

AM Improvements for the Allied Knight T-60.

By Phil Legate – AC0OB

The Allied Knight T-60 AM/CW transmitter (**Figure 1**) was introduced in the 1961 to 1962 time frame as another Novice Class transmitter with 60 Watts maximum input power. The predecessor was the Knight T-50, a 50 Watt CW only transmitter, and its successor was the T-150 a 150 Watt input AM/CW Transmitter.

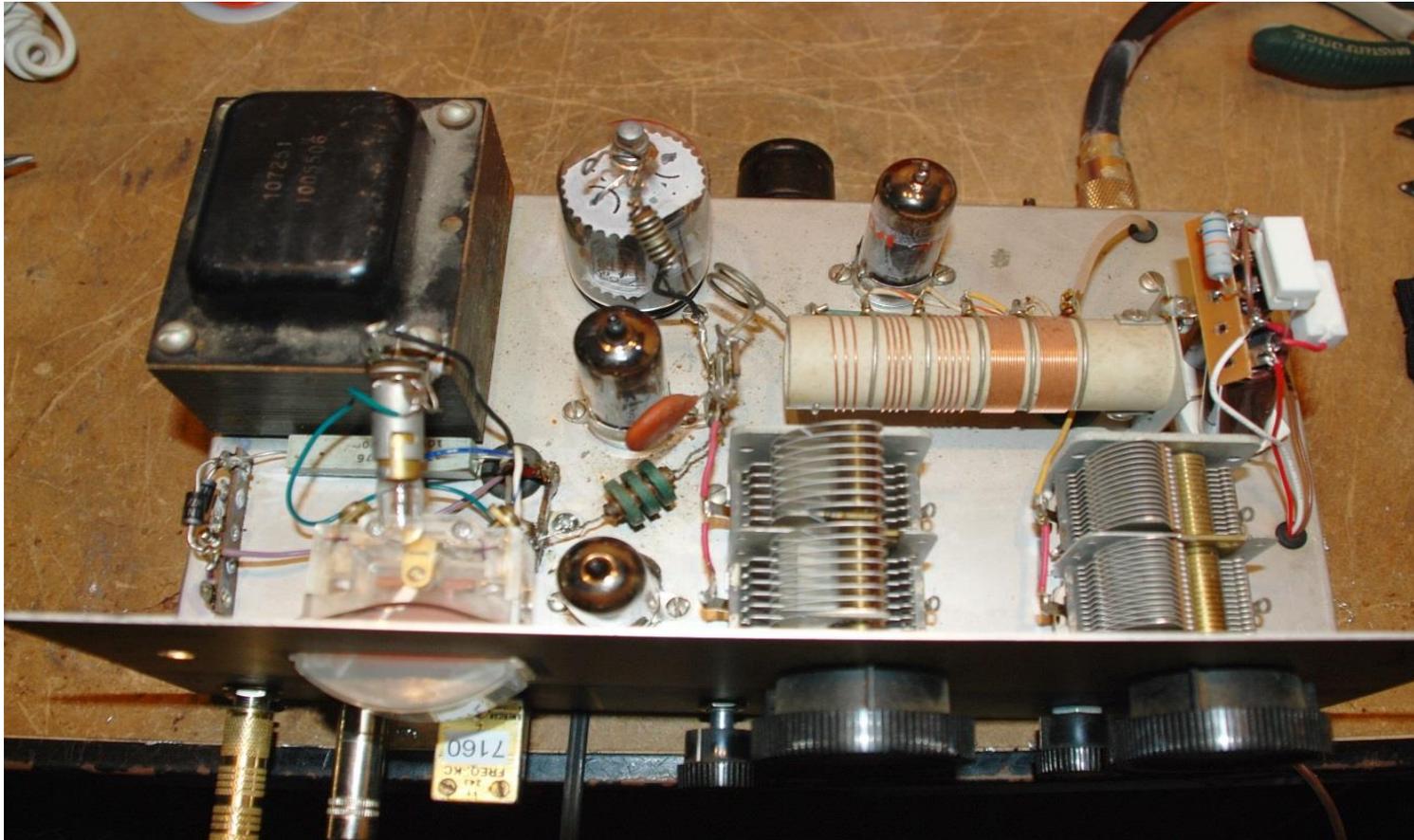


A number of articles describing the Knight T-60 have been previously published but were mainly high-level descriptive accounts and contained no detailed circuit descriptions or technical modifications for improvements (1)(2). Power output of the unmodified T-60 was about 7 Watts on AM and 12 Watts CW...on a good day. This transmitter is definitely a QRP rig but fun to use.

