TVG2 Operation Attempt Notes

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Introduction

On June 5th, 2019 Prof. Zachary Horton, Antonio Munoz, and I visited the Smithsonian Museum of American Natural History to attempt operation of TV Game 2 (TVG2). TVG2 was the second prototype of the TV game console invented by Ralph Baer. It would go through several more iterations until it was sold to Magnavox as the “Brown Box”. Magnavox transformed the invention into a marketable device which was sold as the Magnavox Odyssey.

Prof. Horton was interested operating the unit in order to understand the games and their potential impact on the people who played them. Antonio and I were present to attempt and render the unit operational. My interest came from working with Prof. Horton since early 2018 on Odyssey recreation and enhancement. Antonio is an avid collector of vintage electronics and has extensive electronics repair experience, and this project appealed to both of those interests.

The attempt was unsuccessful. We had four hours and by the end we had reconnected enough circuitry to operate a few subcircuits, but not enough to get a video signal. The unit had fallen into serious disrepair over the years. Besides numerous disconnected wires there were physically broken components (e.g. resistors in two pieces), components disconnected on one one, and bent or missing control switches. A significant difficulty were the two six pole triple pole rotary switch banks present in the unit that were not fully documented in the original schematic. Many of the wires and components intended to be connected to their switch terminals had become disconnected.

No permanent modifications to TVG2 were made. Equipment, components, and extra leaders were only connected via probes or clips temporarily via probes or clips.

The first portion of this document briefly outlines the general testing procedure. The next section details all the connections made with jumpers. Next, a possible reconciliation of the switch bank wiring is presented. Afterwards, the original handwritten notes made during the attempt are duplicated. At the end, the original schematics available and studied prior to the attempt are reproduced.

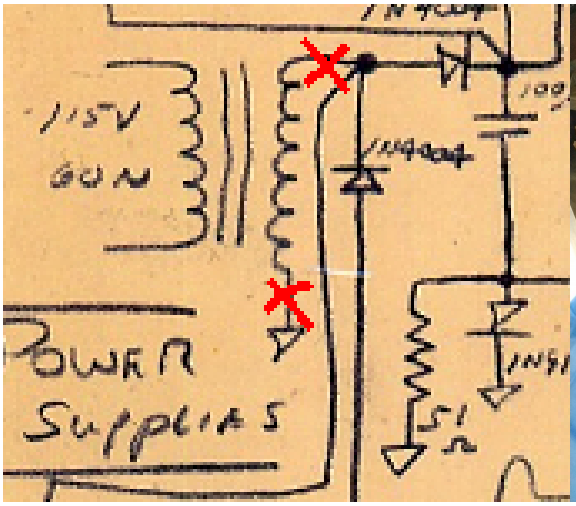
Setup

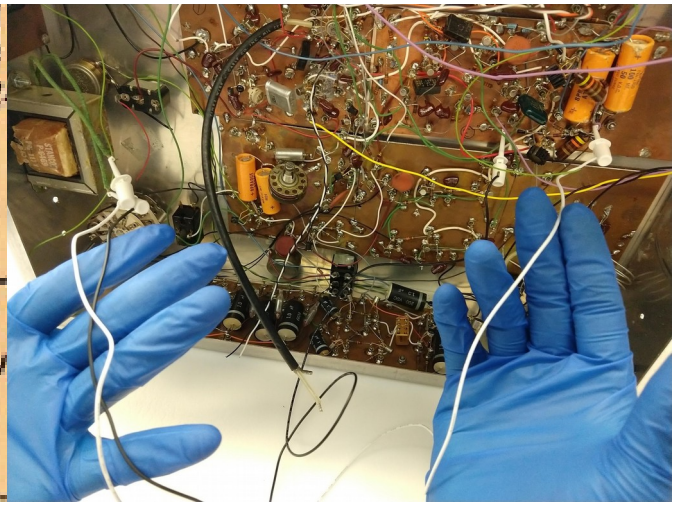
During the attempt, a variac was at all times. Whenever power was applied to TVG2, the voltage was increased slowly using the variac. AC current clamps were used to measure the current flowing through the primary and secondary coils of TVG2's power transformer. No dangerous current draw was observed at any time.

Connections

Transformer Secondary Coil

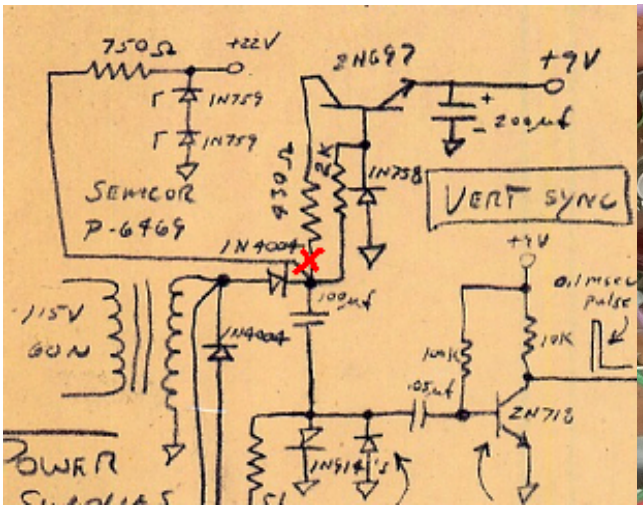
Transformers secondary coil was disconnected from the rest of the circuitry. It was connected with clip on leads. A convenient ground was used for one end of the winding. The other was connected to the appropriate junction of two 1N4004 diodes as indicated on the schematic.

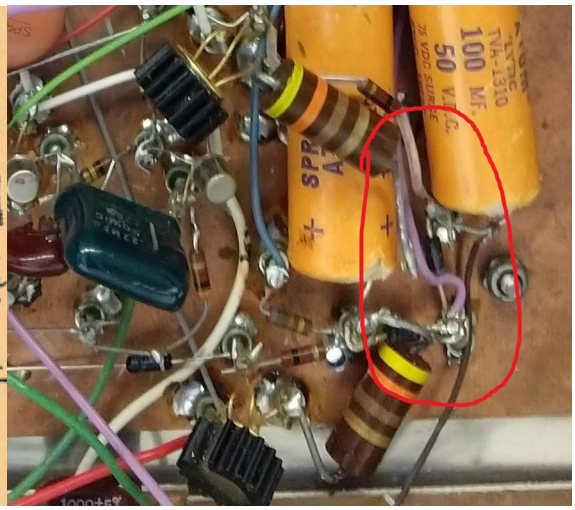


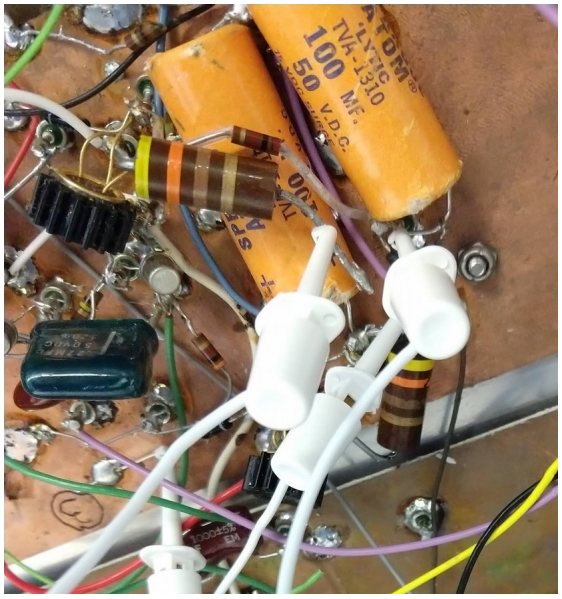


470 Ohm +9V Regulator Resistor

The Vin side of the 430 Ohm resistor feeding the +9V regulator was disconnected. It was reconnected with clip on leads.

