28 October 1964

Mr. D. Brown
West Lambs Road
Pitman, New Jersey

Dear Don,

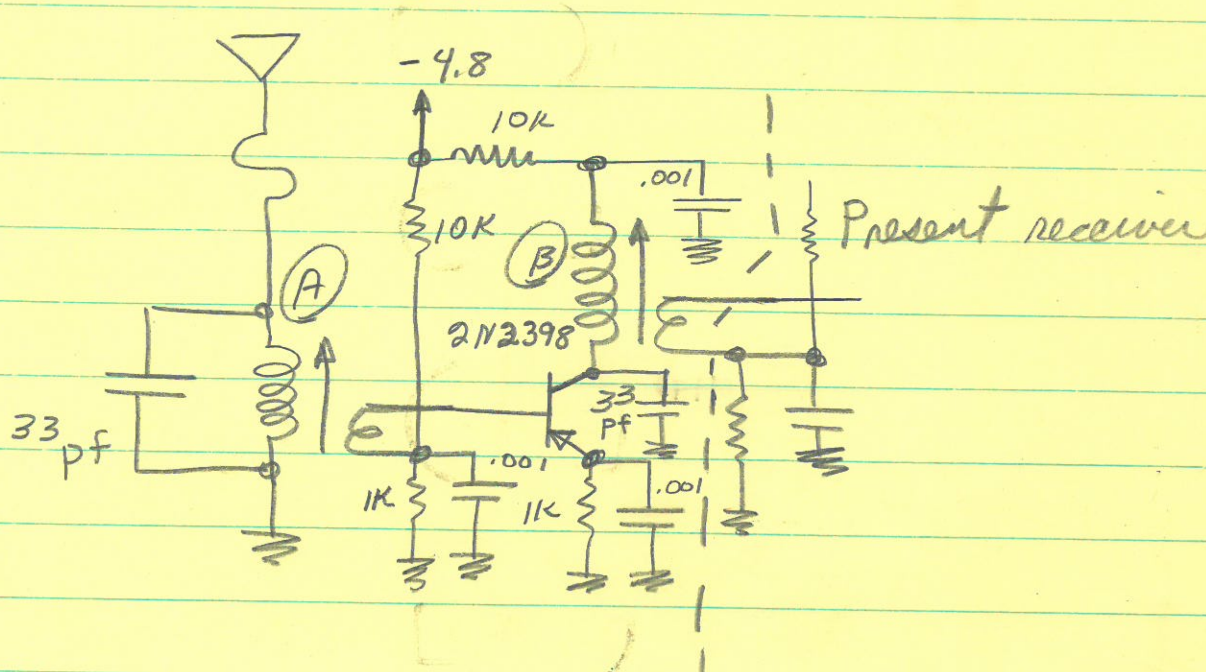
These are the schematics of the U^2 as it presently stands. The transmitter is nearly self explanatory. The receiver front end is a standard superhet. The first audio amplifier is biased to handle the range of audio signal levels without clipping. The second stage is a symmetrical limiter with threshold characteristics provided by the 1N198 diode and 1.5K resistor in the base circuit. The next two stages form a medium gain audio driver with negative feedback for low output impedance. This output drives all channels. The channel's frequency selecting tank is capacity coupled to the input and a secondary drives the two-transistor synchronous switch. The input collector of the synchronous switch is coupled to the input signal through a 3.9K resistor. The remaining transistor is an emitter follower that allows tuning the channel filter for frequency tracking and provided feedback for oscillation in absence of signal. A two stage RC filter removes most of the hash before application to the servo amplifier. The servo amplifier has been arranged to allow PNP in both outputs. The 2N1924 is a heavier chip transistor with about twice the power rating of the 2N1305. The input stage is a differential amplifier to provide better temperature tracking for signal off conditions i.e., the servo will not creep.

That about sums it up. Tracking and interaction are good with only one servo connected. There may be some problems when other servos are connected. The range effect is nearly optimum i.e., for sudden drop outs (such as agc not following) the servo remain motionless while for very gradual drop out (such as extreme range) the servo will offset about 10% of its travel and show evidence of noise. Range looks good.

Regards,

Carl

Mar 15, 1965



R.F. Amplifier

(A) & (B) are identical to present ant coil.

Don:

I am sending back the originals. I finally achieved some good prints for my use if necessary.

Carl

Don,

The frequencies are 3150 cps, 2640 cps, 2300 cps, 1715 cps. The oscillators are quite stable so long as the ± supply voltages are within 1 volt of each other i.e. +6 & −6 volts are within 1 volt of each other. The error at 3150 with 1 volt difference is about 4 cps. These frequencies represent the center of control position for ail, elev & rudder. It should be low motor. The motor control should tune 3150 →.