Circuit Description:

The T-60 is a four tube, Bandswitched AM/CW transmitter for the 80 to 6 meter bands, **Figure 2**. A Triode-Pentode 6HF8 serves as the Oscillator and Buffer-Multiplier-Driver. A 6DQ6 television, horizontal “sweep” tube serves as the RF Final. The audio and modulator section is comprised of two tubes: The 12AX7A is the speech amplifier whereas the 6DR7 is the Screen Grid Modulator (SGM) with a Controlled Carrier circuit.

The power supply is a silicon diode rectified full wave voltage doubler with minimal filtering.



General Comments:

I purchased this transmitter with a Knight R-100A receiver from a collector of electronic gear. Since this was to be my personal T-60, I decided to investigate the various shortcomings and make modifications for improvement.

Contrary to previous modifications of similar screen grid modulated gear (ER #309, 311, 312, 314, 315), there is no room on this chassis for an additional bias voltage circuit nor room for a changeover Relay and its circuitry.

The power supply has poor voltage regulation. This transmitter was no exception. Power supply voltage regulation was poor, with a delta of 87 volts, and the 12AX7A was DOA as well. I powered up the rig on a Variac and monitored the voltages. The 12AX7A plates were receiving over 340 volts on KeyUp at 120VAC. This stage is always conducting, whether it be KeyUp or KeyDown, and looking at the feed circuit (plate rail), one can see why some 12AX7A failures occurred.

Although we are constrained by chassis size, we will improve the power supply, speech amplifier, and modulator.

Before beginning the modifications, tighten all mechanical connections, especially the tube socket screws since the ground lugs on the tube sockets are used for component ground “returns.”

Power Supply Modifications (Figures 3-6):

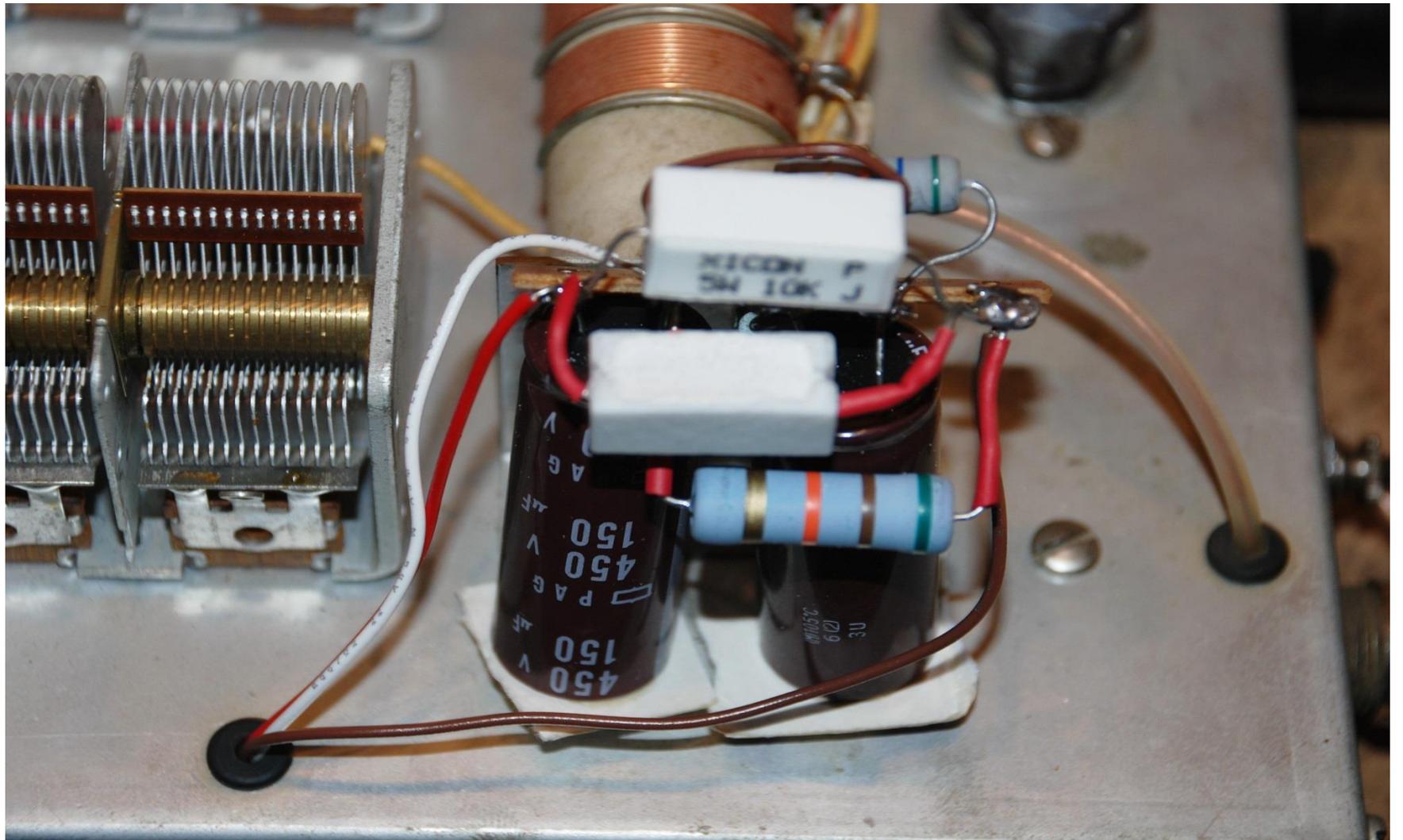
Note: Components marked with a single Asterisk “*” are modified values. Components marked with a double Asterisk “**” are new components. Voltages marked with a single Asterisk “*” are KeyDown values. Resistors are Metal Oxide types unless otherwise noted. All capacitors are 1 kV rated ceramic types unless otherwise noted.

