# COMPOSITE VIDEO AMPLIFIERS

Easy solutions that bypass RF and IF circuitry
during vintage-TV Tests and Demonstrations.

# For B&W Tube TV, a
# Transistor Amplifier
Designed by Wayne Abare

# For the CT-100, a
# Tube Amplifier
Adapted by Pete Deksnis

Wayne Abare, presenter
Pete Deksnis, power point guy

# In the Beginning…

When, in December 1953, the FCC approved folding color into the existing 1941 monochrome standard, broadcast stations scrambled to convert transmission systems to accommodate color.

To this end, manufacturers such as GE, Dumont, Dage, and RCA developed color monitors built around the first tricolor CRT available in reasonable quantity, the 15GP22.

Late in March 1954, RCA began the largest run of 15GP22-based color television sets ever produced. It was the Model CT-100, also known as the Merrill.

# ...in the beginning.

Few Merrills were sold to the public. Many languished in warehouses, others were assigned to RCA executives, stations, and NBC facilities. Jack Webb had one. Jack Benny reportedly had a blond Merrill. KING-TV in Seattle kept one in its transmitter building.

Only one is documented to have been sold to a consumer, although there were certainly others.

# Mutt Color-Monitor

With so many Merrills unsold and with many placed in the hands of both RCA executives and NBC television network stations, it was only natural that the CT-100, designed for consumers, would be pressed into service as an over-the-air monitor for color broadcasters.

# Why use a CT-100 to monitor composite video?

- Not only was the CT-100 readily available, it represented the culmination of a synergistic meld of business, science, engineering, manufacturing, and media. it was a magnificent example of state-of-the-art consumer electronics in 1954.

- No, it was not perfect. High voltage regulation was better in the 15-in. color Westinghouse H840CK15. Color sets took constant adjustment, although this was due in part to the broadcasters, who also were also in a learn-while-doing mode.

- However, color processing circuitry was second to none in the CT-100. True wideband color decoding gave, at least in theory, a sharper color rendition than the H840CK15’s equal-band decoding. And, while a CBS 15-in. color set used the same wideband decoding as the CT-100, too few were made to satisfy the market for color monitors.

# Mutt Color-Monitor

There would also be a need for an in-studio monitor that accepted composite video rather than a broadcast signal.

To that end, the CT-100 was often adapted to display composite video by modifying the CTC2 chassis used in a CT-100.

# Rx-to-Monitor Schemes

Many methods were employed to inject a CT-100 chassis with composite video. The most simple was to connect the video signal directly to the control grid of the first video amplifier, a 6CL6.

This however is not recommended. The output of a CTC2 second detector is typically 6 Vp-p while the output of the RCA TX-1C colorplexer is specified as 1 Vp-p.

Clearly, an amplifier is required.

# Rx-to-Monitor Schemes

It started early: of the two-hundred famous 1954 Rose Bowl sets, at least one -- RCA Model 5, serial number B570 -- was modified to accept composite video.

This set was updated by adding a 6J6 to the rear of the chassis. Little is known of the actual circuit, as the executive who used this set at the end of its useful NBC life had the 6J6 circuit stripped from the chassis.

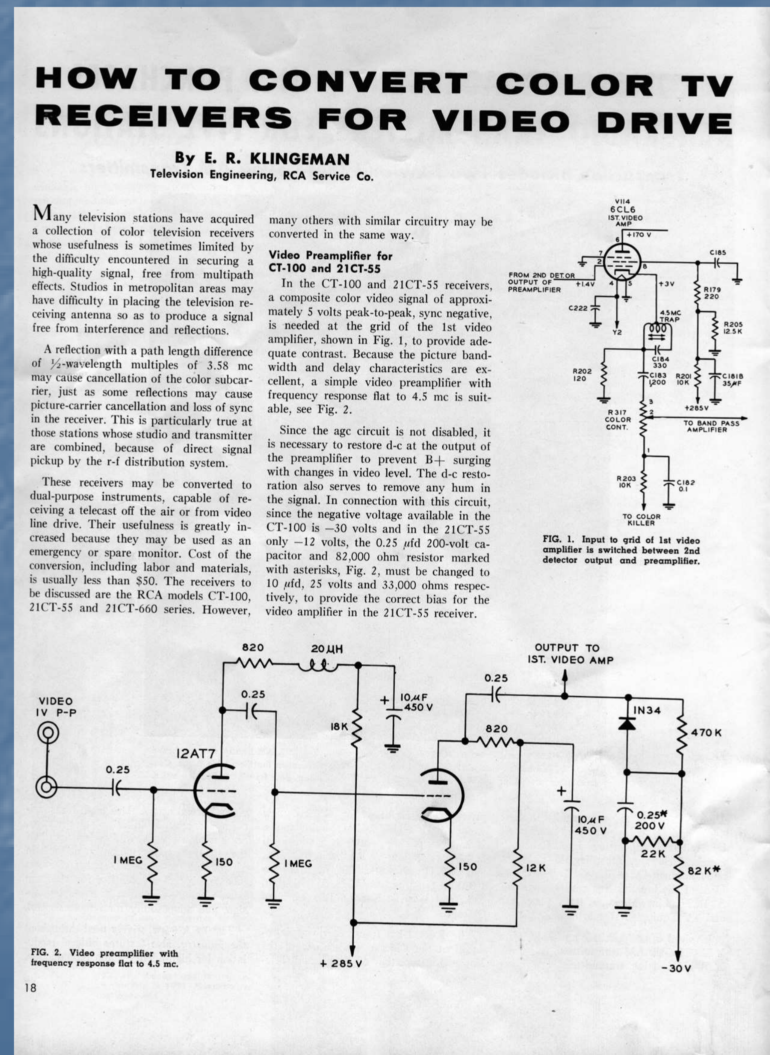
Little more than a tube socket and the ‘6J6’ chassis reference are left.

# Rx-to-Monitor Schemes

By 1956, the RCA Service Company published an article in *Broadcast News* that offered three Rx-to-Monitor conversion schematics. I selected the first version because of the basic simplicity of the 12AT7 circuit and because it included a dc restorer.

The second circuit had its response altered for use with a CTC4 chassis.

The third amplifier was dc coupled, but its output fed the CTC2 chassis through a 10-uF electrolytic without a dc restorer, and so was also rejected.



**HOW TO CONVERT COLOR TV RECEIVERS FOR VIDEO DRIVE**

**By E. R. KLINGEMAN**
**Television Engineering, RCA Service Co.**

Many television stations have acquired a collection of color television receivers whose usefulness is sometimes limited by the difficulty encountered in securing a high-quality signal, free from multipath effects. Studios in metropolitan areas may have difficulty in placing the television receiving antenna so as to produce a signal free from interference and reflections.

A reflection with a path length difference of ½-wavelength multiples of 3.58 mc may cause cancellation of the color subcarrier, just as some reflections may cause picture-carrier cancellation and loss of sync in the receiver. This is particularly true at those stations whose studio and transmitter are combined, because of direct signal pickup by the r-f distribution system.

These receivers may be converted to dual-purpose instruments, capable of receiving a telecast off the air or from video line drive. Their usefulness is greatly increased because they may be used as an emergency or spare monitor. Cost of the conversion, including labor and materials, is usually less than $50. The receivers to be discussed are the RCA models CT-100, 21CT-55 and 21CT-660 series. However, many others with similar circuitry may be converted in the same way.

**Video Preamplifier for CT-100 and 21CT-55**

In the CT-100 and 21CT-55 receivers, a composite color video signal of approximately 5 volts peak-to-peak, sync negative, is needed at the grid of the 1st video amplifier, shown in Fig. 1, to provide adequate contrast. Because the picture bandwidth and delay characteristics are excellent, a simple video preamplifier with frequency response flat to 4.5 mc is suitable, see Fig. 2.