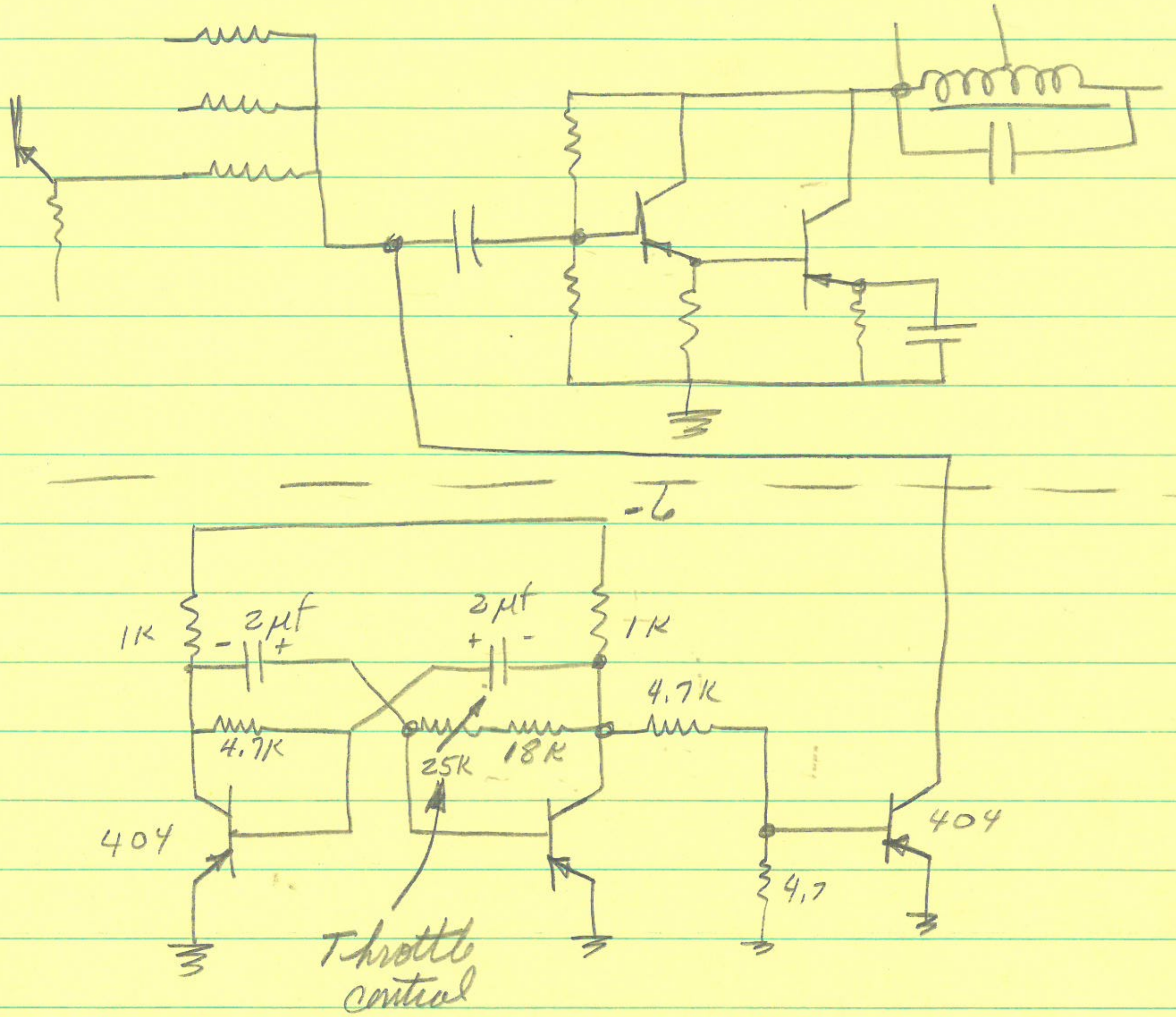
Carl

12 February 1965

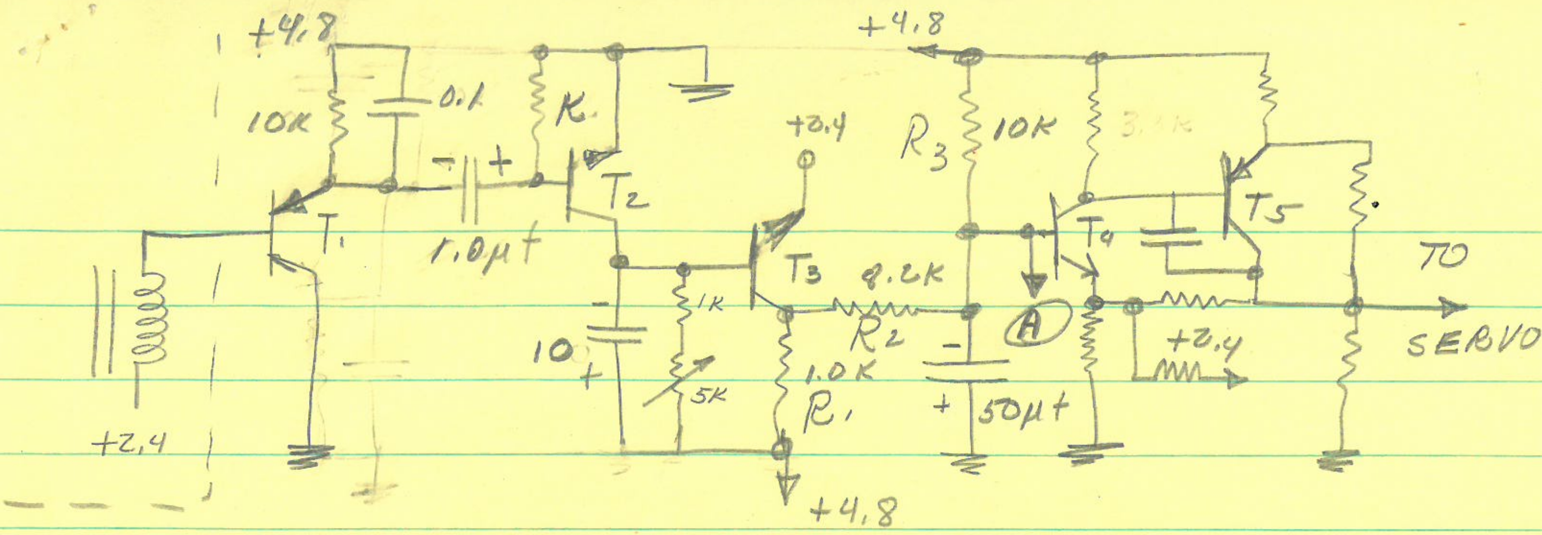
Don,

How to get a fourth channel by amplitude modulation? A little more thought about it raises one question. Originally, when I thought of this I was considering the frequency tracking system wherein servo feedback returned the discriminator. In that system the phase of the discriminator would not drift out of phase appreciably while the tone was off. I am not sure about the present system. Consider the case of full up elevator. The frequency of the discriminator is pulled, and during the off-tone period quickly phase shifts so that when the tone returns I think the discriminator will tend to flip through just as it does when you attempt to pull it too far frequency wise. Now this calculateable so let's try. The discriminator oscillator flips when the phase shift between it and the input reach 90°. Assuming the phase difference is 45° when the control is at extreme the question is how long can the tone be removed before the additional 45° is accumulated. Interesting enough this time is only a function of the difference between the tone and the free running frequency of the discriminator oscillator. Therefore assume a subcarrier of 3000 ~, and assume ±5% frequency change i.e. ±150 ~. The maximum difference therefore is 150 ~. Thus the maximum off time is $1/8 \times 150$ ~ $= 1/1200$ sec! (The 8 comes because 45° is 1/8 of a cycle)

Well this is as is not a problem for if it can loose sync that fast it should regain it that fast when the tone returns. So the only thing to do is test and find out. The modulation in the transmitter should not disturb the subcarrier oscillators to minimize the above problem. An asymetrical multivibrator seems a logical choice. This requires 2 transistors and a clamp requires another. A schematic is shown on the next page and I have tried to arrange it so that it can be rigged up and tacked in to an existing transmitter.



The detection in the receiver poses a different problem. Probably the best place to detect is off the secondary of the audio transformer (the TR-98). This is referenced to +2.4 and has good amplitude. See next page.



The components associated with T_4 + T_5 are the same as presently used to drive the throttle servo. The transmitter modulation should be adjusted to turn the tones off for 5 milliseconds (.005 sec) and the repetition rate should vary from 20 to 40 pps for throttle control. Auxiliary channel may (and may not) be available from point (A). You may have to adjust R_1, R_2 + R_3, particularly R_2 + R_3 to optimize the error voltage range to the servo.