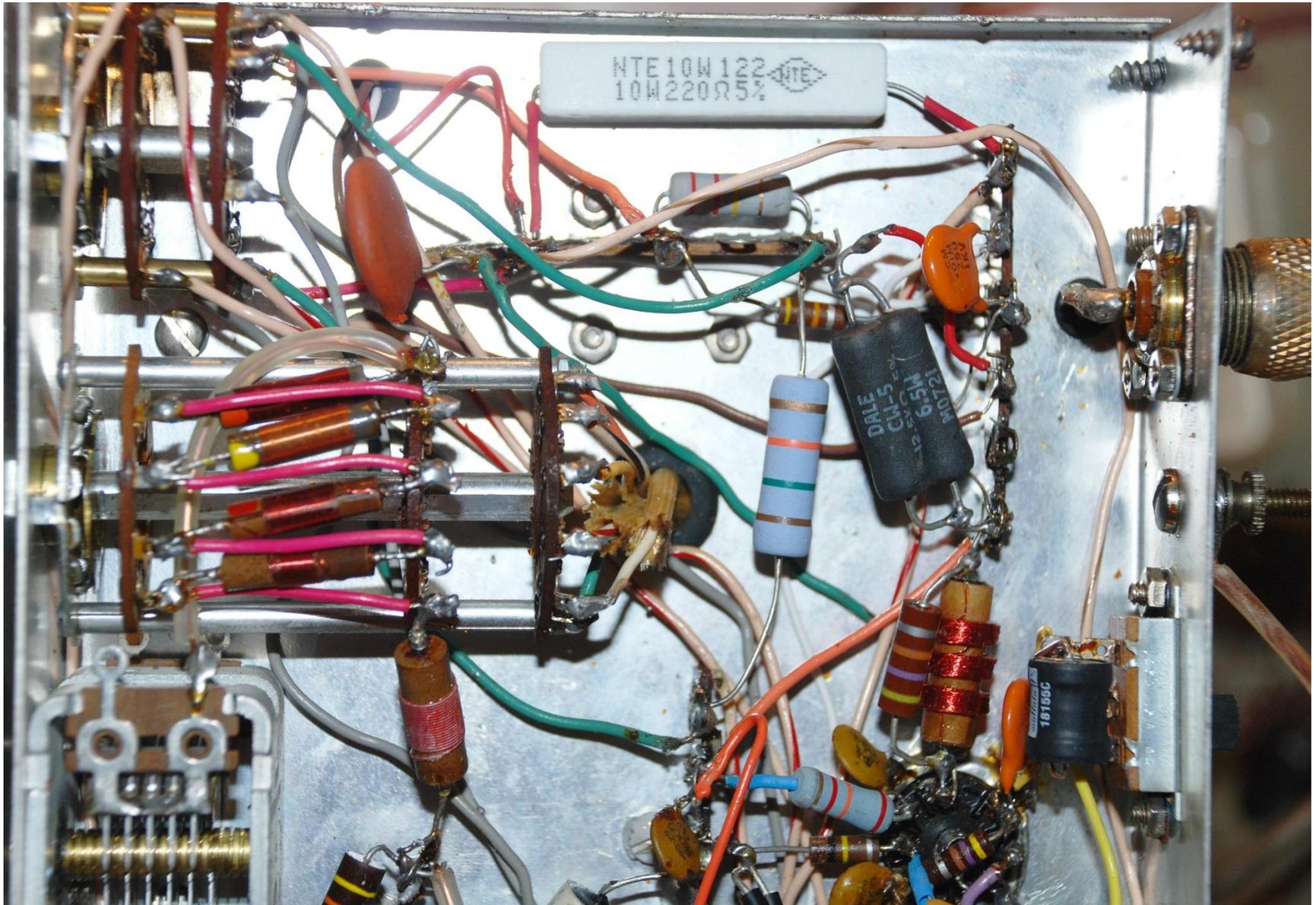
To reduce audio hum and ripple voltage, we modified the power supply as seen below in **Figures 3,4** by: 1) Balancing the voltages, 2) increasing the filtering capacitance, and 3) adding voltage dividers. The additional components to the right of R28 were mounted on the rear of the Pi-Net coil with a 5-lug terminal strip, **Figure 5**. Three new wires from this terminal strip were routed through the adjacent grommet to the appropriate underchassis locations as seen in **Figures 5, 6**. The components in the lower right corner of **Figure 3** and **4** are mounted underneath the chassis. The KeyDown HV B+ voltage is now 50 volts higher than stock.