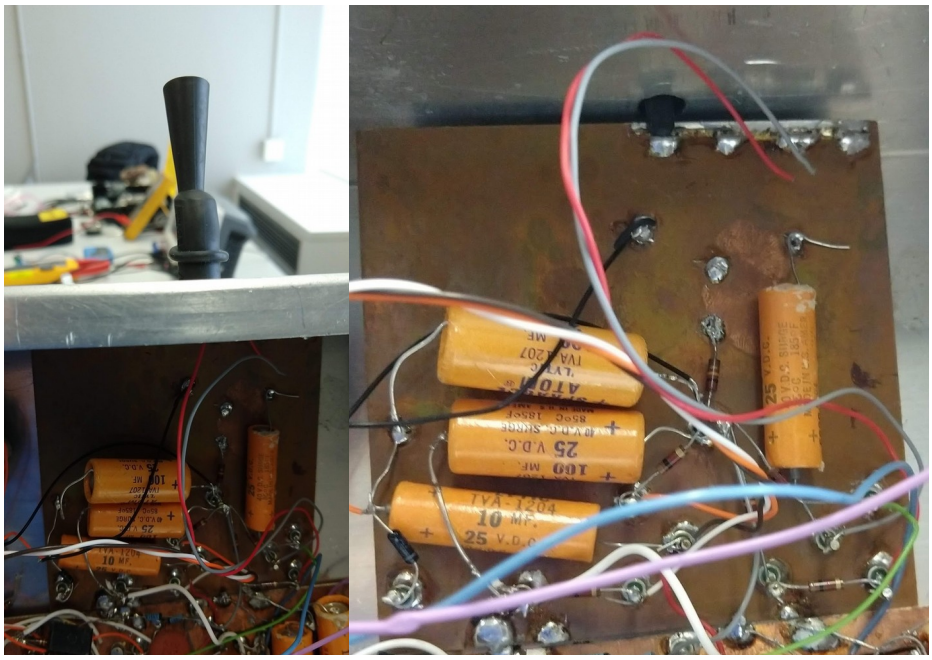






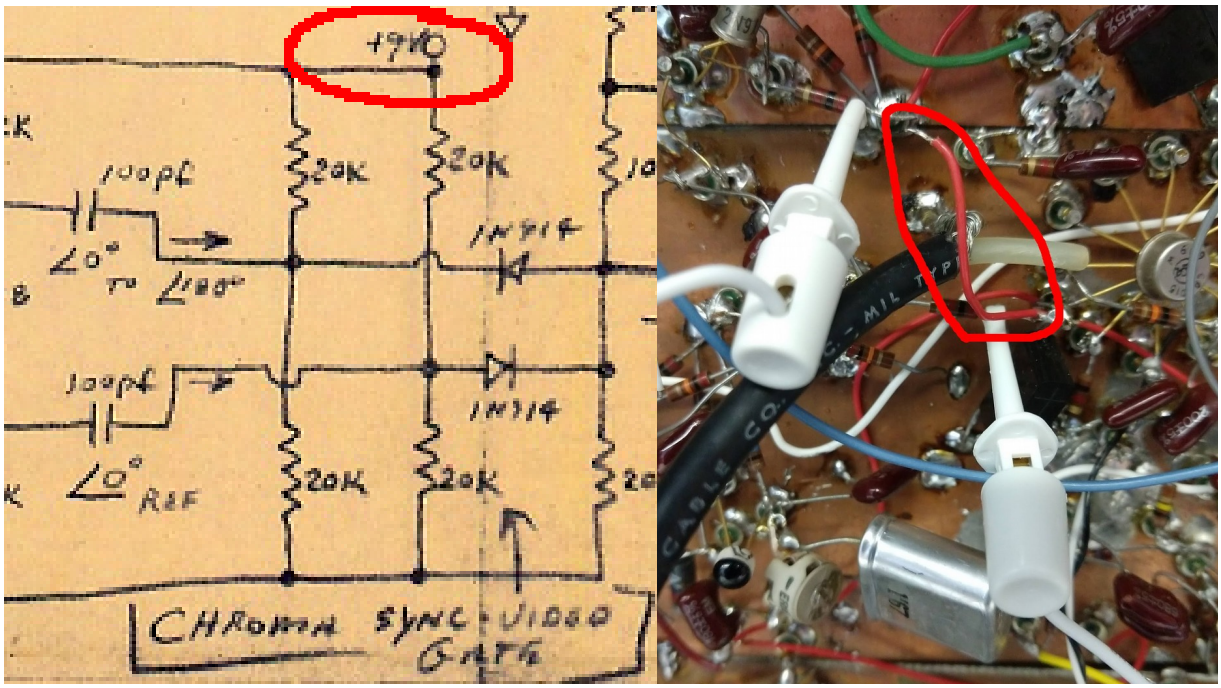
Secured Pump Controller Board

The pump controller board was completely disconnected from the case. It was secured using an alligator clip poking through an old switch hole on the case. This allowed work to be done while TVG2 was upright.



9V Chroma Generator Rail

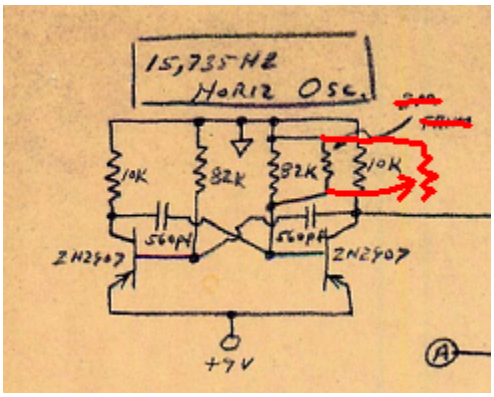
A wire that powered the 9V rail of the Chroma generator came disconnected. The wire was wedged between the copper clad boards in the picture below and grounded out the 9V rail. Finding this short-circuit occupied more than an hour of the attempt. The connection was re-made with a jumper wire as pictured.

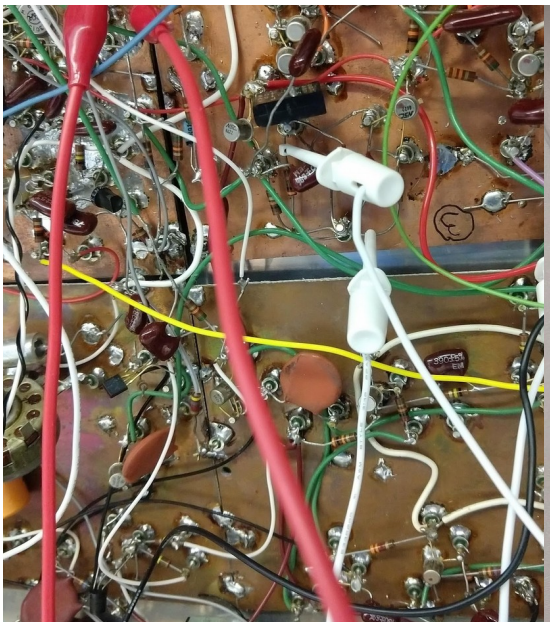


Horizontal Sync Multibrivator Tuning Potentiometer

The 3 megaohm trim potentiometer indicated in the schematic for tuning the Horizontal Sync Multibrivator was no longer present. Another resistor had been soldered in parallel with the 82k resistor noted on the schematic, presumably in place of the trimmer potentiometer. The HSync oscillator's output was measured with an oscilloscope and found to be approximately 1 kHz too low. It was recalibrated by putting a 330 kOhm, 100 kOhm, and 200 kOhm pot in series to form a 430k-630k Ohm variable resistor and putting them in parallel with the 82 kOhm resistor. This allowed the Hsync Oscillator to be tuned to the correct frequency noted on the schematic.