Since the agc circuit is not disabled, it is necessary to restore d-c at the output of the preamplifier to prevent B+ surging with changes in video level. The d-c restoration also serves to remove any hum in the signal. In connection with this circuit, since the negative voltage available in the CT-100 is —30 volts and in the 21CT-55 only —12 volts, the 0.25 μfd 200-volt capacitor and 82,000 ohm resistor marked with asterisks, Fig. 2, must be changed to 10 μfd, 25 volts and 33,000 ohms respectively, to provide the correct bias for the video amplifier in the 21CT-55 receiver.

FIG. 1. Input to grid of 1st video amplifier is switched between 2nd detector output and preamplifier.

FIG. 2. Video preamplifier with frequency response flat to 4.5 mc.

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# Rx-to-Monitor Schemes

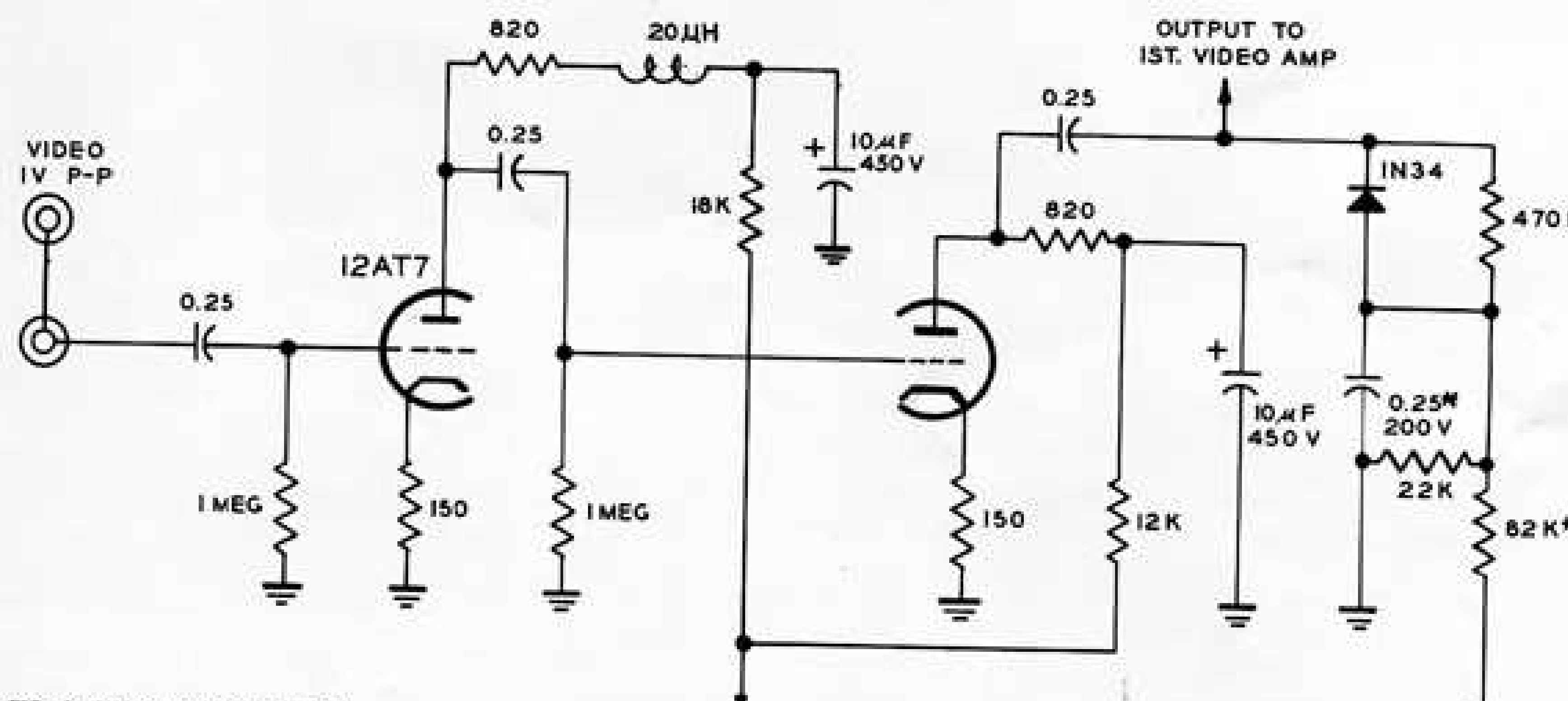
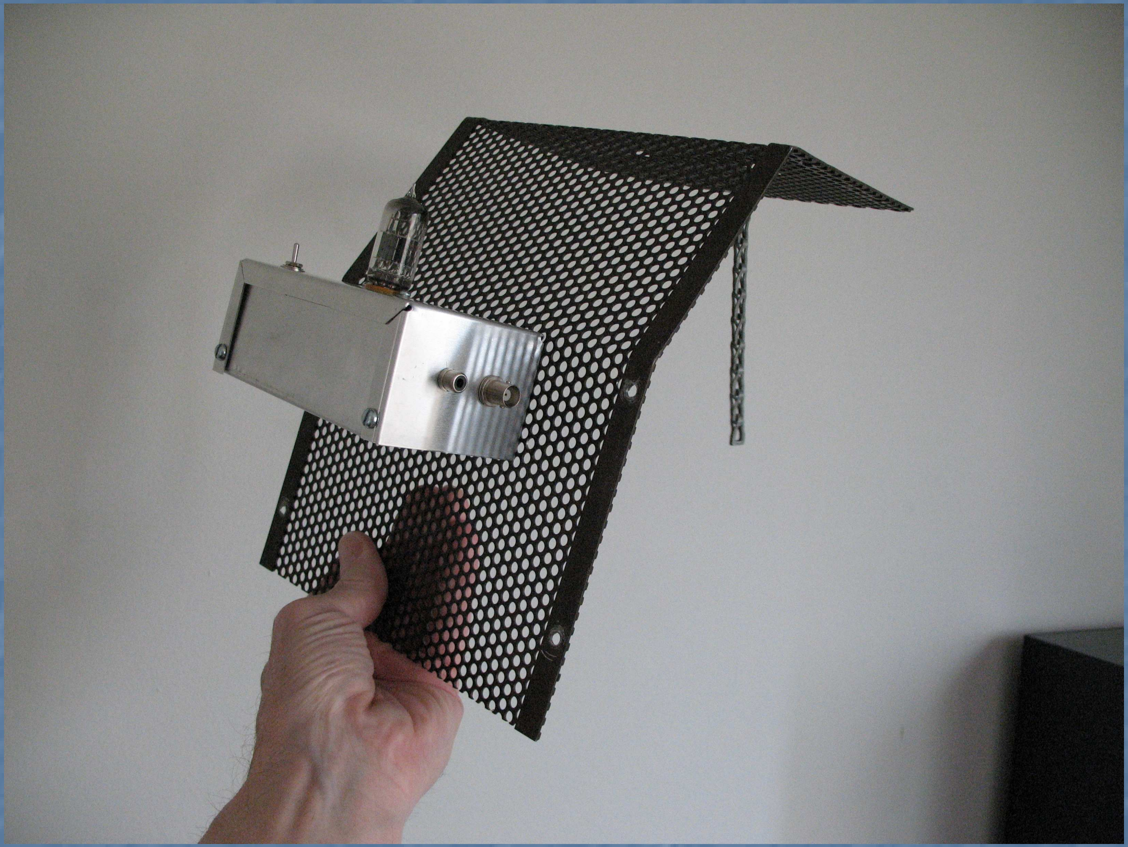


FIG. 2. Video preamplifier with frequency response flat to 4.5 mc.