Orienting the chassis with transformer down, the top right terminal strip lugs 1-4 are cleared and cleaned of components seen in **Figure 6**. The components removed are associated with the output power metering and are relatively useless. We are going to later meter the Cathode of the 6DQ6 for Plate Current metering, in which the majority current is the Plate Current.

To reduce the resulting LV voltages, which are higher than stock, the components seen in the **Figure 4** are used. The zeners are series-parallel connected to reduce the KeyUp voltages to a manageable level.

The stock voltage divider components (not shown on the schematics), consisting of R20 was increased to 15k, 3 Watts.





The Speech Amplifier, **Figure 7**, was modified to present a more articulate audio signal to the modulator.

A new microphone gain potentiometer of 500k ohms was installed to achieve the maximum available audio voltage from the first stage without excessive loading as in the original circuit. Yes, the front panel had to be removed, but it needed cleaning anyway. This first stage is left un-bypassed to achieve the lowest distortion. A new shorting type ¼” microphone jack was also installed in lieu of the RCA jack with a 0.005 coupling capacitor.

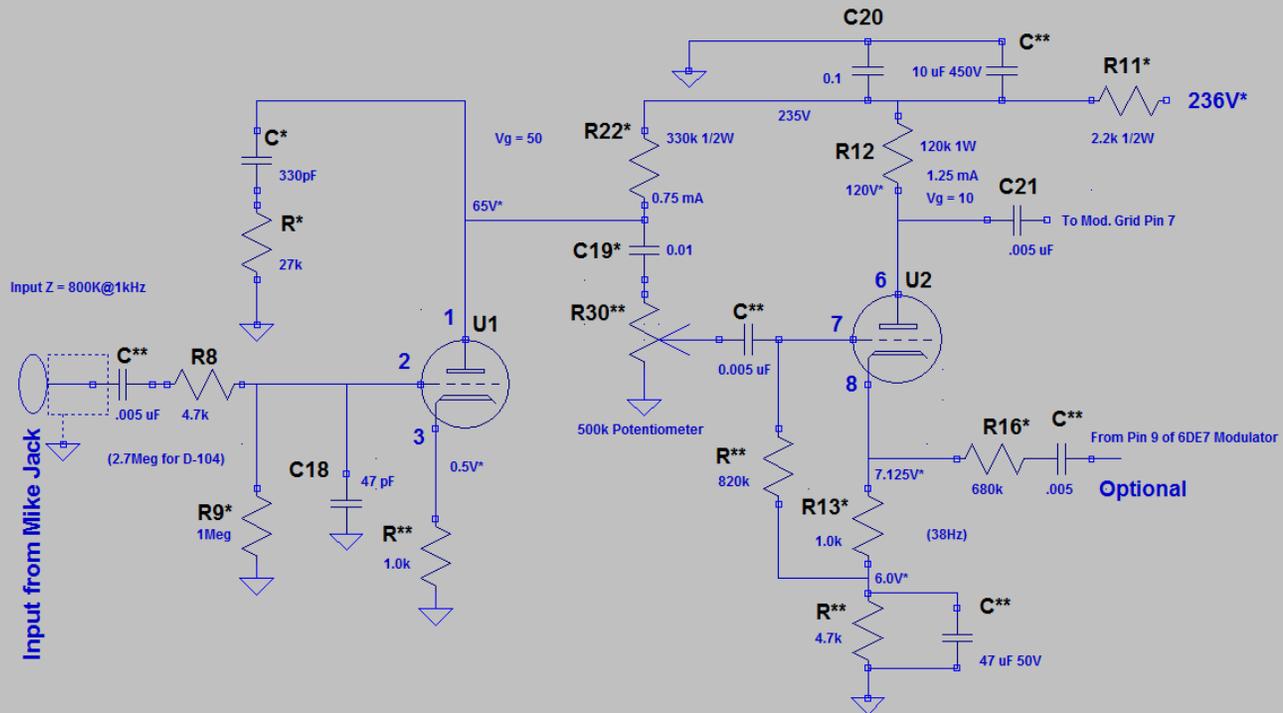
The second stage cathode resistor R13 is also left un-bypassed to reduce distortion. This second stage is “up-biased” to accept a higher peak-to-peak audio voltage from the first stage.

