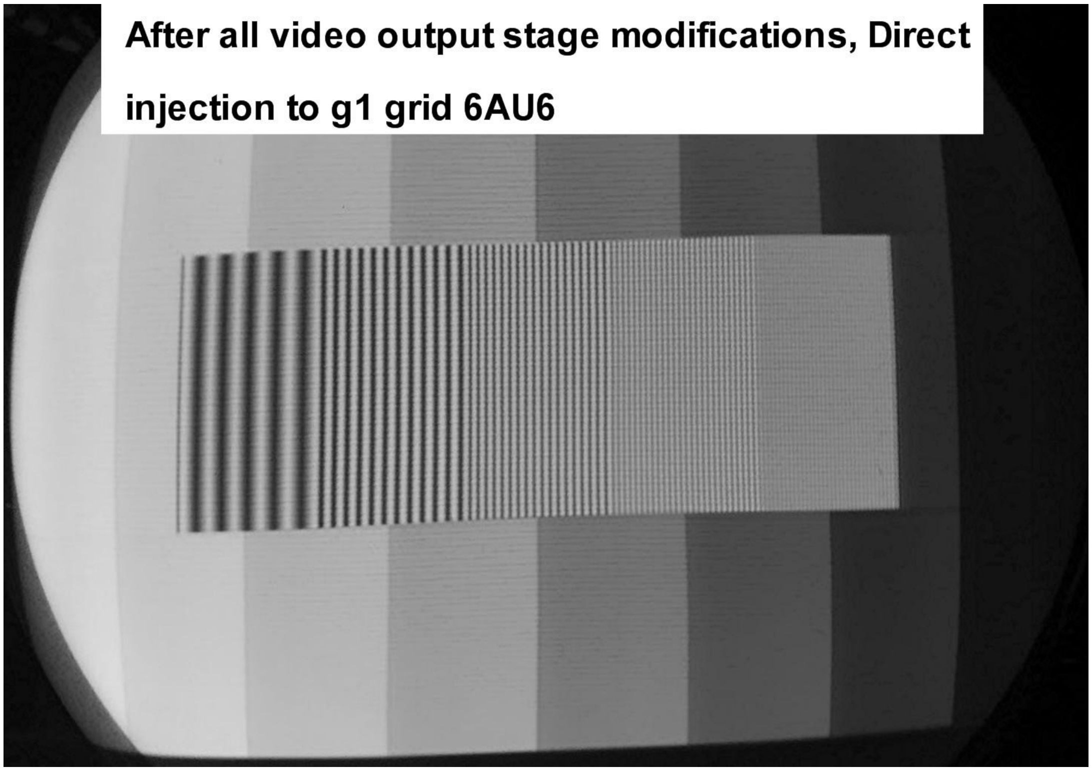
The fact that the set's contrast control is also applied to the 6AU6's cathode slightly complicates things, in that the HF boost becomes to an extent, affected by the contrast control position, in that at low contrast settings there is more relative HF boost. Motorola solved that issue with their special potentiometer and capacitor network arrangement.

When the contrast control is disconnected from the 6AU6 and its cathode resistor grounded instead for maximum gain, the range of the contrast control is too low, in that it cannot get the CRT drive voltage below 20v, for a 2V signal at the detector. However, if the contrast control pot section(1/2) feeding the 6AU6 has a 390 Ohm parallel resistor added, the range of voltage to the CRT's can be controlled from 11V to 50V peak to peak with the contrast control, with a 2Vpp signal at the detector. And this solves the frequency response variation issue with contrast control rotation and it does not present a significant problem.