This is the original RCA Service Company circuit. Note in the lower right a minus 30-volt bias requirement for the amplifier. It is supplied by the CT-100.

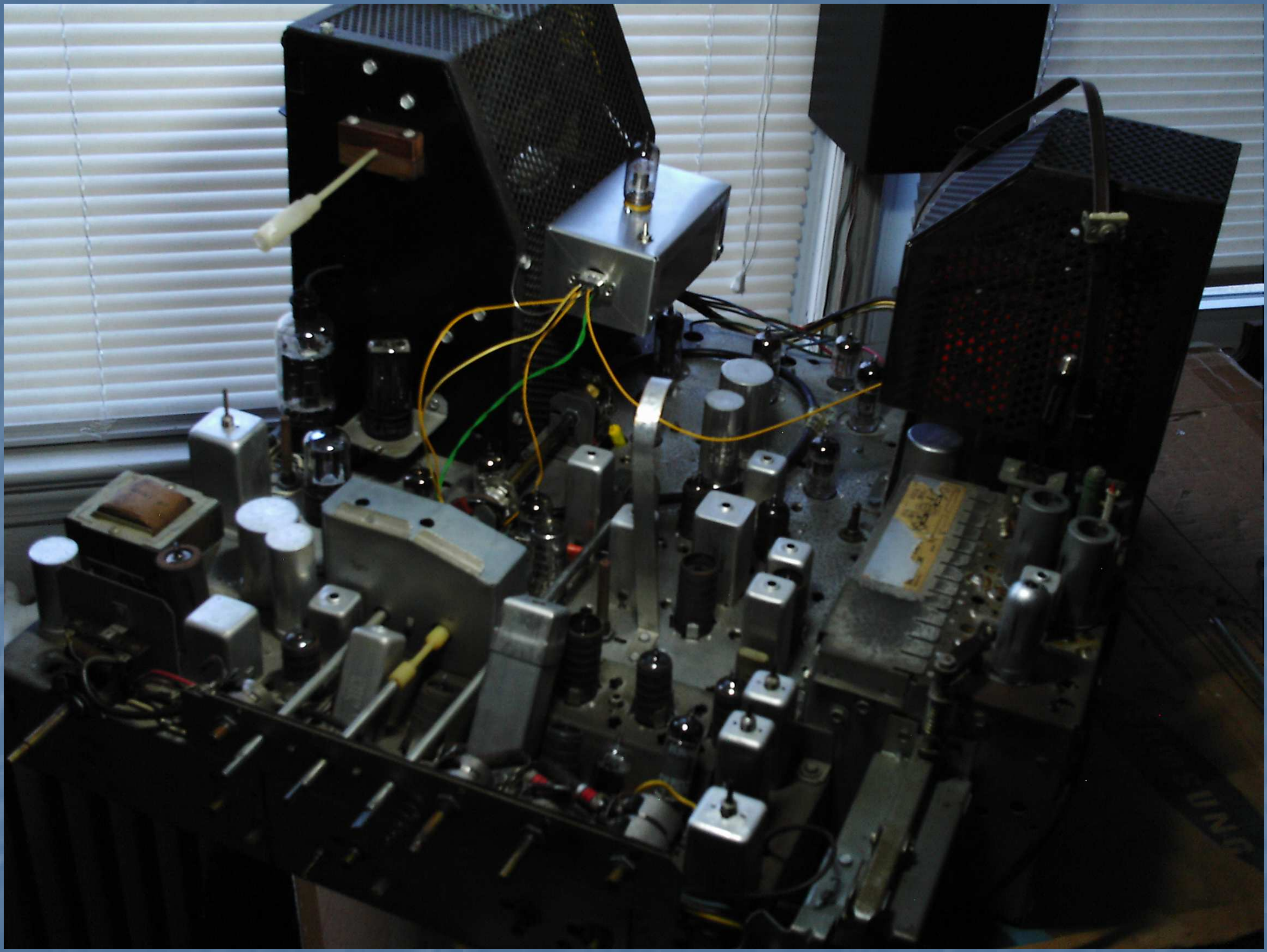
In a 21-CT-55, a resistor and capacitor change value since, in that set, the negative bias voltage is 12 rather than 30.

# Rx-to-Monitor Detail



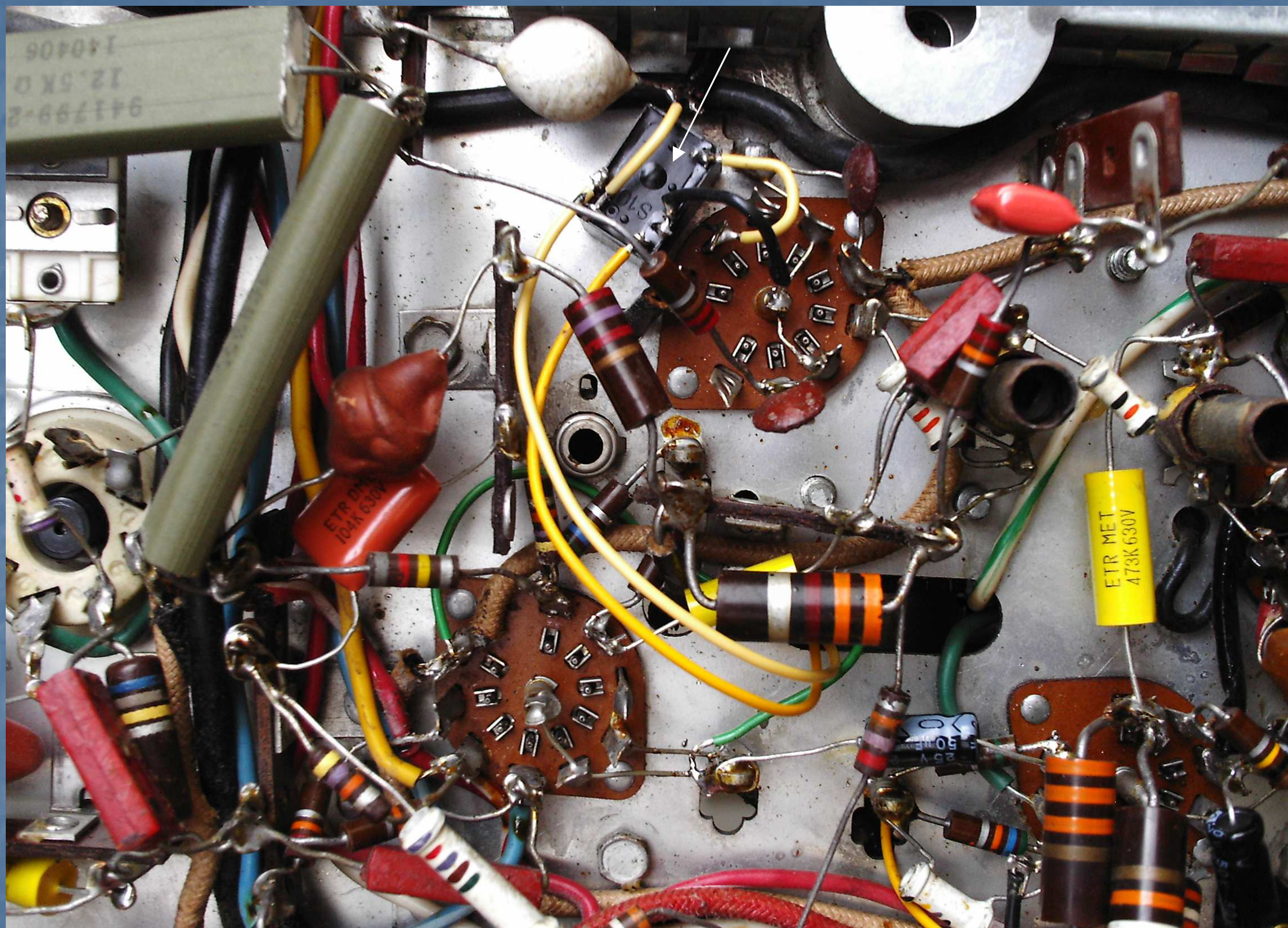
The composite video amplifier is built in a minibox and attached to the H-V cage. This is the first unit built and has provision for RCA and BNC input connectors.