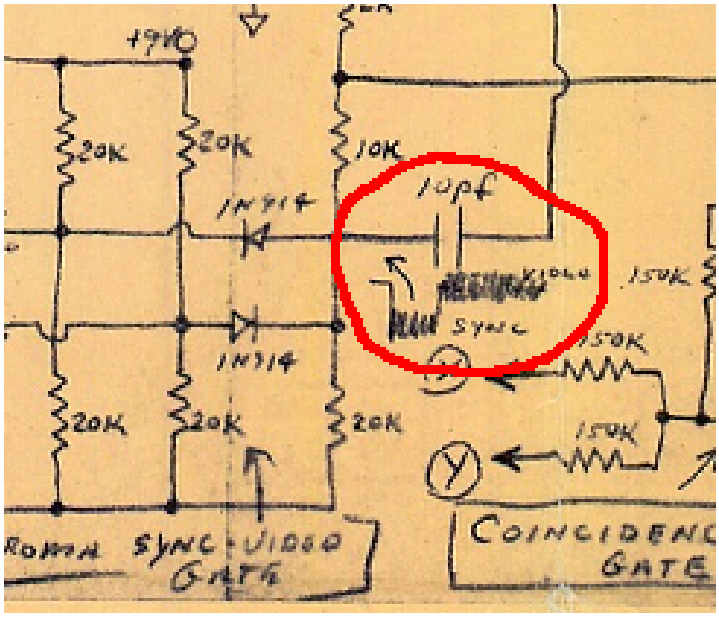
The resistance values were the result of being restricted to what we brought in our toolkit.

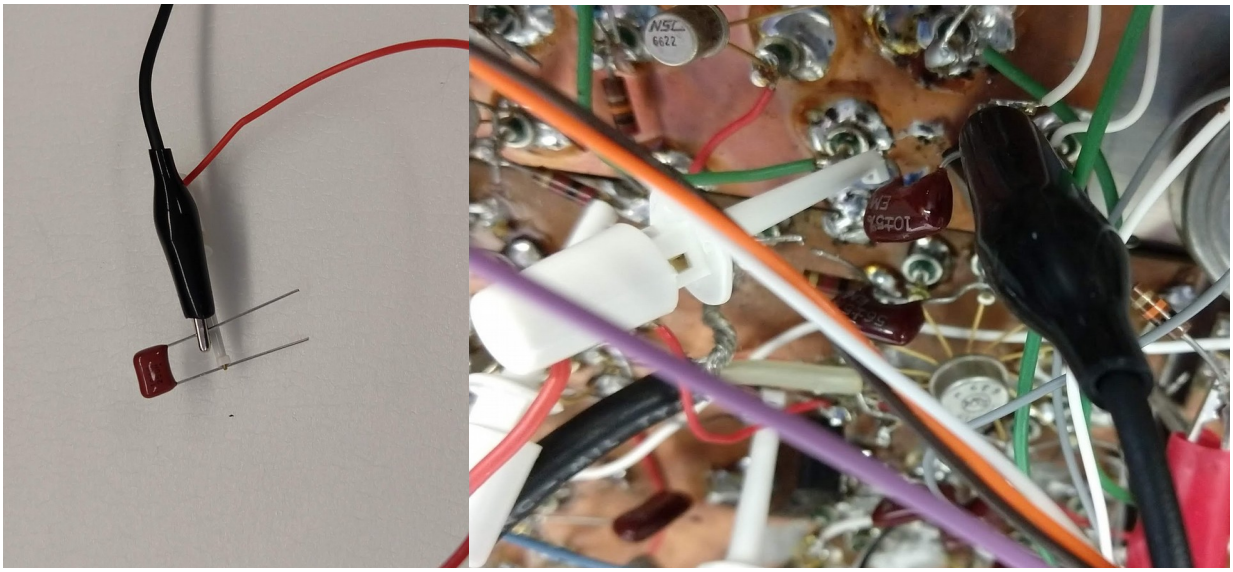




Chroma Output DC Block Capacitor

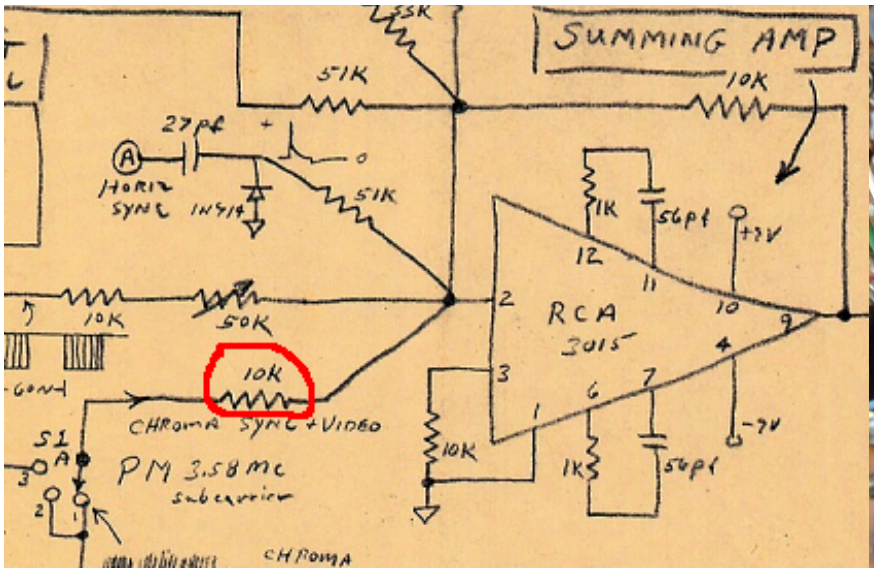
A DC blocking capacitor on the output of the chrome generator did not pass a signal measurable by the oscilloscope. It was bypassed with a 0.1uF capacitor after which a signal could be observed.

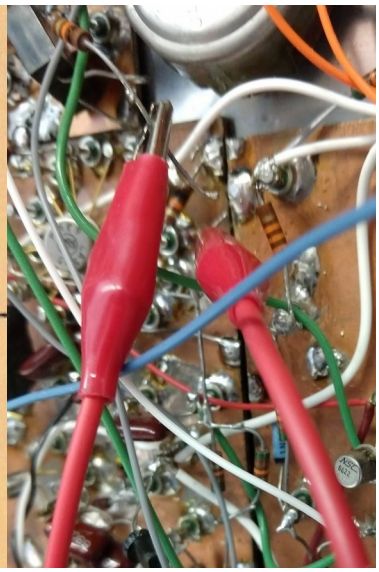




Switch 1A 10k to Summing Amplifier

The lead of the 10k resistor going from S1A to pin 2 of the summing amplifier was disconnected. It was reconnected with a jumper wire.

