

Heathkit of the Month:
by Bob Eckweiler, AF6C



The Heath TX-1 Apache HF AM/CW Amateur Transmitter

Introduction:

As you know from my earlier articles, Heathkit, in the late 50's and early 60's, liked to name their ham equipment after American Indian tribes. The *TX-1 Apache* is one of these ham kits.

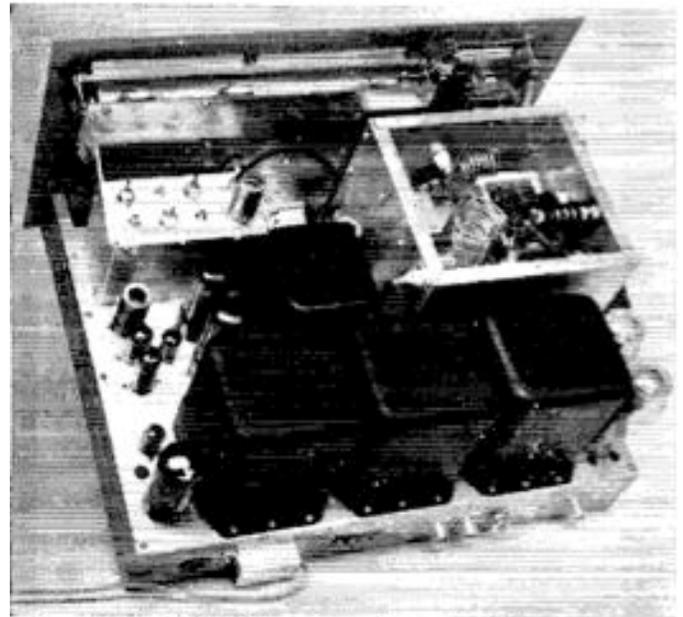


Heathkit TX-1 Apache AM/CW Transmitter
(Operates SSB with SB-10 SSB Adapter)

The *Apache* is a high frequency amateur transmitter that covers 80 through 10 meters. It was manufactured way before the WARC bands so 30, 17 and 12 meters are not covered, nor is the 160 meter band. The *Apache* runs 180 watts on CW and 150 watts on AM using high-level plate modulation. With the optional Heathkit SB-10 SSB adapter it can run 180 watts PEP on SSB.

The *Apache* replaced the DX-100B in 1958, though the popular DX-100B continued in production for two more years until 1960. The *Apache* kit was originally priced at \$229.95 in the Heathkit catalog, and was produced until sometime in 1964, when it was replaced by the
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Heathkit SB-400 CW/SSB transmitter. An interim HX-10 CW/SSB/AM transmitter called the *Marauder* was offered from 1962 to 1965; it physically looks very similar to the *Apache* but adds SSB and uses low-level modulation on AM. The *Apache* transmitter is the companion for the *Mohawk* HF ham-band receiver (See Heathkit of the Month for March 2009). The *Apache* physically looks identical to the *Mohawk* and shares the identical 19-1/2"W x 11-5/8"H x 16"D green cabinet.



Heathkit TX-1 Apache Transmitter shown
with case and final cover removed.

Construction:

If you lift the two units the *Apache* will be easy to distinguish from its companion *Mohawk* receiver. The *Apache* weighs in at a very hefty 107 pounds. Much of this weight comes from five large hunks of potted iron - three of these mount along the back of the chassis; the power transformer, the plate power transformer and the associated choke. Nearby sits the modulation transformer. Another choke is mounted under the chassis for the low-voltage power supply. Above the chassis is a cage that shields the two final tubes and pi-network output; the cage is topped by a small fan motor that cools the final tubes. Also atop the chassis is a shielded box that houses the VFO. Like the

Mohawk, the *Apache* has a drum dial that rotates with the bandswitch so that only the dial marking for the selected band is visible. Near the front of the chassis is the series of gears, pulleys and levers that operate the drum, drive the VFO tuning, link the band-switches and operate the loading control.

The under side of the chassis is divided into four shielded sections. One section contains the under chassis wiring for the audio circuits, another the low-level RF circuitry, a third the RF amplifier input circuitry, and a fourth that contains the wiring for the power supplies and all the bypassing for the rear panel connections. No printed circuit boards are used; all the wiring is point to point.

The Front Panel:

The front panel of the *TX-1 Apache* includes a multipurpose meter and a long slide-rule VFO frequency dial. Both are recessed and set off with a metal frame. When the transmitter is on, the meter and dial are lighted. A large tuning knob operates the VFO and moves the slide rule dial pointer.