# Rx-to-Monitor Detail



Filament power, ground, B+, negative bias, and relay control lines are needed for this installation. Radiation from the cage has not affected amplifier performance.

# Rx-to-Monitor Detail




A small relay at the top center of the picture selects either the second detector or the composite video amplifier as a signal source for the first video amplifier in this CTC2 chassis.

# Another look at the schematic…

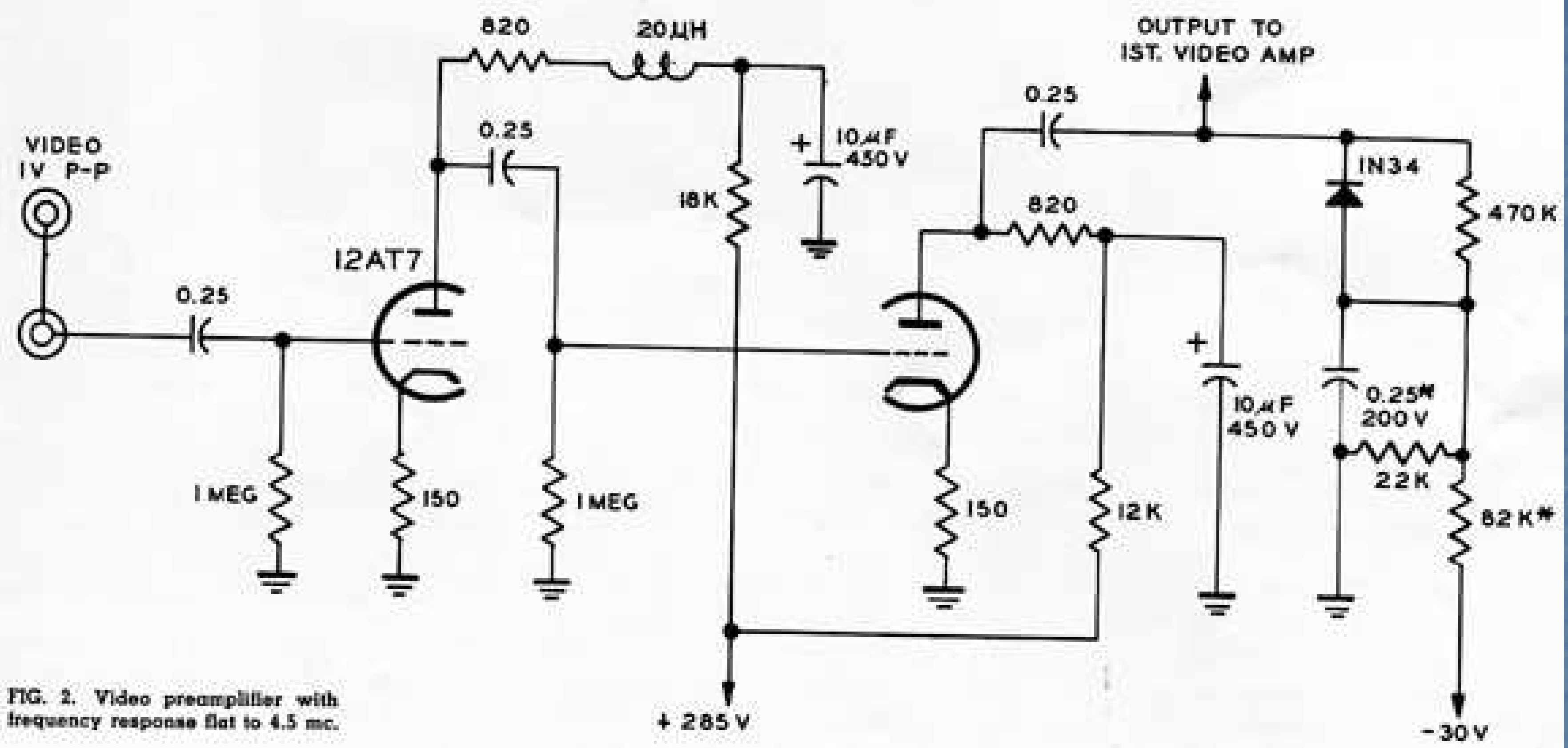



FIG. 2. Video preamplifier with frequency response flat to 4.5 mc.

A caption in the lower left speaks of a flat response out to 4.5 MHz. It is achieved with a single shunt peaking coil in the first stage and the tiny plate load resistors -- only 820 ohms. With a healthy 12AT7, each stage has a gain of about three for a total of six volts out for one volt in. Because of the relatively low gain in each stage, the wide bandwidth is possible.

# What's Next…?

For two years the composite interface adapter operated successfully in my CT-100. I had simplified the installation somewhat by using the under-chassis relay, which was driven by a small toggle switch on the minibox.

Why not somehow make the composite interface adapter portable. One that could be just plugged in without solder, drills, chassis punches, or any hard wiring.

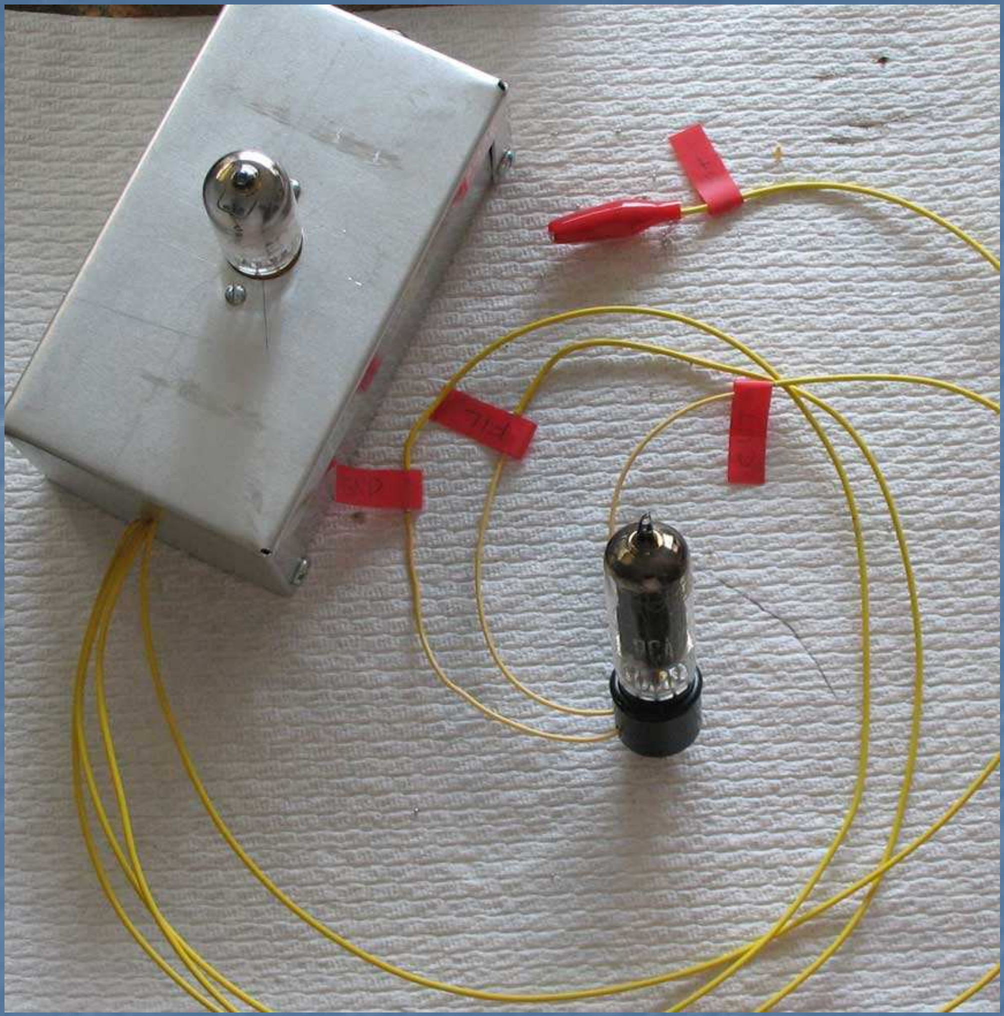
# Here's the Main Ingredient…

I found a bunch of 9-pin socket savers on eBay.