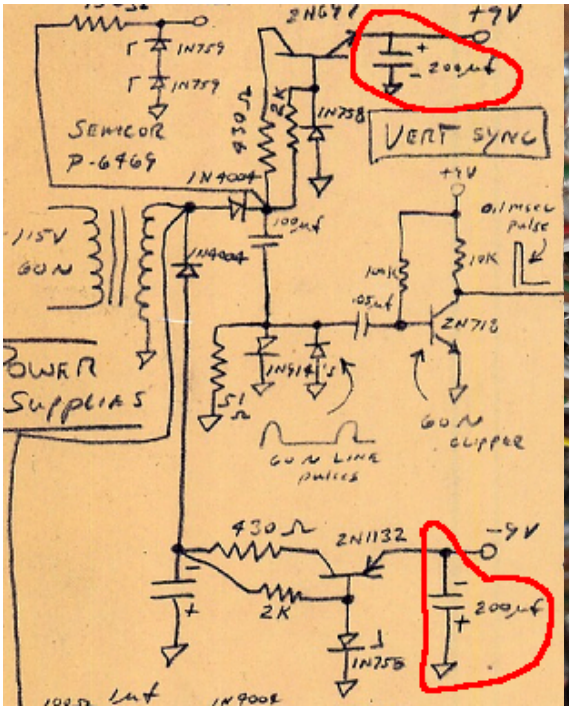


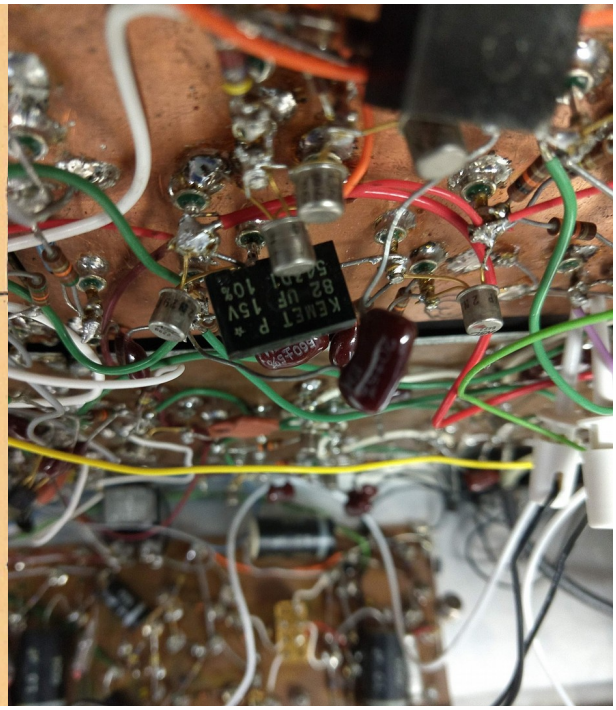


Observations

82uF Capacitor Instead of 220uF for +/- 9V Rails

An 82uF capacitor was found where the schematic indicated a 200uF capacitor would be used for bulk capacitance of both the positive and negative 9V rails.

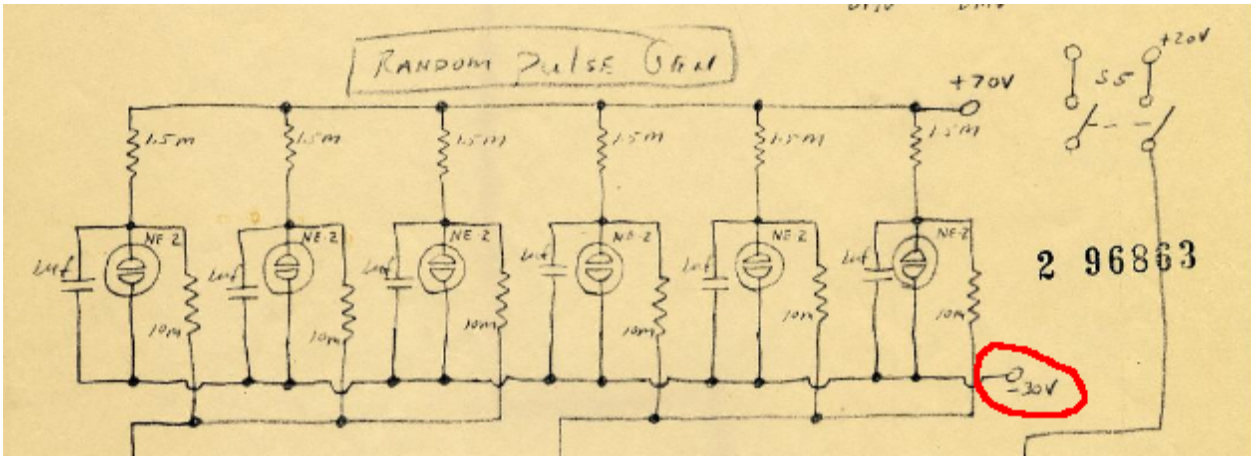




Flickering Cludge Neon Lights

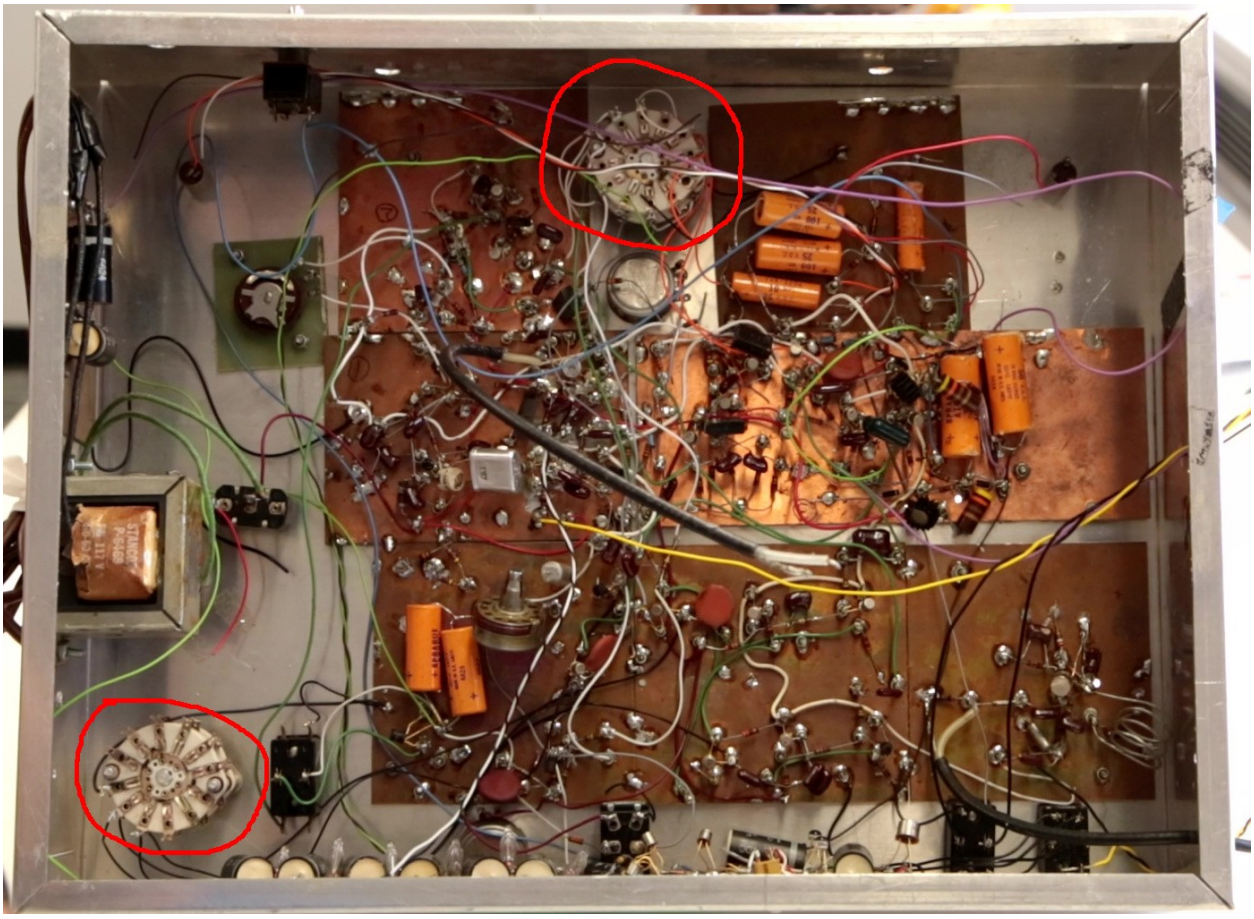
Upon powering TVG2, the neon lights used to create the “Cludge”, or random spot position generator were observed to begin glowing lightly and flicker. Shown on the below schematic, the neon bulbs require a -30V supply that is not present in the TVG2 schematic. The need for a -30V supply was not noticed prior to the attempt, so the -30V supply was not searched for.