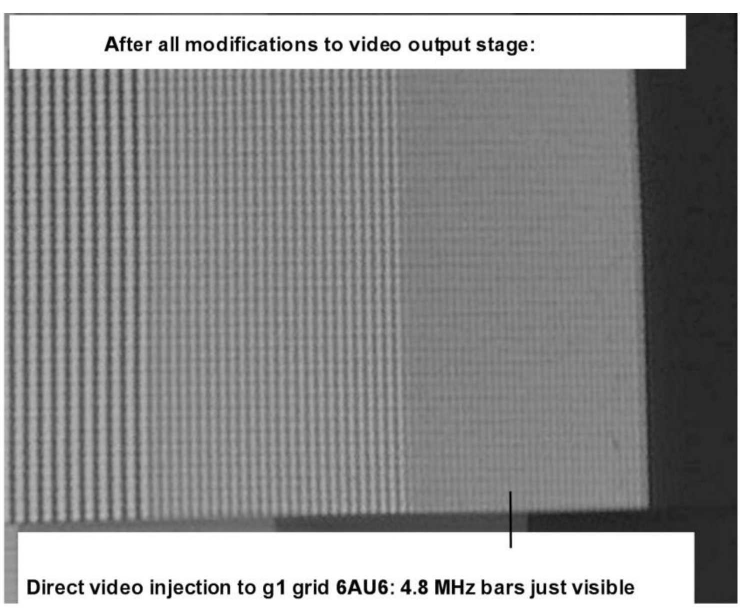
The result is shown below on the scope after the modifications:



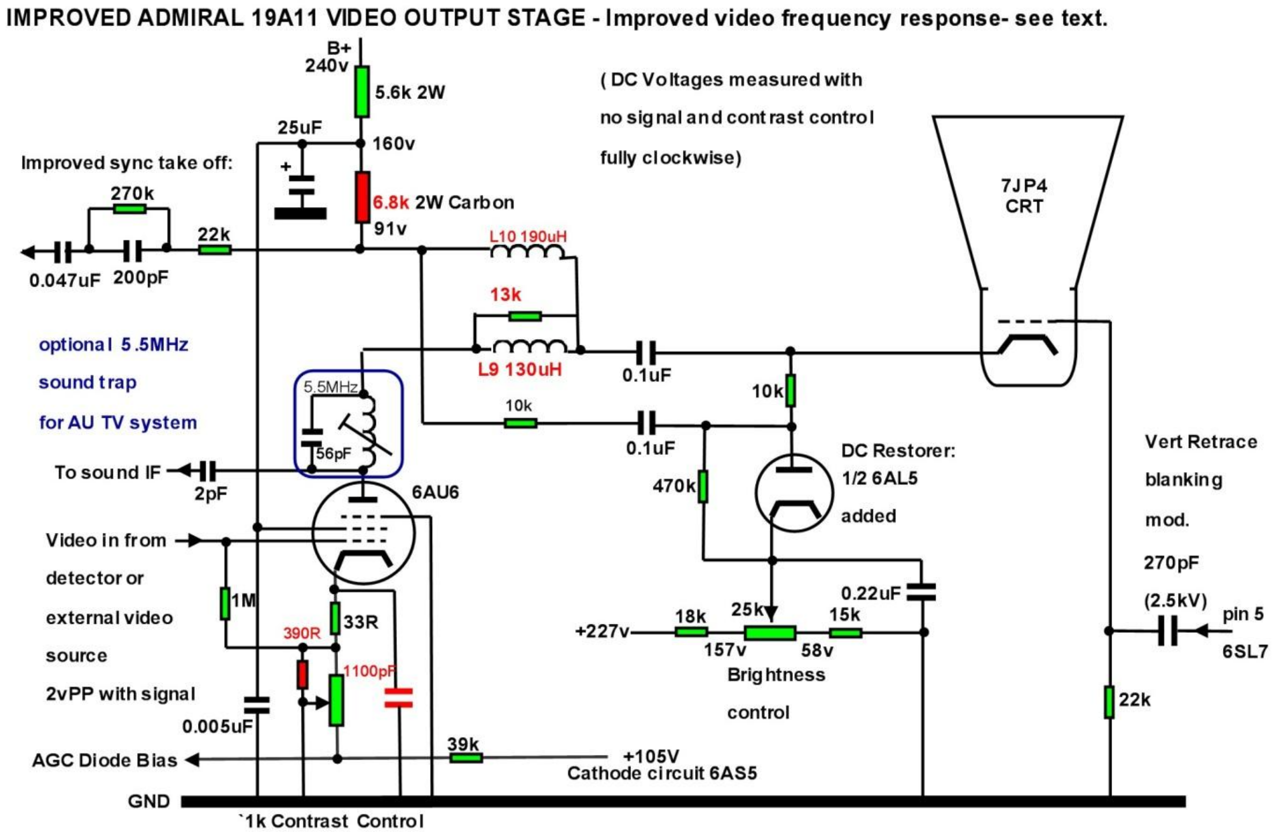
The 6AU6 video amplifier is now performing well, and here is the screen result:



A magnified image shows that the 4.8 MHz bars are just visible:



The video output stage in my set now conforms to the diagram below. Also it has a DC restorer and Vertical retrace blanking modifications:



In my set, the improvements in the video amplifier frequency response at 5.5 MHz, means I now do not have to incorporate the original 5.5 MHz trap I had previously inserted in the anode of the 6AU6 in the past to boost the sound level.

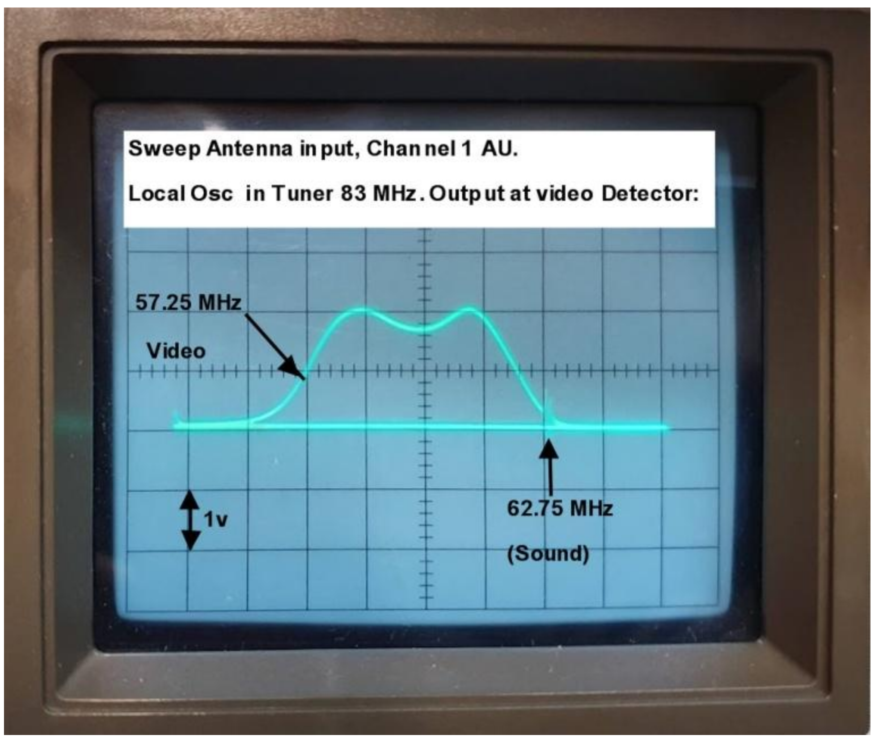
With this new modification and the trap and 2v pp at the video detector and 30v pp at the CRT anode, the audio level into the volume control is just over 3v pp. Before the modifications, it was in the order of 1.5v pp or a little less. The presence or absence of the 5.5 MHz narrow band trap doesn’t affect the overall response at the cathode of the CRT to any significance though. So in this case the trap can be removed or left alone.

Video IF alignment and modifications:

What about the picture quality as viewed by receiving an “Off Air” station?

Regardless of the performance of the video output amplifier, even if it is perfect, the screen picture will only be as good as the Tuner and alignment of the Video IF, and the video detector’s performance.