# The Main Ingredient.

…and modified them to drive the composite interface adapter directly from the first video amplifier in the CTC2 chassis.

# A Plug-n-Play CIA.



Pop out the 6CL6 first video amplifier and plug it into the socket saver.

# A Plug-n-Play CIA.

Only the B+ is obtained form another location. An insulated alligator clip connects the adapter to +275 volts at the above-chassis contrast pot.

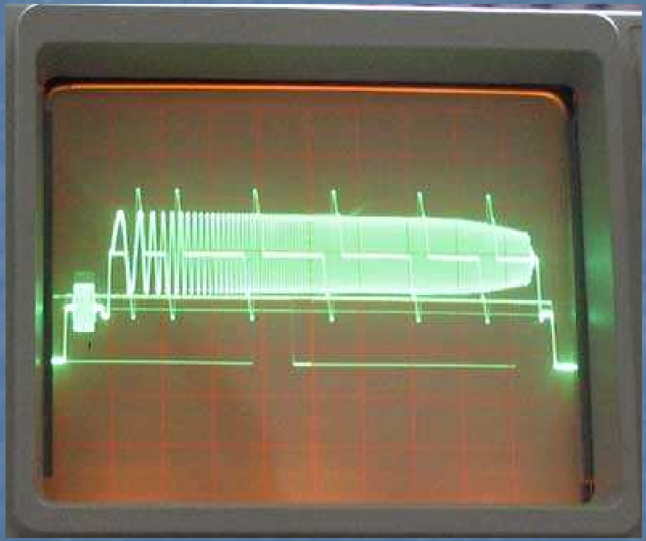
# A Birdseye View...

Another operational CTC2 chassis testing the plug-n-play adapter.

# Testing…

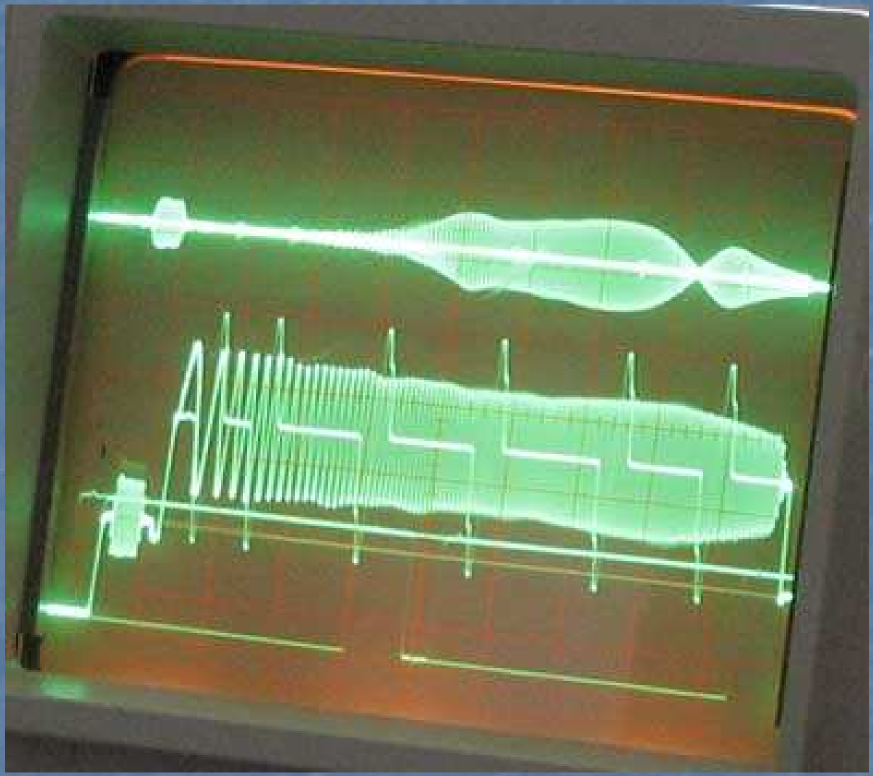
Two test were made on this new plug-n-play adapter.

A 5 MHz sweep.



# Testing…

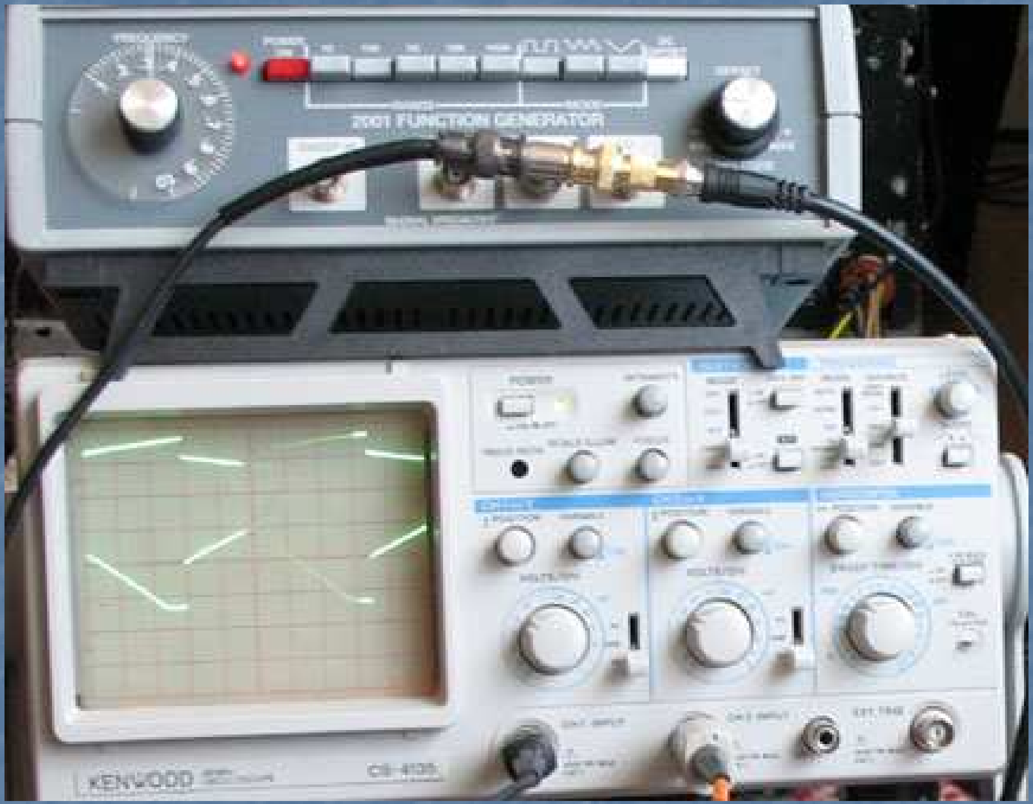
The top trace is the output of the chroma amplifier receiving the full 5 MHz sweep. The notch is at 4.5 MHz to reduce interference from the sound carrier.