The center group of controls are (from left to right and top to bottom):

High Voltage On - red jeweled lamp

TUNE/OPERATE - toggle switch

POWER: ON/OFF - toggle switch

METER - rotary switch:

DRIVER current,

GRID current,

FINAL plate current,

HV - plate voltage,

MODulator current.

STANDBY/OPERATE toggle switch

Final **LOADING: 0 - 10** - capacitor

DRIVER Tuning: **0 - 10** - capacitor

DRIVE Level - potentiometer

VFO tuning knob

SPOTTING - push button

The bottom row of controls (from left to right) are:

MIKE connector (Amphenol series 75)

Audio **GAIN**

Mode **CW, SSB, AM** - rotary switch

XTAL/VFO - rotary switch

FINAL tuning **0 - 10** - capacitor

BAND: 80, 40, 20, 15, 10 - rotary switch

KEY - 1/4 inch phone jack

Note: bold letters indicate the front panel nomenclature.

Tube Lineup:

The *Apache* utilizes eighteen tubes marked V1 to V19. There is no V13; that this was omitted for superstitious reasons seems unreasonable. Perhaps V13 was to be the rectifier tube for the -150 volt bias supply, and was replaced by selenium rectifiers prior to production. Two selenium rectifiers are used in the full-wave -150 volt bias supply. Another single selenium rectifier is used for the negative modulator bias supply.

V1	6AU6	VFO
V2	5763	Driver
V3	6CL6	XTAL Oscillator/Buffer
V4	6AQ5	Clamper
V5	6146	Final Amplifier
V6	6146	Final Amplifier
V7 a	12AX7	Audio Preamp
V7 b	12AX7	Audio Amplifier
V8 a	12AU7	Audio Amplifier/Clipper Driver
V8 b	12AU7	Audio Amplifier
V9	12BY7	Audio Driver
V10	6AL5	Clipper Diodes
V11	EL34	Modulator
V12	EL34	Modulator
V13		not used
V14	5V4G	Low Voltage Rectifier
V15	5R4GY	Plate Voltage Rectifier
V16	5R4GY	Plate Voltage Rectifier
V17	0B2	Screen Voltage Regulator
V18	0B2	Screen Voltage Regulator
V19	0A2	VFO Voltage Regulator

(and three selenium rectifiers for the bias supplies).

Circuit Description:

VFO:

The VFO uses a single 6AU6 operating as a Clapp oscillator. It has three output ranges dependent upon band: 1,750 - 2,000 KHz on 80 meters, 7,000 - 7,175 KHz on 20 and 15 meters and 7,000 - 7,425 for 40 and 10 meters. Stability is achieved by the use of temperature compensating capacitors, an 0A2 voltage regulator tube stabilizing the VFO plate voltage and a separate filament transformer that keeps the VFO tube's filament on continuously.

RF Buffer/Crystal Oscillator:

The output of the VFO goes to a 6CL6 buffer stage. This stage provides buffering as well as some frequency doubling. Its output is 3.5 MHz on 80 meters, 7.0 MHz on 40 through 15 meters and 14 MHz on 10 meters. The buffer stage operates as a Colpitts crystal oscillator when XTAL operation is selected.

RF Driver:

The buffer output goes to the 5763 power pentode driver circuit. This stage operates straight through on 80 and 40 meters, as a doubler on 20 and 10 meters and as a tripler on 15 meters. Drive level is controlled by a front panel potentiometer that controls the driver tube screen voltage. Driver output is tuned by a fixed load pi-network.

Final Amplifier and Clamper:

The final amplifier uses a pair of 6146 transmitting tetrodes operating in Class C on CW and AM phone and in Class AB₁ (linear) on SSB. A 6CL6 clamper circuit protects the final tubes when in the AM and CW mode. Final grid drive is also fed to the clamper tube. Should drive be lost the clamper tube starts to conduct heavily. Since the tube's plate is connected to the final screens, the reduction in screen voltage limits the final plate current. In SSB mode the clamper is not needed since the tubes are operating in linear class; the clamp circuit is switched out and the final screens are connected to two series connected 0B2 voltage regulator tubes to provide a fixed 210 VDC screen voltage.

Keying:

On CW the *Apache* uses a clever time-delay differential keying circuit. This circuit uses an NE-2 neon lamp to allow the VFO to start and stabilize a few milliseconds prior to bias being removed from later stages; it also keeps the VFO running until after bias is restored when the key is let up. This circuit makes the Apache keying very clean. However, after many years of use the NE-2 can begin to fail and cause erratic keying behavior. Fortunately NE-2s are still easily available and inexpensive.