The series C** and R** components (330 pF and 27k ¼ Watt) rolls off any unnecessary high frequency audio components, hiss, and noise. These components can be placed across R30 if desired.

Feedback components R16*, C** are optional and were not used. They are only to be used in case some distortion is heard. In fact, with all of the un-bypassed cathode resistors, distortion is low and the feedback circuit was found to be unnecessary.

If one cannot find an Astatic D-104 microphone the *Shure 450 Series II dynamic microphone*, set to High Impedance, makes an excellent replacement for any vintage transmitter.

Knight T-60 12AX7A Speech Amp Stage



The Cathode Follower (CF) modulator is shown in **Figure 8**. The modulator tube type was changed to a **6DE7** dual, dissimilar triode because of its first stage characteristics.

The specifications on the original T-60 schematic show a voltage of 70 volts on the second stage grid. This voltage has to be 70 volts in order to arrive at a cathode voltage of 135 volts at Pin 9.

This cannot be accomplished with a 6DR7 as in the original schematic. In fact, only about 27 volts are presented to the second stage grid in the original circuit, and the cathode voltage is only about 90 volts. This leaves only 45 volts to bias the Final's screen grid.

The characteristic curves for the first stage of the 6DE7 were consulted and it was found that a grid voltage of -2 volts was needed at a plate voltage of 70 volts, so the cathode voltage was set 2 volts higher than the grid. This stage was also up-biased to accept higher peak-to-peak voltages from the last speech amplifier stage. The 680 ohm resistor is also left un-bypassed to reduce distortion.

While leaving all audio stages un-bypassed reduces the total gain, this audio chain still has plenty of audio gain. In this transmitter about 60 degrees rotation of the Microphone Gain potentiometer yielded plenty of modulation at 100% as seen on the oscilloscope.

The cathode circuit of the CF stage was modified as well. R19 was changed to a 100k 2 Watt resistor and a new controlled carrier circuit was implemented. R18 is now a 27k ohm, 2 Watt resistor and C23 was changed to a 0.22 uF, 250 volt film capacitor. This change allows maximum audio voltage to be developed across R19 with a subsequent reduction in CF current. It also maintains a quiescent DC voltage of approximately 85 volts in order to bias the Final screen to produce 15 Watts output.

Additional capacitors were placed across R19 in order to create a 750 Hz pre-emphasis for better articulation of the transmitted audio and a 68 pF capacitor was added to shunt any VHF RF that may have made it to the Modulator stage.