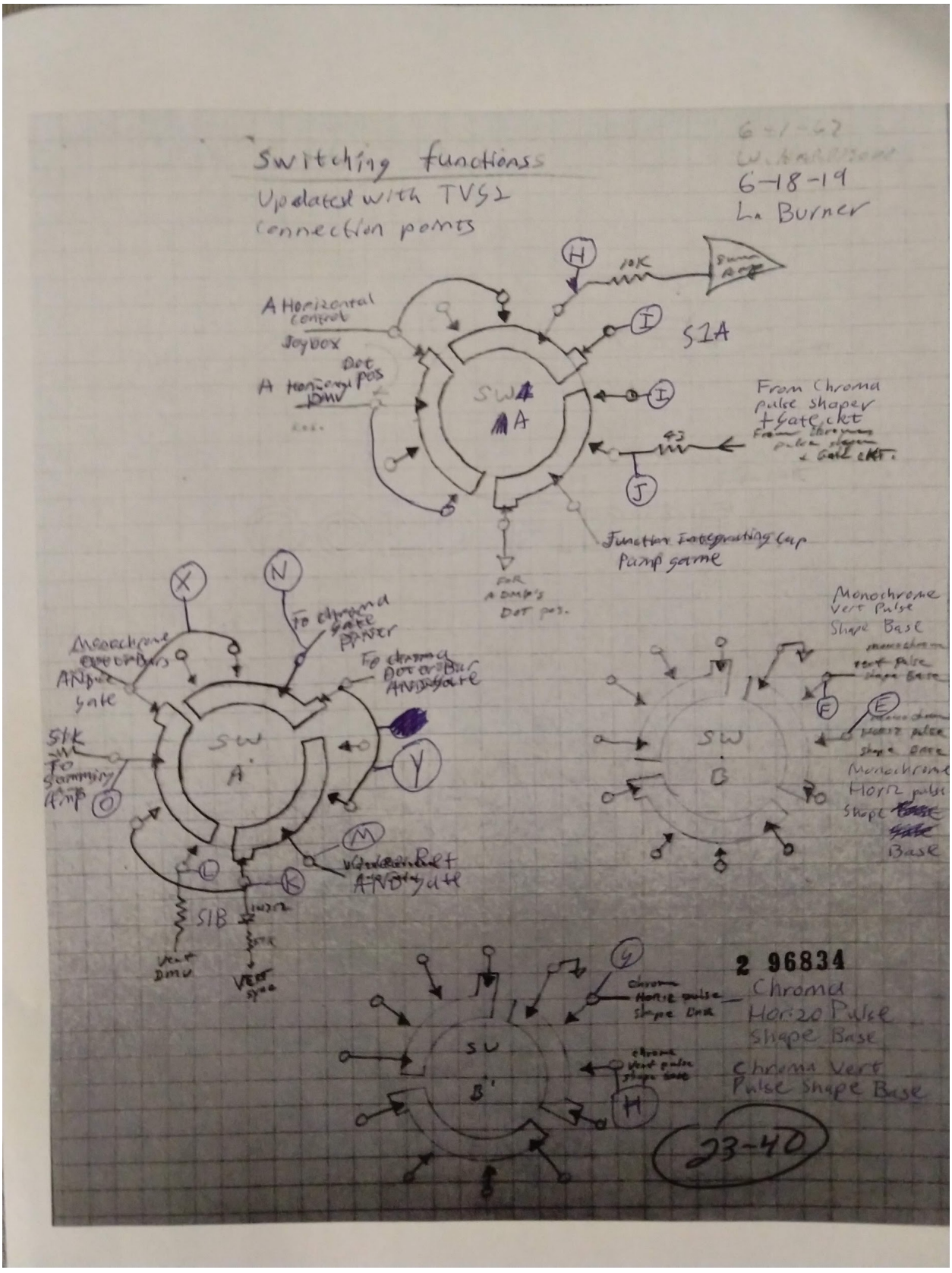
This means there may be a -30V rail that was built into TVG2 to support the Cludge circuit. Alternately, an external -30V supply may have been required for complete operation. Finally, it is possible that the external -30V supply was not required to get the desired effect and ground was simply used instead.