Audio:

The transmitter audio circuit is designed for use with a high impedance microphone, such as the Astatic D-104 that was very popular at the time. Three stages of RC coupled audio pre-amplification are followed by a 6AL5 dual-diode that acts as a clipper. The diodes are biased so that the negative peaks are clipped before the positive peaks. It is the negative peaks that cause splatter when over-modulating. A low-pass filter and an additional stage of audio gain follow the clipper. Two audio gain controls are used - one between the first and second audio stage and a second just before the audio driver. This allows the level of clipping to be adjusted to suit the user.

Amplitude Modulator:

A 12BY7 audio driver pentode brings the audio up to a level that will drive the modulator. A transformer couples the audio to the grids of a pair of EL34 (6CA7) modulator tubes that are configured as a class AB₂ push-pull modulator. The modulator is capable of 100 watts of audio output, more than enough to fully modulate the final amplifier. A modulation transformer matches the relatively high 11K ohm plate to plate impedance of the modulator tubes to the 3K ohm impedance of the final plates. A 500 ohm tap on the modulation transformer's secondary provides high-power low-impedance audio to drive an external modulator should the TX-1 be used as an exciter for a kilowatt amplifier/modulator. The secondary of the modulation transformer is shorted and screen

voltage is removed from the modulator tubes when operating in CW and SSB mode.

Power Supplies:

Heathkit designed the *Apache* with rugged heavy duty power supplies. The low voltage transformer provides 6.3 VAC heater voltage for all the tubes except the VFO and rectifiers. A second filament winding provides 3.5 amps at 6.3 VAC at the rear accessory socket. Two 5 VAC windings provide filament voltage for the low and high voltage rectifier tubes. The low voltage supply uses a 5V4G rectifier and produces 350 VDC for most of the circuitry including an extra 85 ma available at the rear accessory socket. The low voltage power supply filter is capacitor input and utilizes a 7 henry choke. Taps on the winding of the power transformer secondary supply voltage to two bias supplies, one full-wave for the driver, finals and keying circuit and a second, half-wave, bias supply for the modulator tubes.

The other 5 VAC winding on the low voltage power supply lights the filaments of two 5R4GY full-wave rectifier tubes that are wired directly in parallel. A separate 1800 VCT 400 ma transformer provides a solid 750 VDC through a 5.5 henry choke input filter. Two 125 μ F capacitors in series, each shunted with a 15K ohm bleeder power resistor, provide the filter capacitance. Voltage is tapped off from the center of the bleeder resistors to provide positive bias for the clamp circuit when the plate voltage is present.

Single Sideband Mode:

The *Apache*, can not operate in SSB mode by itself. However it is set up to use the Heathkit SB-10 SSB Adapter. When the *Apache* mode switch is placed in the SSB position the output of the driver is switched to a connector on the rear apron and a second rear connector is switched to the grids of the final amplifier. The mode switch also switches the final amplifier from class C to class AB₁ linear so it can amplify the SSB signal without distortion. The SB-10 connects to these two rear connectors The *Apache* provides heater, B+ and bias voltage as

well as other needed connections to the SB-10 through the accessory socket. Maybe we'll cover the SB-10 in a future HotM article?

Personal Experience:

My Heathkit TX-1 *Apache* arrived on July 1st of 1961. Sixteen evenings of fun construction later it was on the air. Construction was not difficult and the unit worked right off the bat. That is more a tribute to Heath's excellent instructions than any building skill I might have possessed. As the kit went together it kept getting heavier and heavier; that is probably the one point I remember most about assembling the TX-1. Another was installing and adjusting the linkage that drove the band-switching, the loading capacitor and the VFO tuning. It was important to be sure they were aligned right for smooth operation. Mine always worked well, though there were complaints about the linkage from others building the kit. Operation was rock solid and I never got any poor audio reports using the *Apache*. I used it mostly on CW and AM, but did get to operate it with a borrowed SB-10 SSB adapter for a few weeks.

The transmitter went into storage when I went off to college. I didn't fire it back up again until moving to Orange, CA. On April 9th 1968, using a Hustler 4BTV vertical and an NC-88 receiver I got back on the air. Most of my contacts in those days were on CW, SSB had pretty much taken over. However, I did operate some AM around 7.280 MHz where a group of AM-ers frequented.

Sometime in the early seventies I sold the *Apache* to Jack - WA6LOH (now W6LOH) who used it on CW for many years. Just a few years ago Jack offered to give it back to me, but alas with no place to put it I declined and it has since found its way to places unknown.

73, from AF6C



Remember if you come across any old Heathkit Manuals or Catalogs that you do not need, please pass them along to me.

Thanks - AF6C

This article originally appeared in the July 2009 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.