Knight T- 60 Modulator Stage V3 6DE7

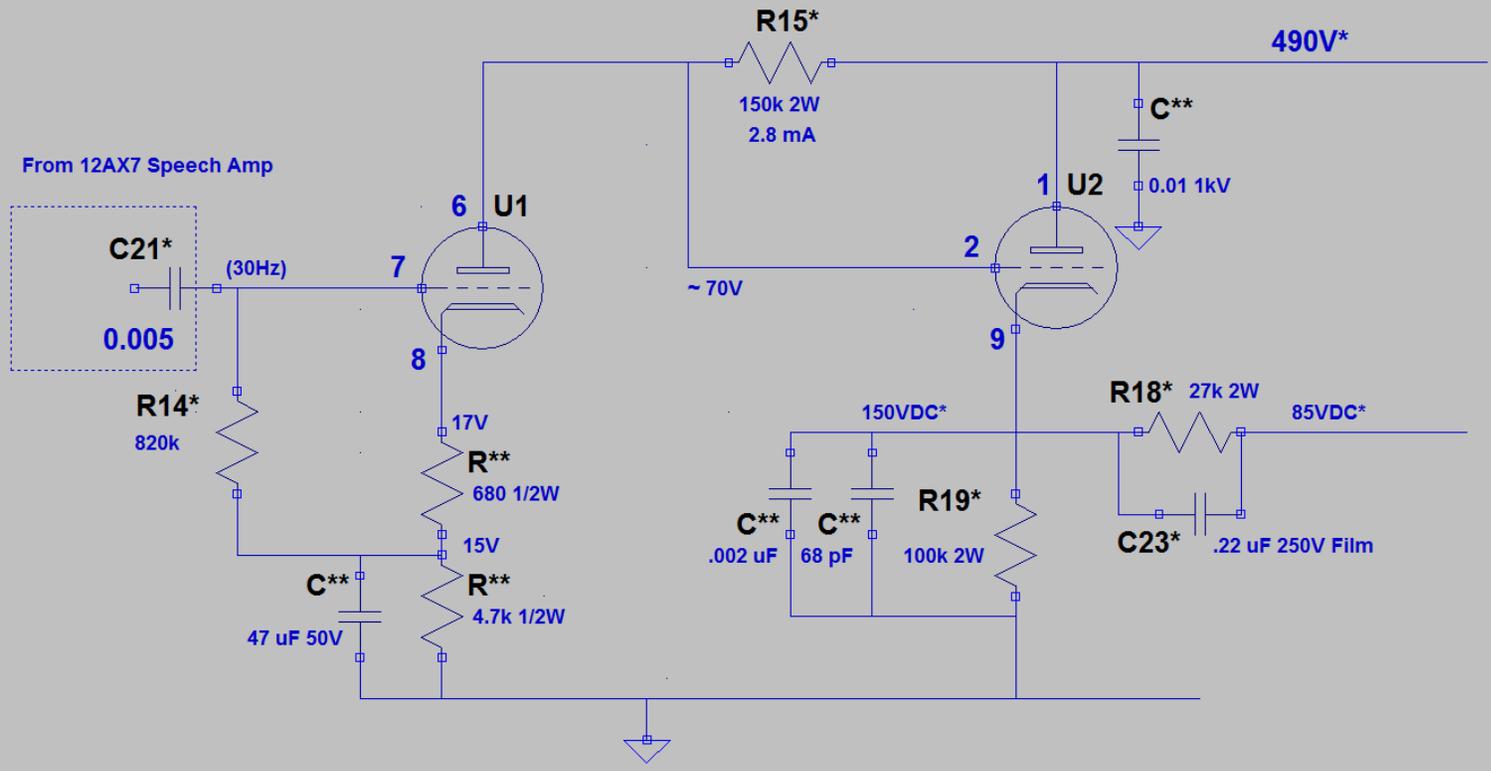


Figure 9 is the V1 Oscillator and Buffer-Multiplier-Driver schematic.

C30, the Bandswitch coils L1 through L5, and C10 form a Pi-Net matching circuit between the output of the Buffer-Driver and the grid of the Final.

A number of components in the original circuit were found to reduce RF output and subsequent drive.

First, the original grid resistor of the oscillator did not allow a high enough level of RF voltage to be developed. The grid resistor R1 was changed to 100k ohms and the capacitor C1 was increased to 50 pF. Interestingly, R1- C1 is on an octal jack at the front panel, hence the reason for so much stray RF in the chassis underside. It is advisable to keep the oscillator wires as close to the chassis as possible. To reduce crystal heating, a 1/2 Watt 22 to 30 ohm carbon composition or carbon film resistor is placed at the octal plug terminal in series with the blue wire coming from the C2 capacitor.