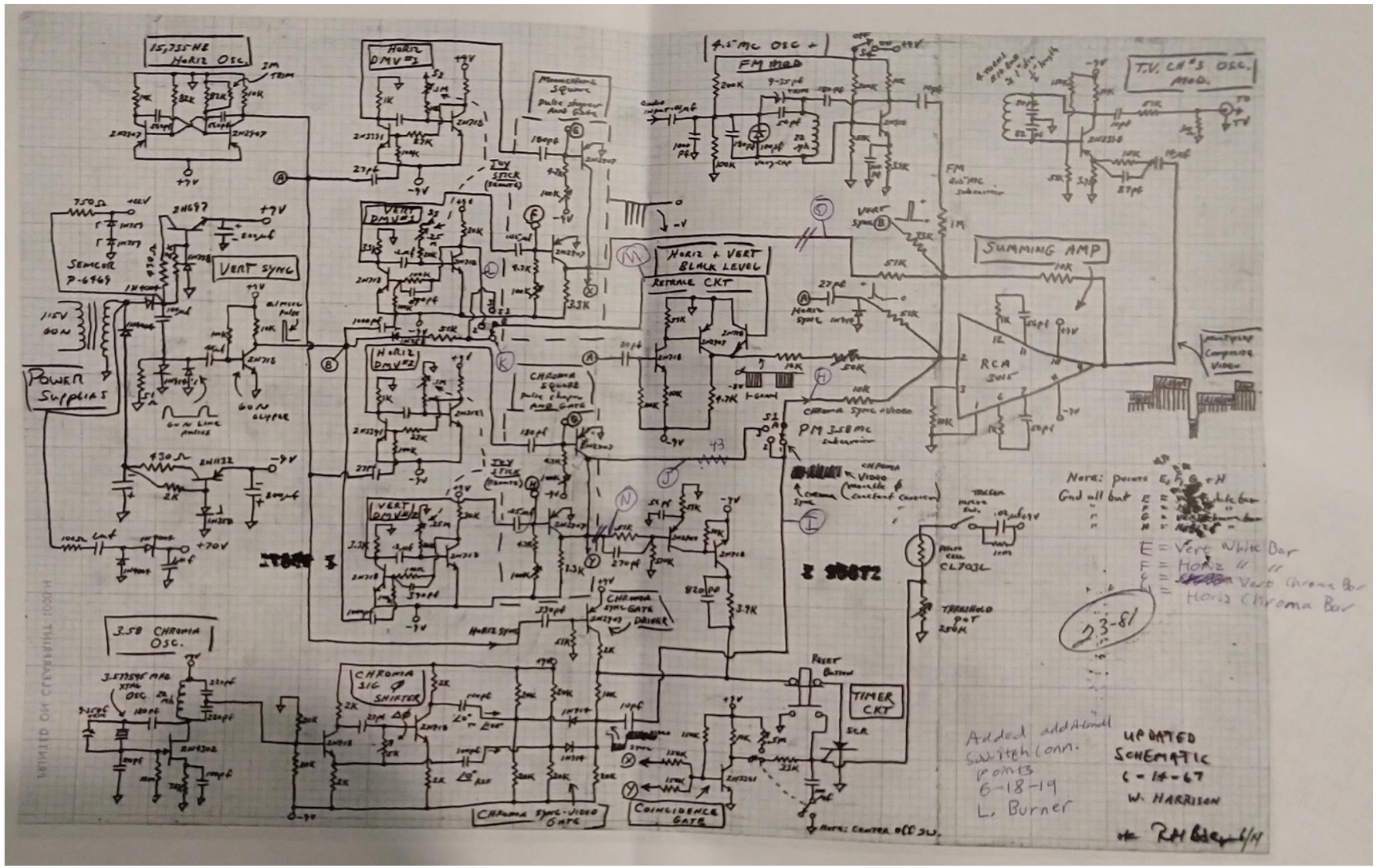


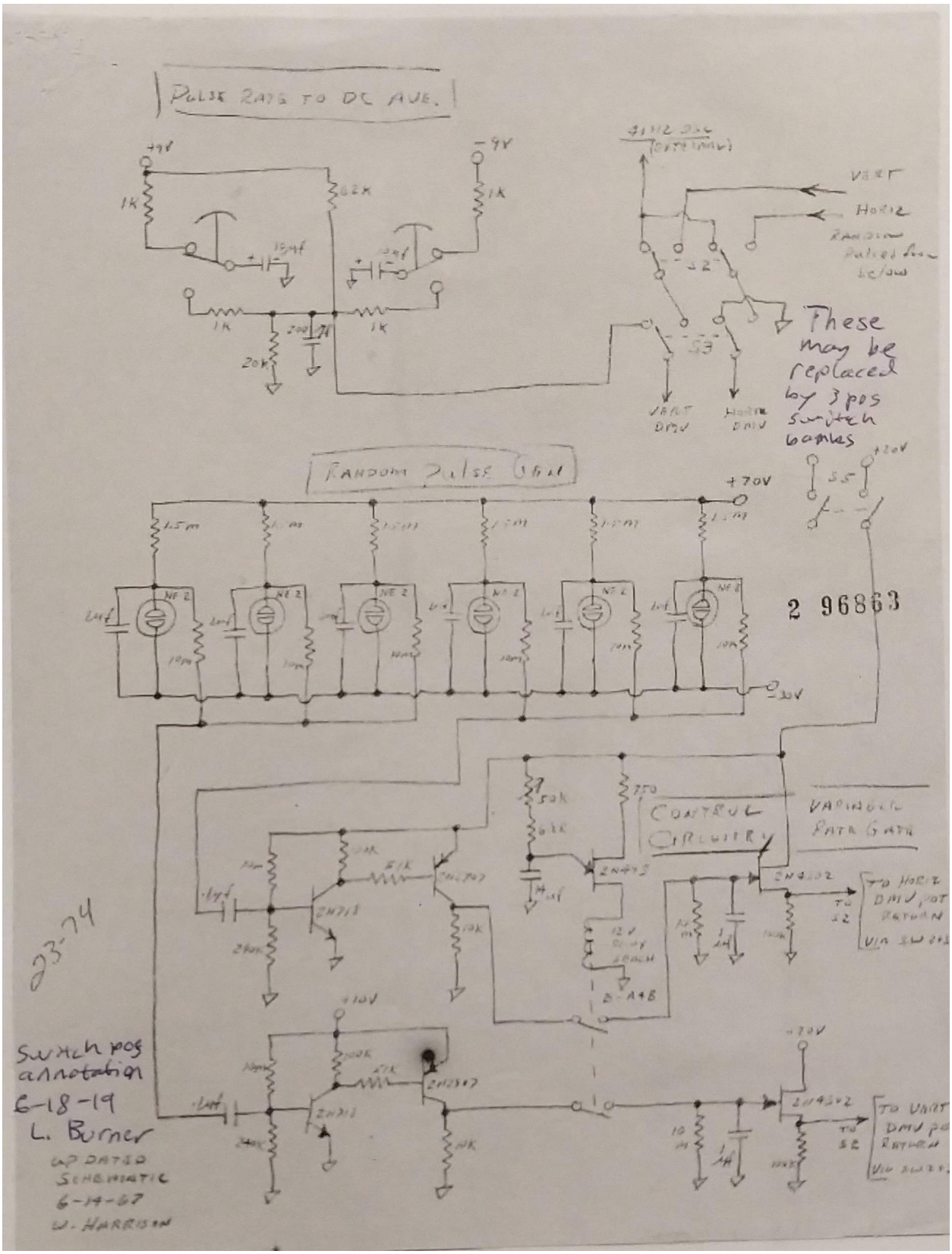
Possible Connection of Triple Throw Switch Banks

After the attempt, Prof. Horton reviewed documents from the Ralph Baer papers and found a diagram dated prior to the TVG2 schematic showing the six pole triple throw switches. I made an attempt to resolve the two documents based on what I encountered during the attempt and Prof. Horton's understanding of the units intended functionality. An annotated version of the switch diagram and TVG2 schematic are reproduced below showing my best attempt to reconstruct what might actually be inside TVG2.



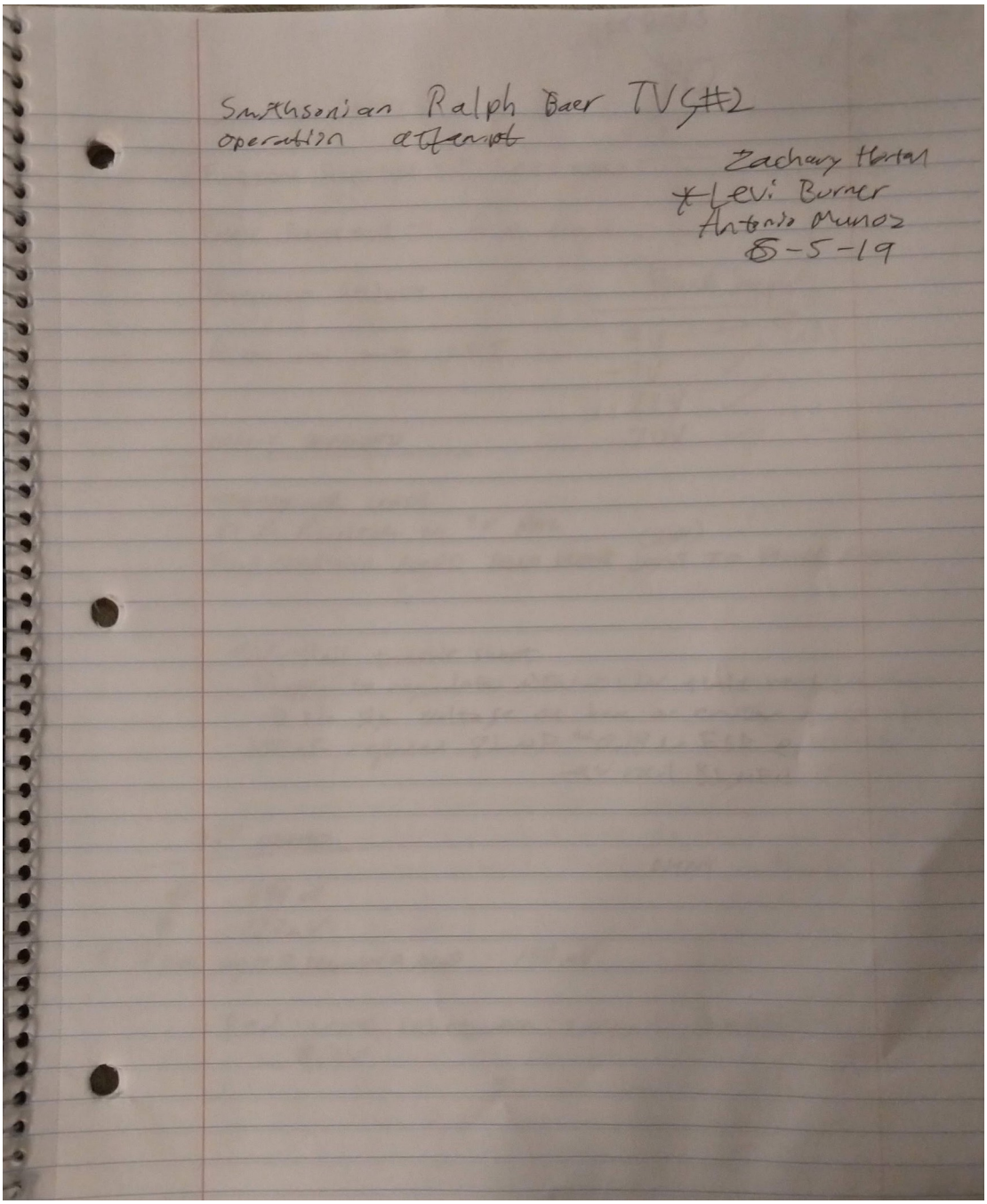

Switching functionss
Updated with TV52
connection points
6-18-19
L. Burner
A Horizontal control
Joybox
A Horizontal Dot pos
SW A
S1A
10K
From Chroma pulse shaper + gate ckt
Function Integrating Cap pump game
For A Dump's Dot pos.
To chroma gate power
To chroma Dot or Bar AND gate
SW A'
S1B
Vert Dmv
Vert Sync
SW B
Monochrome Vert Pulse Shape Base
Monochrome Horiz pulse shape Base
SW B'
Chroma Horiz pulse shape Base
Chroma Vert pulse shape Base
2 96834
Chroma Horiz Pulse Shape Base
Chroma Vert Pulse Shape Base
23-40