The 5 MHz sweep  looked reasonable.

# Testing…

However the effect of a 30-Hz square wave on the output was disappointing.




The top trace is the output of the first stage. The bottom trace is the output of the second stage, which is worse because it’s a case of garbage-in, more garbage-out.

# Improving the Low Frequency Response

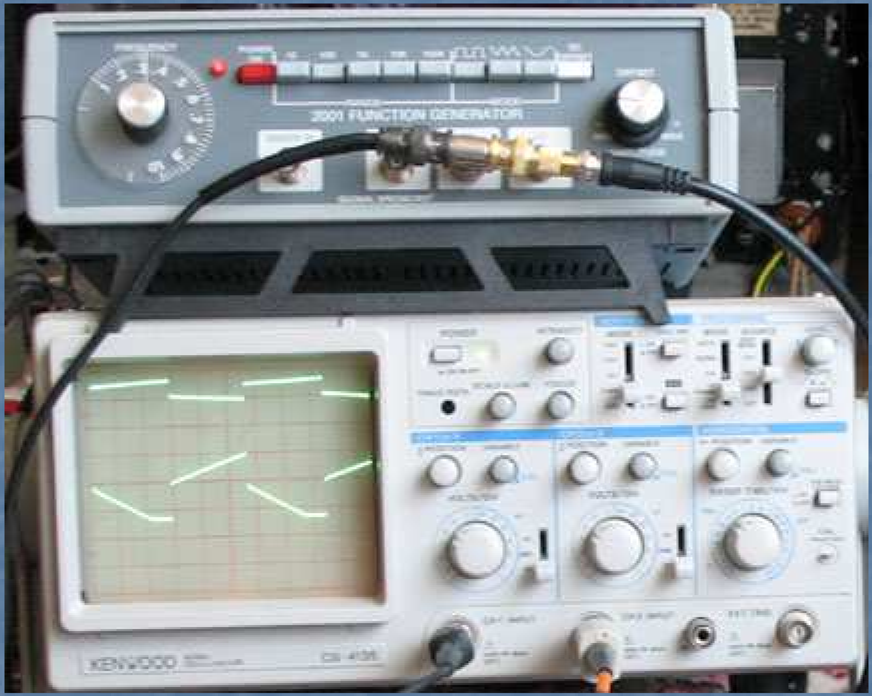
I grabbed my copy of Grob *Basic Television* which is the text used in my first television course in tech school. Just what was needed.

Basically, the large phase angle that wants to form at the very lowest frequencies must be compensated for in a design balance that includes making the time constant of the plate decoupling RC network ten times better than the lowest video frequency, which is 30 cps in typical NTSC video amplifiers of the 40’s and 50’s.

# Improving the Low Frequency Response

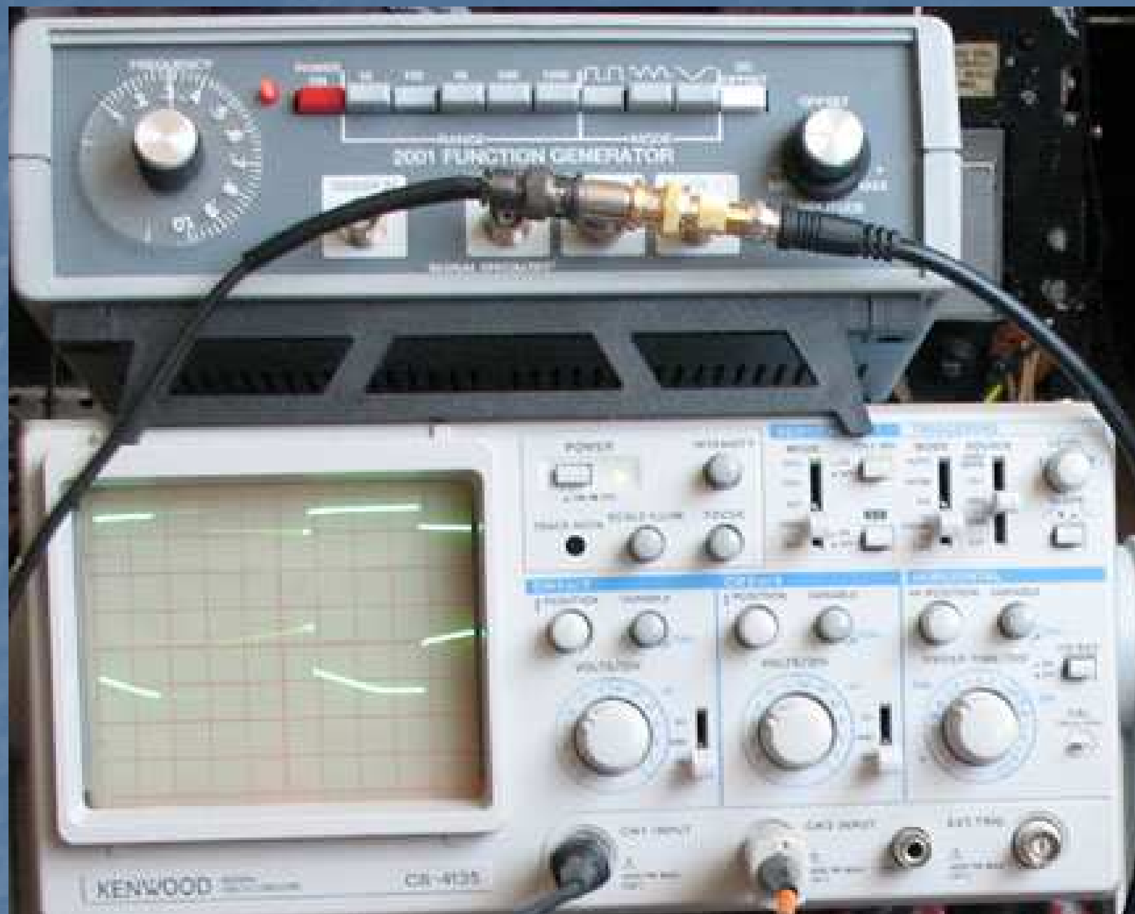
Additionally, the RC coupling network components can not simply be increased in value to meet low frequency requirements because tube physics issues become significant spoilers.

# Improving the Low Frequency Response




The decoupling network for the first stage was modified by doubling the capacitance from 10- to 20-*u*F. Notice how the top trace is becoming more square while the lower Trace improves too, a result of being driven by the improved waveform.