In my set, because the sound and vision channel frequency are 5.5 MHz apart, the video IF had to be aligned for a wider overall bandwidth than in the manual which specifies the shape for the 4.5MHz case. With increased bandwidth, all else equal, there is a reduction in gain. Some modifications were required to achieve the following alignment. This is a sweep at the antenna input as seen at the video detector after alignment:



My 19A11 had been set up to receive Australian VHF Channels 1 and 2. In the case of channel 1 for example, the vision carrier is 57.25 MHz and the sound carrier 62.75 MHz, a 5.5 MHz difference between vision and sound.

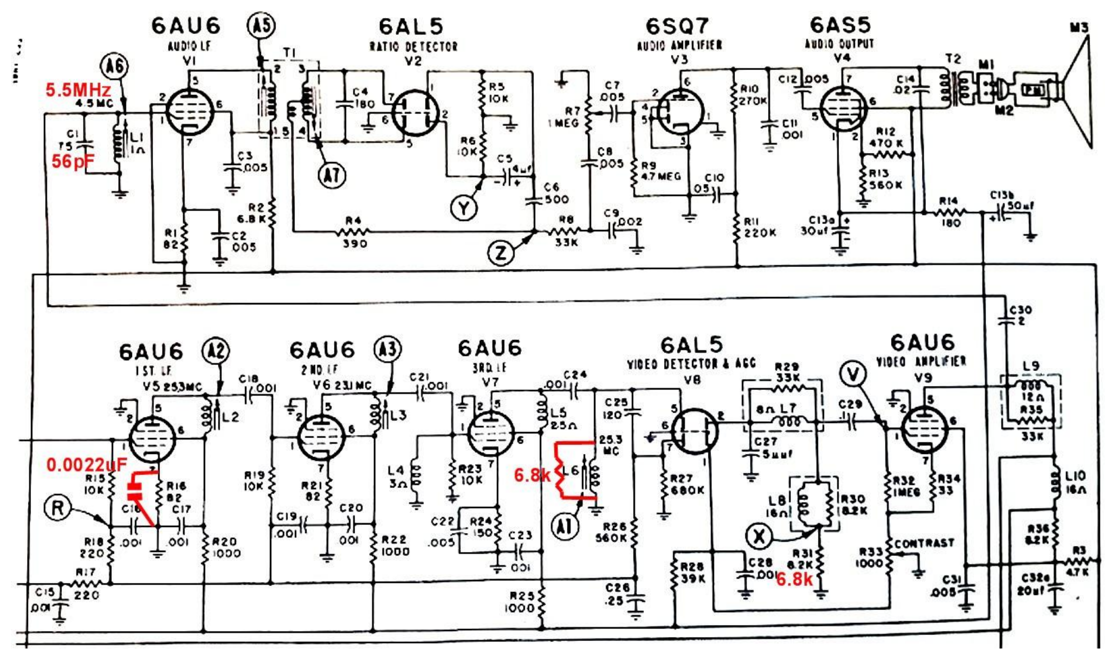
In the original Admiral set, Channel 2 (American) had a vision carrier of 55.25 MHz and a sound carrier of 59.75 MHz, a 4.5 MHz difference between vision and sound, and a local oscillator running at 81 MHz.

Therefore, for the set to work here (at least when analog TV was still transmitting) the video IF had to be aligned to increase its bandwidth and the sound IF and Ratio Detector centred on 5.5 MHz rather than 4.5 MHz.

The video IF Band-pass curve must have a relative amplitude of around 2 to 5% at the sound carrier frequency to recover enough sound carrier signal to heterodyne with the vision carrier to produce the inter-carrier sound signal for the sound IF stages. In the 19A11 they extracted the inter-carrier sound signal from the anode circuit of the 6AU6 video output tube V9 so as to add some gain, rather than extracting it from the detector feeding V9's grid.