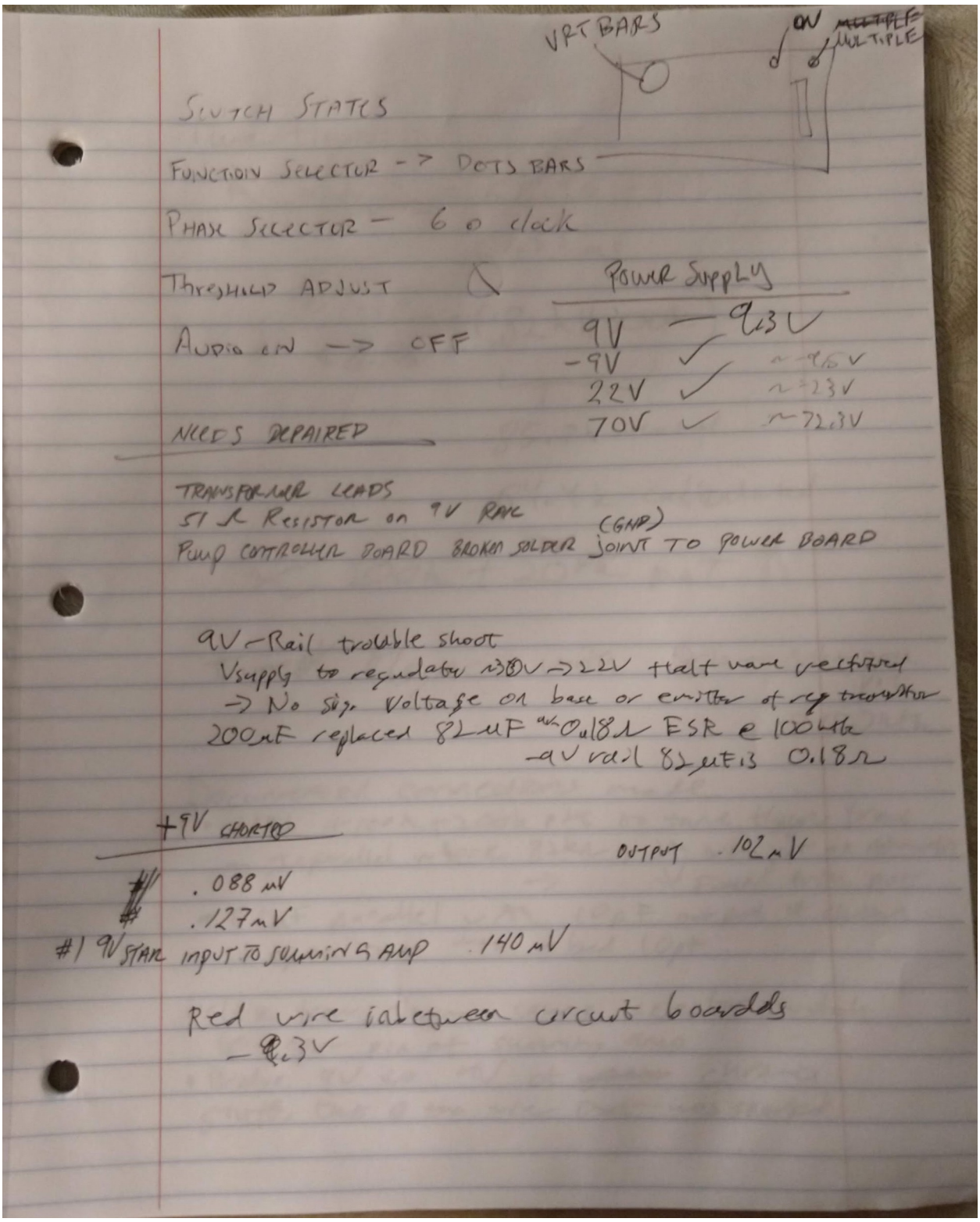

15,735-HZ Horiz Osc.
Horiz DMV #1
Horiz DMV #2
VERT DMV #1
VERT DMV #2
VERT SYNC
POWER SUPPLIES
Monostable Square Pulse Shaper And Gate
4.5 MC OSC + FM MOD
T.V. CH #3 OSC. MOD.
SUMMING AMP
RCA 3015
HORIZ + VERT BLANK LEVEL RETRACE CKT
CHROMA SQUARE Pulse Shaper And Gate
3.58 MC subcarrier
CHROMA VIDEO Variable Constant Current
3.58 CHROMA OSC.
CHROMA SIG Ø SHIFTER
CHROMA SYNC GATE DRIVER
CHROMA SYNC-VIDEO GATE
COINCIDENCE GATE
TIMER CKT
RESET Button
SCR
CL703L
THRESHOLD pot 250K
Note: points E, F, G, & H
Grid all but
E = Vert White Bar
F = Horiz " "
G = Vert Chroma Bar
H = Horiz Chroma Bar
23-81
Added addAbroll switch conn. points 6-18-19 L. Burner
UPDATED SCHEMATIC 6-14-67 W. HARRISON
RM Bly 6/14


PULSE RATE TO DC AVE.
+9V
-9V
1K
62K
1K
1K
1K
20K
VERT
HORIZ
These may be replaced by 3 pos switch banks
RANDOM PULSE UNIT
+70V
-30V
2 96863
CONTROL CIRCUITRY
VARIABLE RATE GATE
+10V
23-74
Switch pos annotation
6-18-19
L. Burner
UP DATED SCHEMATIC
6-14-67
W. HARRISON

Handwritten Notes

Page 1





SWITCH STATES

FUNCTION SELECTOR -> DOTS BARS

PHASE SELECTOR - 6 o clock

THRESHOLD ADJUST

AUDIO ON -> OFF

Power Supply		
9V	—	9.3V
-9V	✓	~ -9.6V
22V	✓	~ 23V
70V	✓	~ 72.3V

NEEDS REPAIRED

TRANSFORMER LEADS
51 Ω Resistor on 9V RAIL
PUMP CONTROLLER BOARD BROKEN SOLDER (GND) JOINT TO POWER BOARD

9V-Rail trouble shoot
Vsupply to regulator ~30V -> 22V Half wave rectified
-> No sig. Voltage on base or emitter of reg transistor
200nF replaced 82μF ~0.18Ω ESR @ 100kHz
-9V rail 82μF is 0.18Ω