# Improving the Low Frequency Response



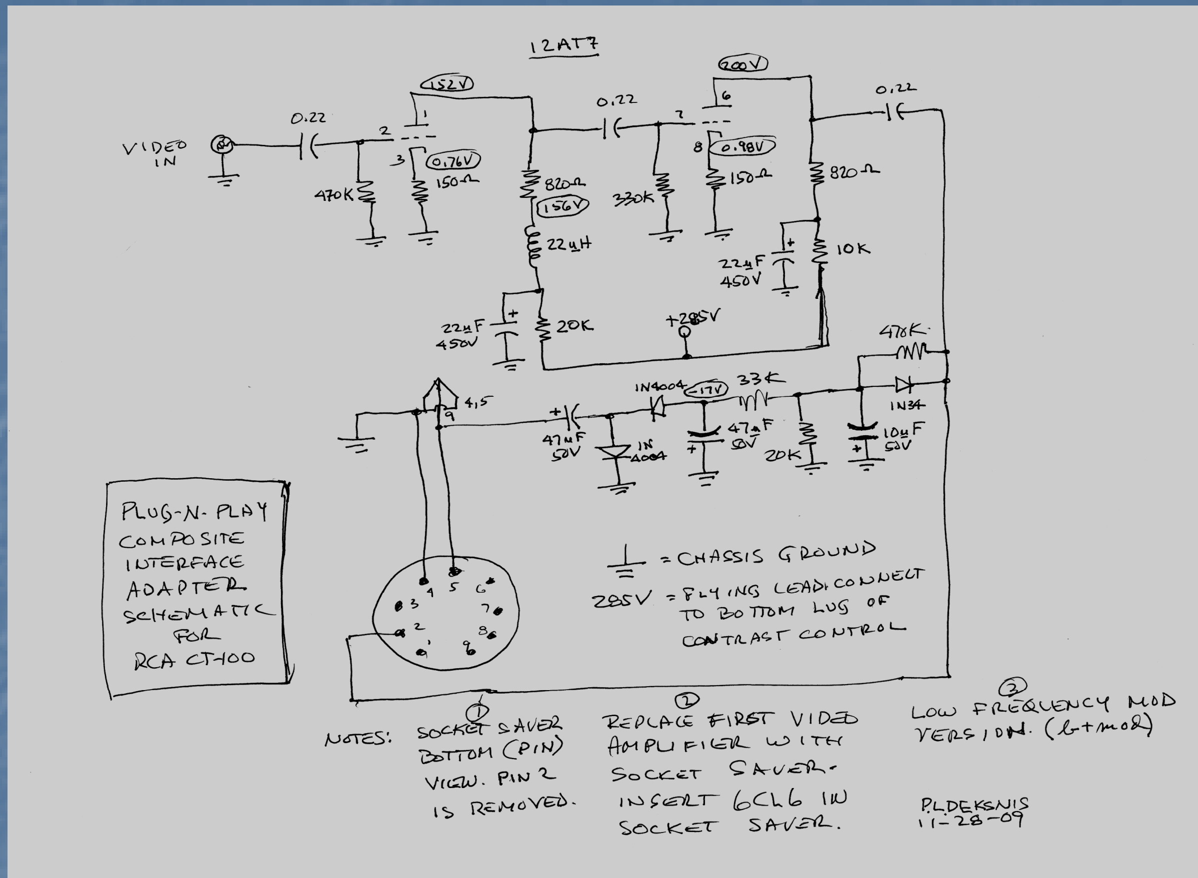

The decoupling network for the second stage was also modified by doubling the capacitance from 10- to 20-*u*F. I also lowered the value of the grid resistors. The first stage (top) wave is now nearly eyeball-flat with concomitant second stage improvement. There are four changes that did the trick…

# Improving the Low Frequency Response

The fix to the 1956 circuit:

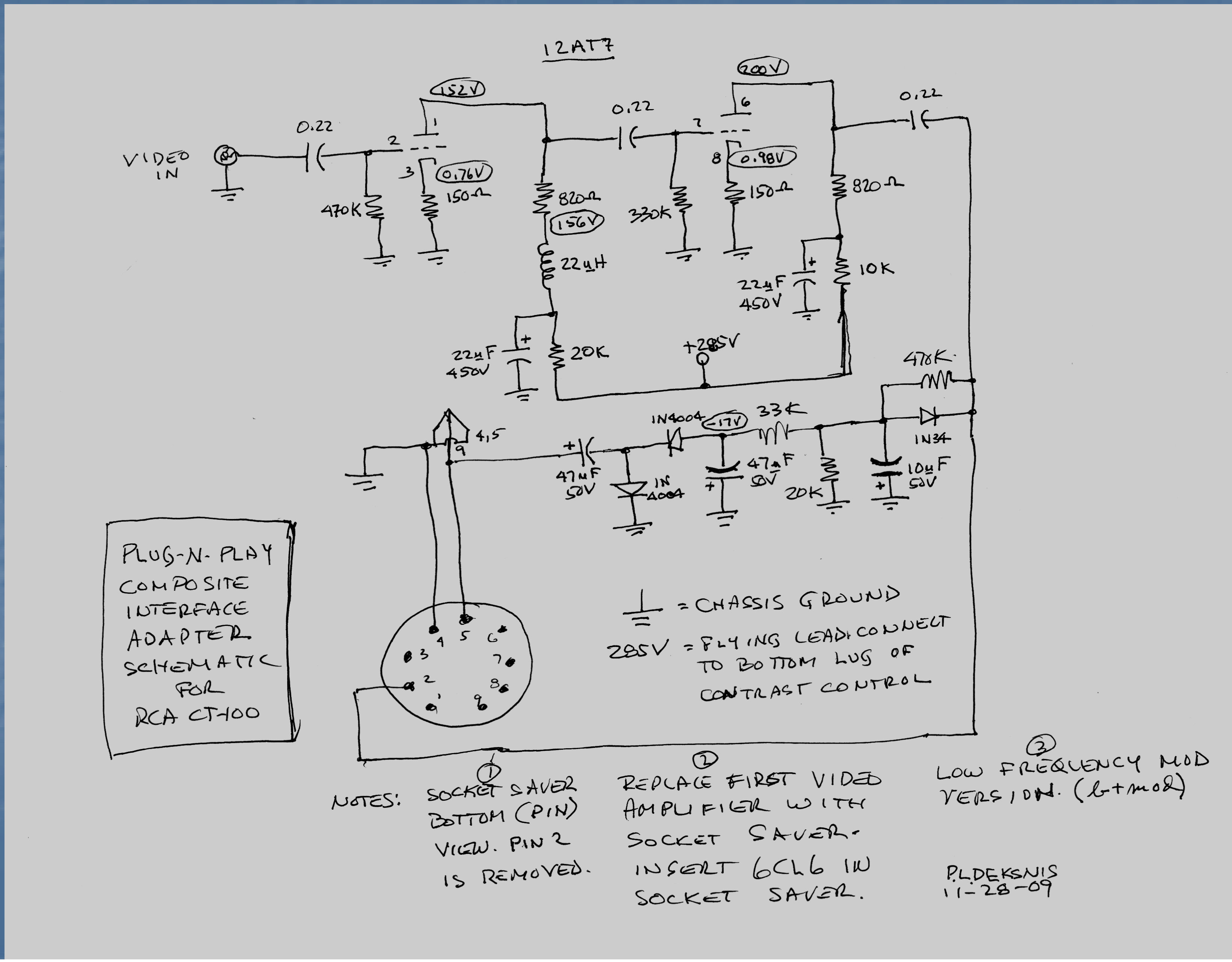
[1] first stage grid resistor decreased from 1 meg to 470K
[2] second stage grid resistor decreased from 1 meg to 330K
[3] first stage decoupling circuit capacitor increased from 10 to 20 *u*F
[4] second stage decoupling circuit capacitor increased from 10 to 20 *u*F