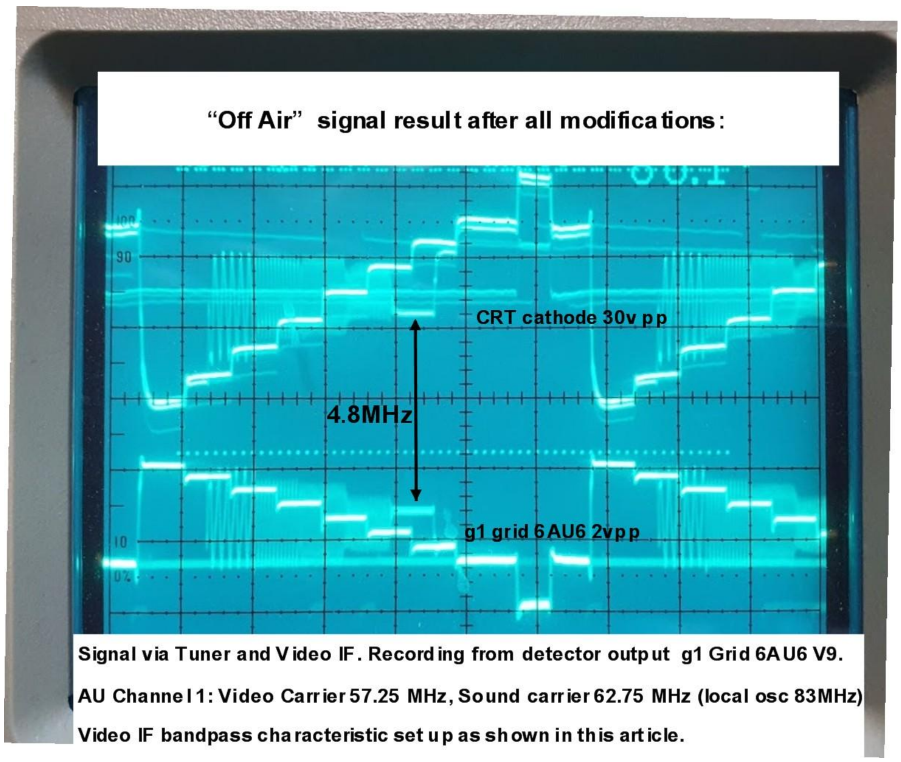
The oscillator in the tuner unit was easily altered on channel 2 from its standard 81MHz to 83MHz to receive AU Channel 1. Likewise the Channel 3 oscillator setting (slug) was easily adjusted to receive AU channel 2.

There is not an abundance of video gain in this set, due to the limited number of IF stages, so it required some small modifications to increase the gain and assist it. The circuit below indicated what needed to be changed to suit receiving signals in Australia. The video output stage mods are not shown on this sheet:



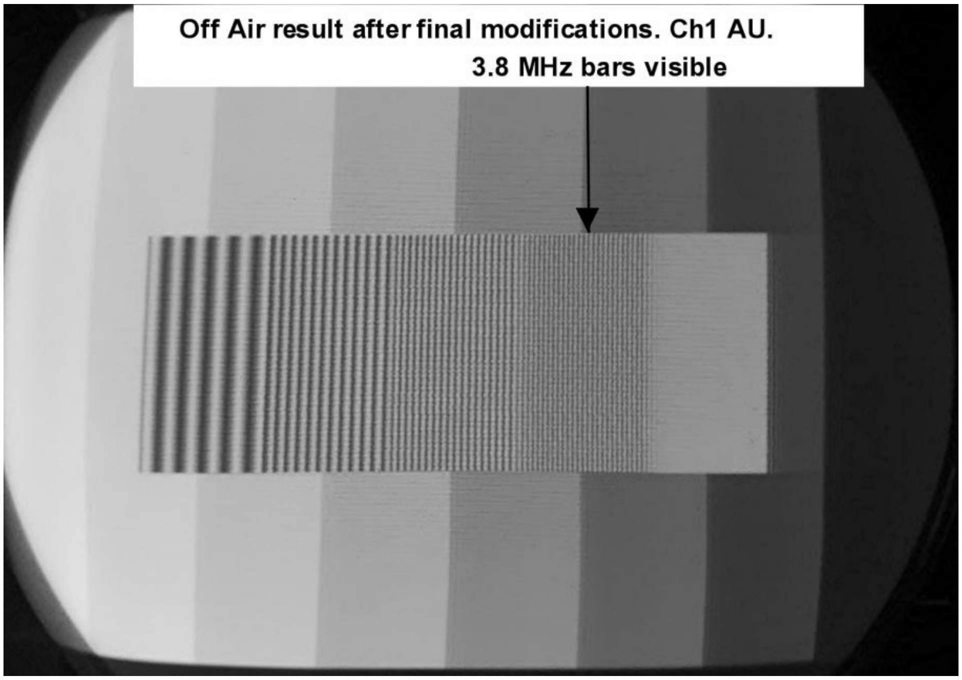
The added 0.0022uF mica capacitor in V5's cathode circuit was required t help boost the IF gain, to make up for a combination of the wider required bandwidth and the lowering of the resistor values in the detector and video output stage from 8.2k to 6.8k (in the interests of improved video frequency response) A 6.8k damping resistor was added across L6, required to help dampen a peak in the response and widen the IF bandwidth by 1 MHz, required because of the 5.5 MHz, rather than 4.5 MHz sound system.