+9V SHORTED

OUTPUT .102mV

#1 .088mV
#2 .127mV
#1 9V STAR INPUT TO SUMMING AMP .140mV

Red wire between circuit boards
-9.3V

Tune Hsync

RC = 1/14.5kHz = 68.96

63.55 us

$\frac{63.55}{68.96} \cdot (82k \| 300k)$

85.7k measured

64.4k calculated

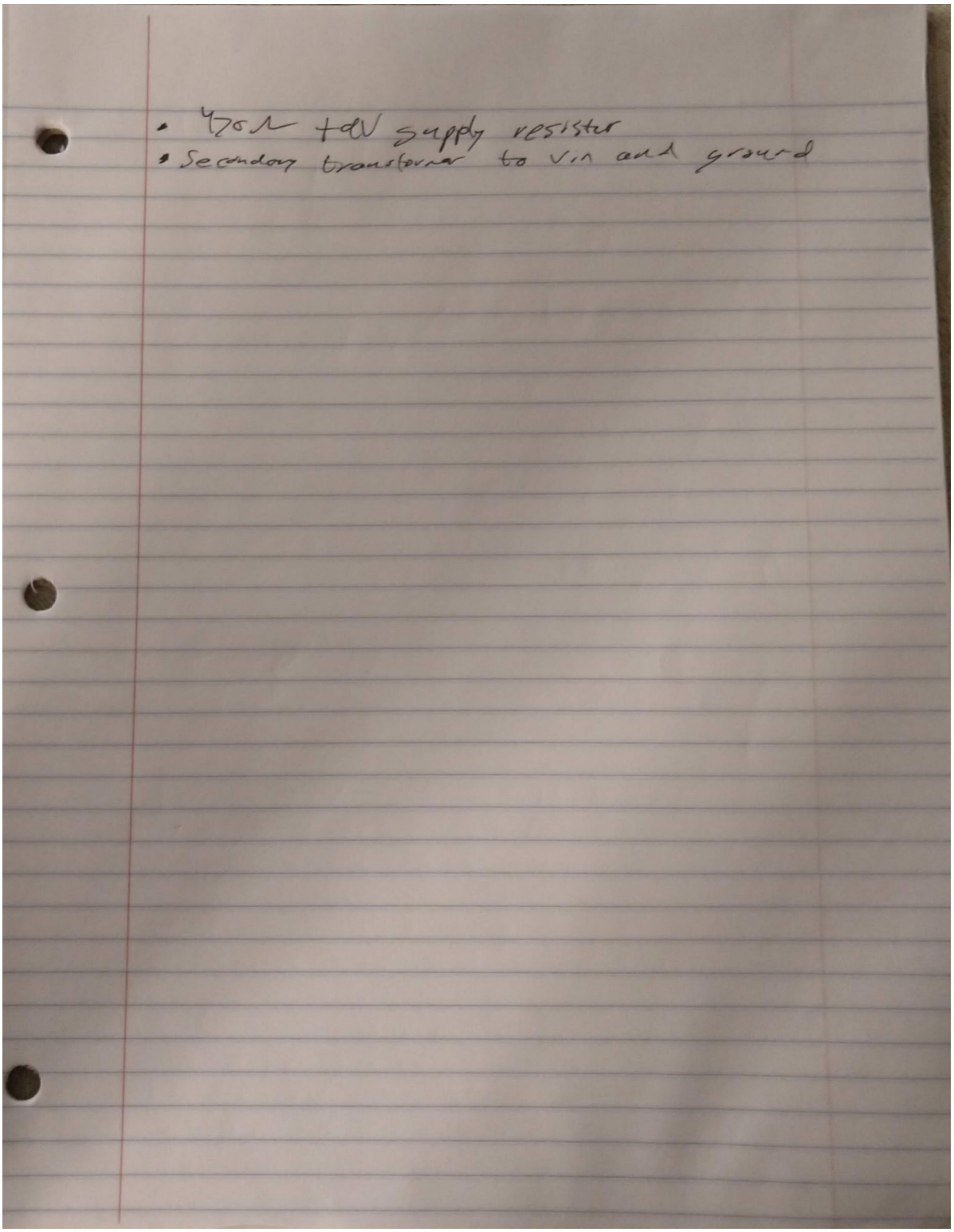
~ 200k + 20k pot

tuned Hsync with 330k + 100k + 200k pot

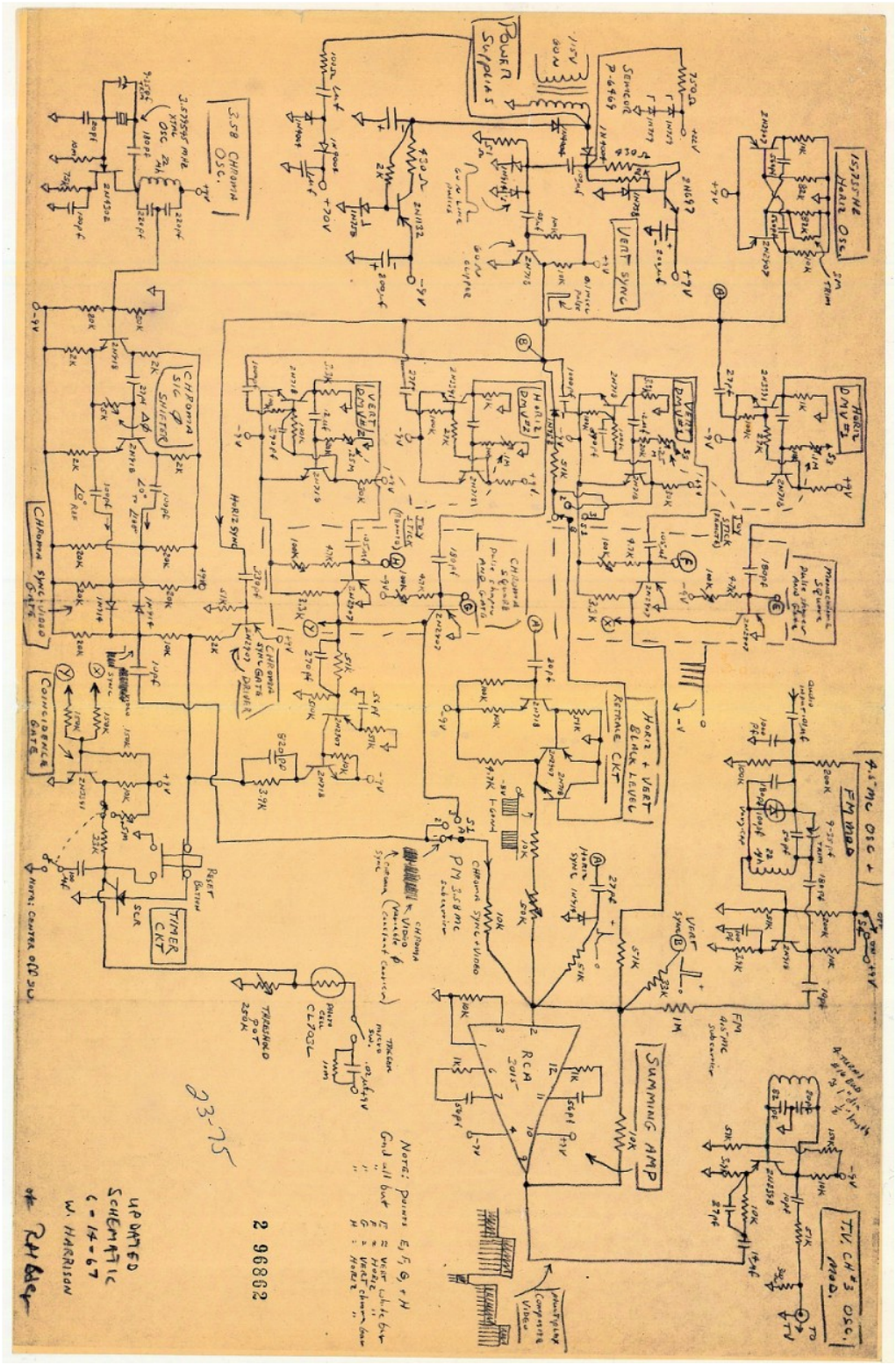
→ 15.7kHz

Documented connections made

- 330k + 100k + 200k pot to tune Hsync freq
  - In parallel where 82k + 3M trim pot on schematic → Found trim pot
- 0.1uF parallel with 10pF output of chroma + sync there was a bad 10pF
- 10k from chroma source selector switch to input pin of summing amp
- Bridge 9V to 4V of ~~ground~~ chroma stuff, this is the wire that was shorted


• 470Ω +dV supply resister
• Secondary transformer to Vin and ground

TVG2 Schematic



Cludge Schematic