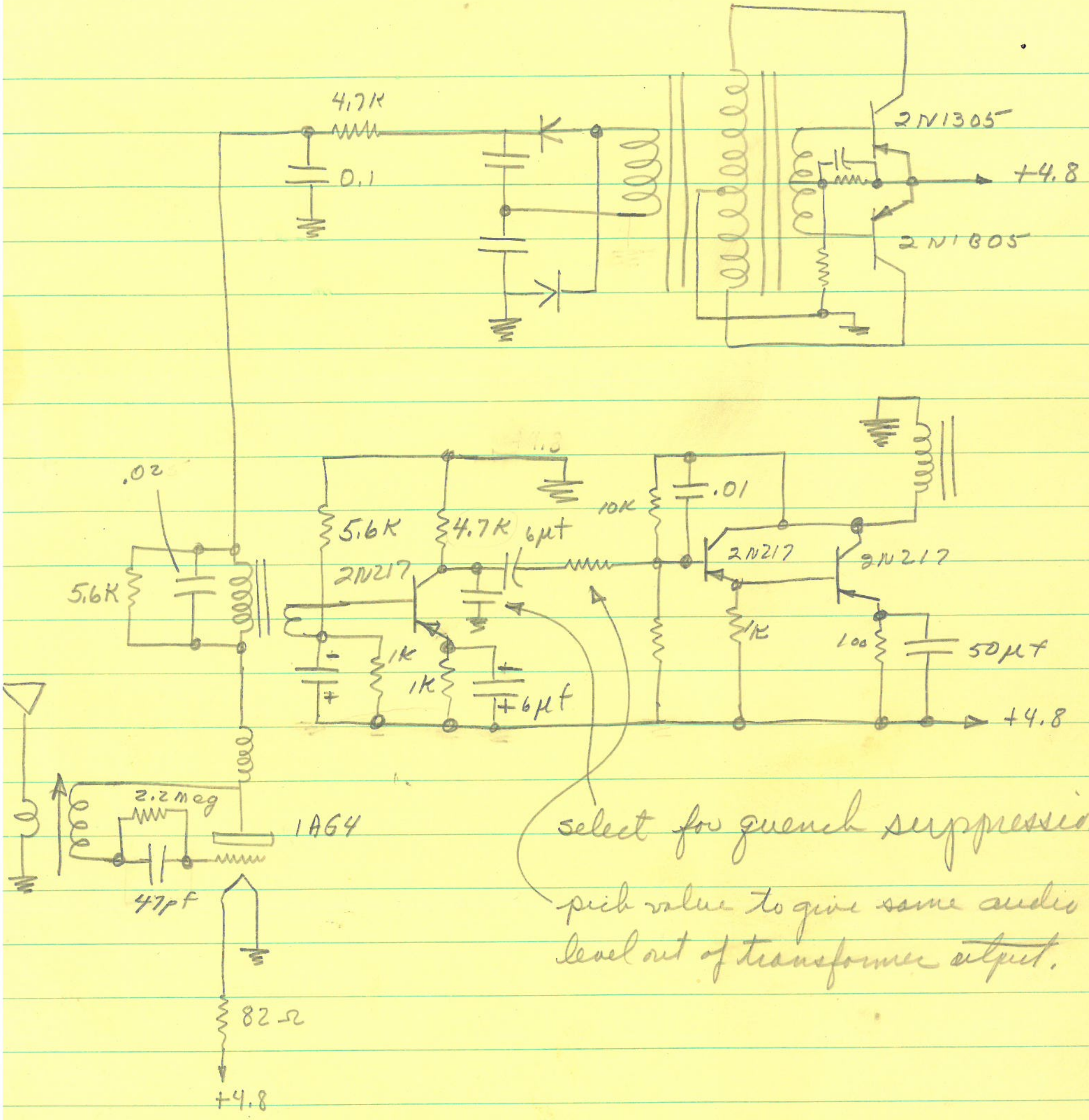
Transistor T_1 functions as an emitter follower tone detector. The detected pulse drives T_2 to charge the 10 mfd capacitor. T_3 generates a constant width pulse that is integrated and smoothed by R_2, R_3 and the 50 mfd capacitor.

Well thats about it. Build the transmitter portion first and set it up to turn off the tones .005 seconds at a rate variable from 20 to 40 pps. Next investigate cross talk effects due to discriminator oscillator unlocking. If these check out, then build up the receiver portion. Good Luck

Regards

Carl

25 May 1965



select for quench suppression

pick value to give same audio level out of transformer output.