Once this was done I was able to check the video signal resolved at the video detector output on a channel signal. Obviously not as perfect as that delivered by direct video injection to the grid of the 6AU6 but still good enough to resolve the 3.8 MHz bars



As can be seen from the above, the 4.8 MHz bars are not resolved due to the bandwidth of the video IF and video detector filtering. It might be possible to improve this by modifications to the inductors in the detector circuit, but since, even with a perfect composite signal presented to the grid of the 6AU6 by a signal generator with 4.8 MHz bars, these are not resolved well anyway. Therefore it would be unlikely that any practical benefit would come from modifying the detector.

The following result shows the Off Air screen image which is much better than the image was before modifying the video output stage:



In addition, now that the video amplifier has a fairly flat response across all video frequencies, it should be unlikely it could cause the streaking effect seen on some 19A11 sets, though the picture had not suffered to any great degree from this problem in my set, pre-modification, but clearly a flat video frequency response will help this issue.

Conclusion:

It appears that Admiral with their 19A11 set (or Motorola with their VT-71 model) decided there was not a lot of point in extending the bandwidth of the 6AU6 video amplifier much beyond 2.5MHz.

In addition they were not concerned by the preponderance of low frequency gain in the stage, relative to the high frequency end above 1 MHz or concerned about the bumpy band-pass response either. Though it appears Motorola had fixed these issues in the VT-73 model. I don't have a VT-73 set to test, but the design suggests the problems have been largely solved there.

With the overall band-pass response documented by Rider, for the American 4.5 MHz relationship between picture and sound, it is unlikely that the 3.8 MHz bars, on a signal originating from the video detector, with the standard IF setup receiving an American channel signal, would have a normal relative amplitude. Likely they would be attenuated.

The above raises the question:

Would it be worth modifying the video amplifier in American sets to improve the picture? The answer is yes for three reasons.

1) The modification eliminates the low frequency response issue relative to the high end, and this will reduce the chance of the broad smearing overshoot effect.

2) Motorola thought it was worth fixing this frequency response imbalance in their VT-73 set, even to the extent that they created a special contrast control potentiometer.

3) The modifications are highly beneficial for picture quality when composite video is injected directly into the set at the grid of the 6AU6. This is happening more and more now that analog channels are off air and better image quality is assured by direct signal injection. Plus, being an earthed chassis (at least when a 3 wire line cord is fitted to the 19A11) it is dead easy to inject video directly into the grid of the 6AU6, and in this set, the sync take-off is at the video amplifier output which is helpful.

Finally, the Admiral 19A11 set is capable of good image reproduction, when the Video output stage is working as well as it can do (with the modifications suggested here) and also when the Tuner and video IF system is in ideal alignment and the CRT has good focus. Adding the DC restorer and the vertical retrace blanking modifications are also helpful.

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