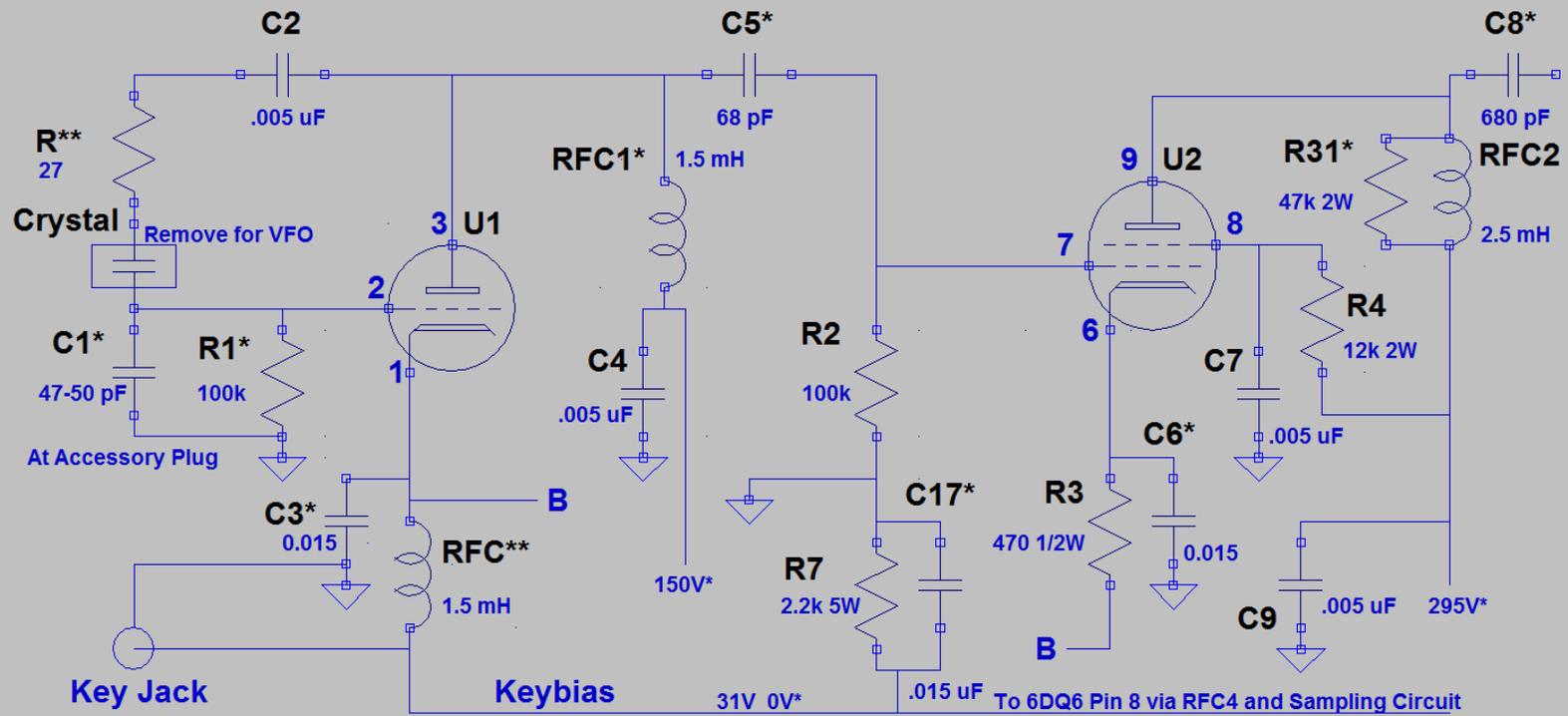
Secondly, the oscillator is “over coupled” to the Buffer. C5 was reduced to 68 pF and the RFC1 choke was decreased to 1.5 mH. With this modification alone, power increased to 9 Watts at 7.160 MHz.

Since there was RF on the KeyBias line, a 1.5 mH choke was installed in the cathode circuit of the oscillator. The slide switch terminals are now used to mount this new 1.5 mH choke. In addition, 0.01 uF ceramic capacitors were placed across the original 0.005 uF ceramic capacitors to reduce stray RF.

The Buffer-Driver stage was also modified in two areas. Its plate choke RFC2 was reduced to 2.5 mH, and the coupling capacitor C8 was reduced to 680 pF. The bandwidth-broadening resistor R31 was increased to 47k ohms, carbon composition, 2 Watts. This resulted in a total output power in the AM mode of 15 Watts at 7.160 MHz.

Previous articles noted parasitic oscillations in the two lower bands. I found no parasitic's either before or after modification. However, looking at the values of the RF components in the original circuit, I can believe some parasitic's may have arisen with various tubes.