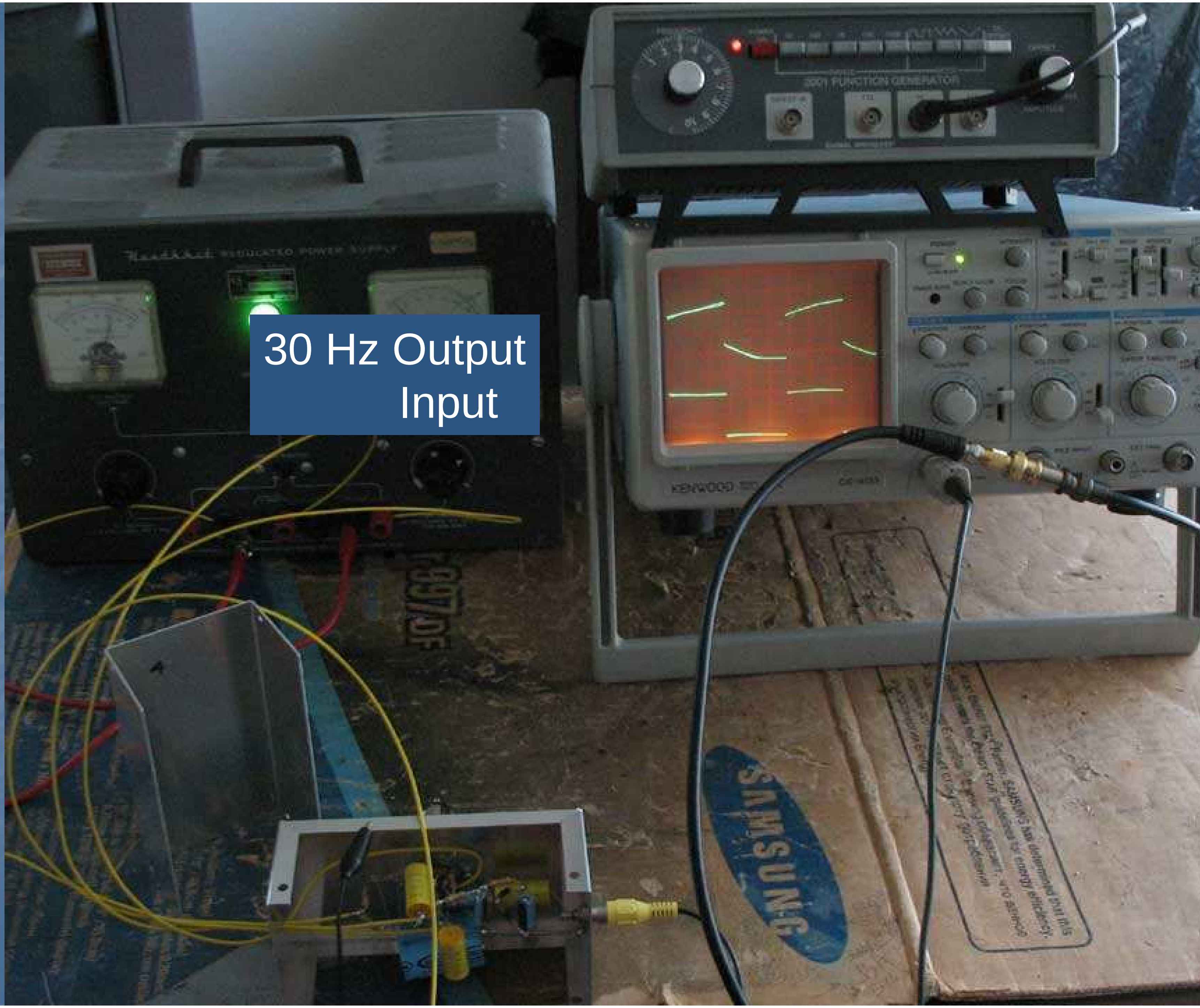
# One Final Refinement




The circuit also includes a voltage doubler powered by the 6.3 Vac filament line. This eliminates the need to use the CTC2 as a negative bias source.

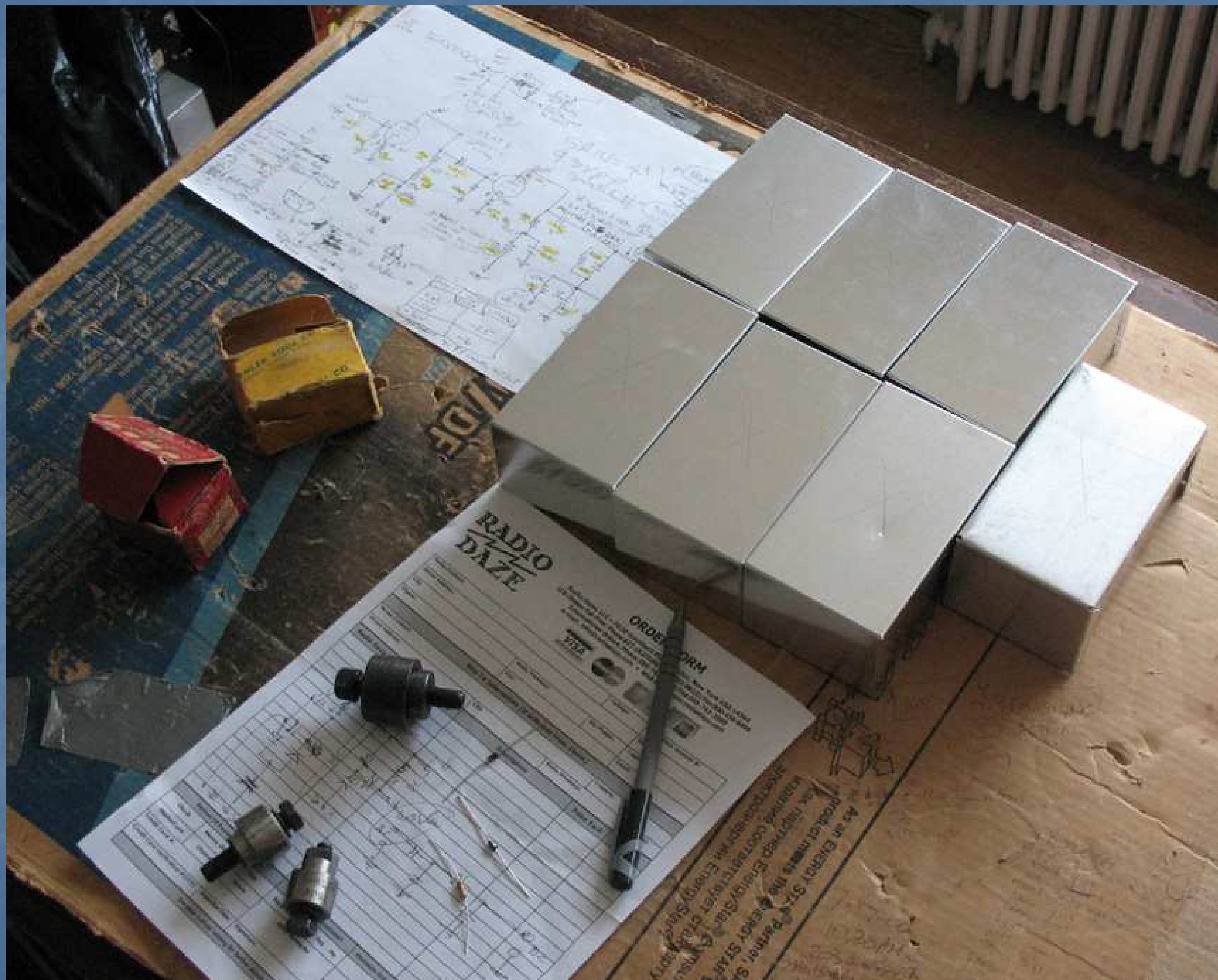
# Schematic


12AT7
VIDEO IN
0.22
470K
150Ω
152V
0.76V
820Ω
156V
22uH
22uF 450V
20K
+285V
330K
200V
0.98V
10K
IN4004
-17V
33K
47uF 50V
20K
IN34
10uF 50V
470K
PLUG-N-PLAY COMPOSITE INTERFACE ADAPTER SCHEMATIC FOR RCA CT-100
= CHASSIS GROUND
285V = FLYING LEAD; CONNECT TO BOTTOM LUG OF CONTRAST CONTROL
NOTES: ① SOCKET SAVER BOTTOM (PIN) VIEW. PIN 2 IS REMOVED.
② REPLACE FIRST VIDEO AMPLIFIER WITH SOCKET SAVER. INSERT 6CL6 IN SOCKET SAVER.
③ LOW FREQUENCY MOD VERSION. (b+mod)
P.L.DEKSNIS 11-28-09




30 Hz Output
Input

A total of nine Composite Interface Adapters were built.



The final run of six were produced in 2009.

Results…