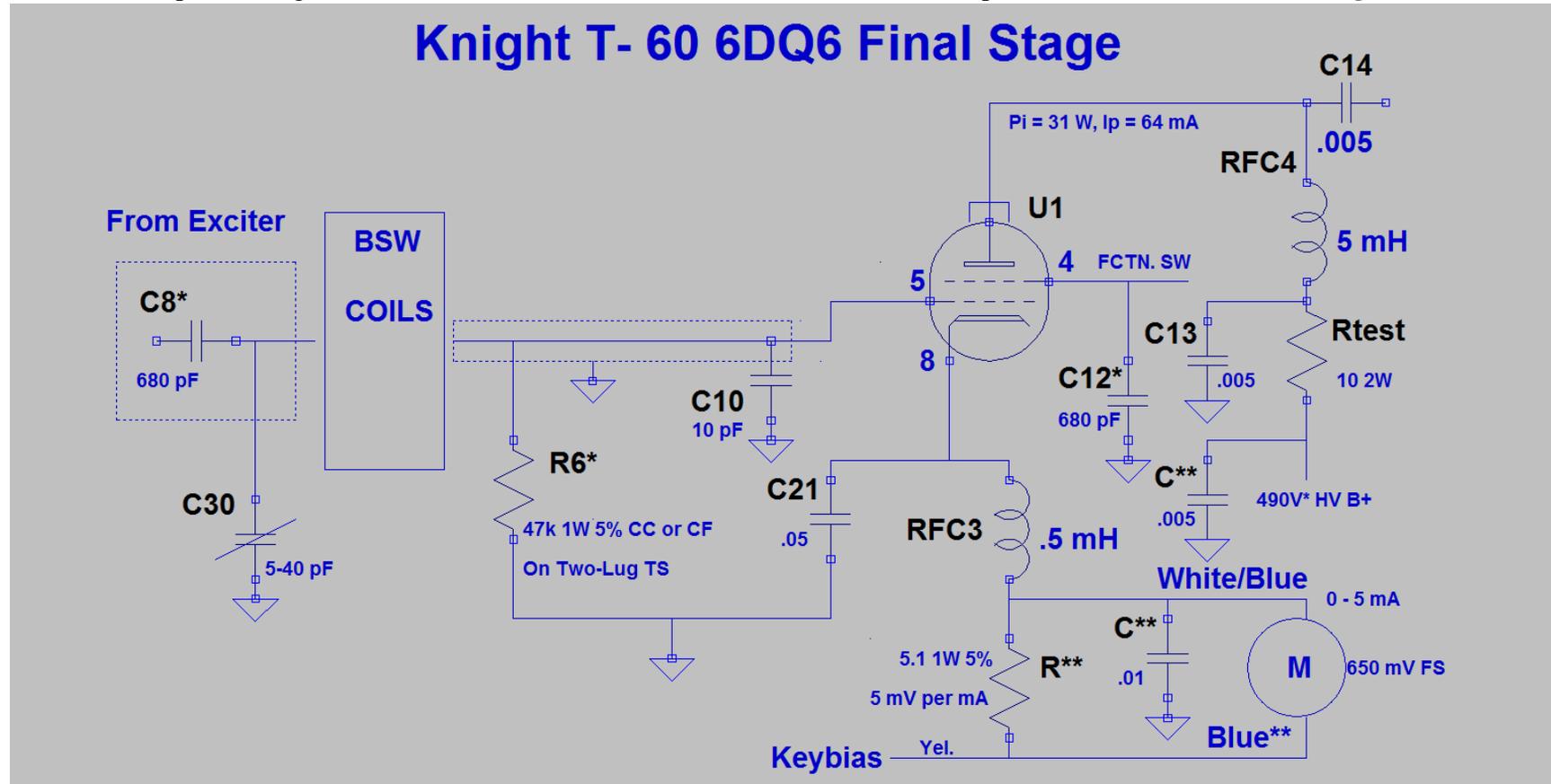
Knight T- 60 Osc. Mult. Driver V1 6HF8



The 6DQ6 Final circuit is shown in **Figure 10**. Since the RF power metering circuit was dismantled, we use the meter to sample Plate current via the cathode current.

The original ground wire common to both the meter lamp and the meter *minus* is removed. A new ground wire is connected to the meter lamp ground terminal using a new #6 ground lug placed underneath the terminal strip ground lug immediately below it.

The meter lamp mounting tab is bent and is now mounted on the corner screw of the power transformer, as seen in **Figure 2**.



A new 5.1 ohm 1 Watt resistor is placed in series with the original RFC4 choke and the KeyBias line. A new solid Blue wire is routed to the “minus” side of the meter as per the schematic **Figure 10**. The original White/Blue wire remains on the positive side of the meter terminal. Now you can visually *Dip* the plate current.

The meter indication is multiplied by 20 to arrive at the plate current. A new 1 Watt R6 replaces the ½ Watt 47k ohm grid leak resistor. A new 0.01 uF capacitor, located at the accessory plug, is placed on the positive lead of the White/Blue lead going to the meter. C12 is replaced with a 680 pf 1kV ceramic capacitor to allow higher frequency audio to be developed while also shunting any RF at the screen grid.

With 31.4 Watts input, 15 Watts is about the maximum AM power one can squeeze out of the 6DQ6 Final in an SGM configuration. The 60 Watts input specification is for CW where the R20, R21, R22 voltage divider increases the Final’s screen voltage and increases the plate current.

The PI-Net circuit was one of the features that was well designed in my opinion. Its impedance matching efficiency verses power output is essentially flat over all bands. Sampling of the resulting RF spectrum showed a bandwidth of 13 Khz with no harmonics or other spurious signals outside this bandwidth. If you intend to operate in the two lower frequency bands exclusively, a 47 pF to 68 pF ceramic 2 kV capacitor across the C16 loading capacitor will increase power output slightly.

Conclusion:

While a number of components were added or modified for such a simple transmitter, this AM QRP rig now has better audio and higher RF output. Another useable, historical SGM transmitter rig has been added to my vintage radio collection.

References:

1. QST, May 1962, Page 60.
2. ER # 74, Page 20.