Hellenedyne

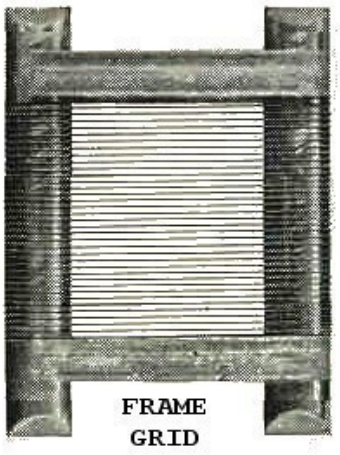
SLAYING THE 1AD MONSTER

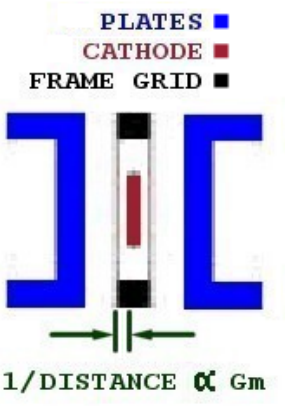
VERSION 1 ©2008

The information below is not guaranteed to be free of errors.

1. INTRODUCTION

The Hellenedyne is my flagship regenerative-reflex receiver. Since I was a child I wanted to design a simple tube radio that could **"hear it all"**. Would you believe there is a single active device receiver that: 1) can hear down to the noise floor, 2) employs no RF transformers, 3) has regeneration that is smooth as glass, 4) uses 16-ohm earphones, 5) runs off 18 volts of plate, 6) is composed of only ten parts, and 7) uses a single triode? God decided to make this our reality.

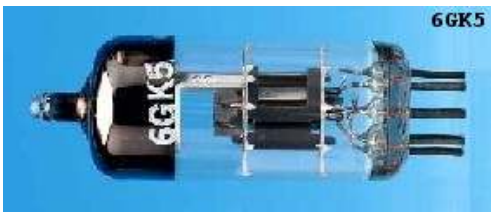




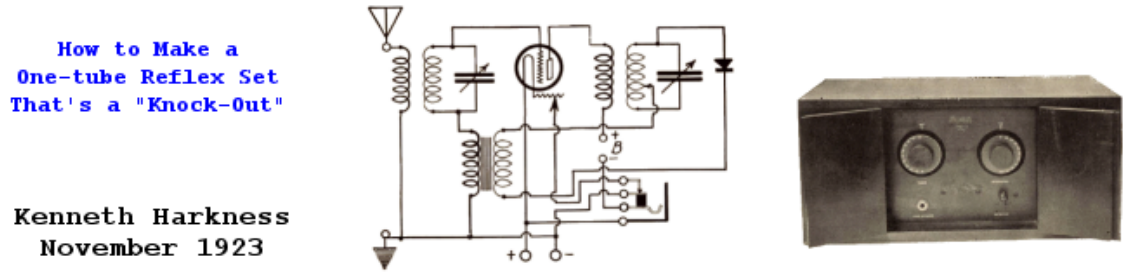
2. 3GK5 TRIODE

Recently I read my first 450 page vacuum tube theory book. Using the new knowledge and sophisticated power models I arrived at a unique triode, the 3GK5. This modest $5 B7G-base tube can be run off two "D" type and two "9V" type batteries for about 30 hours. This triode exhibits a large plate resistance and transconductance at low voltages. This was determined using data from manufacturer's curves. At 20 V I calculate the 3GK5 to have a plate current of 5.2 mA at 0 V grid. Plate resistance is 4660 ohms and transconductance a massive 7300 µMHOs. Space charge tubes, for example the 12K5 popularized by *Norm Leal*'s venerable regen boast 15000 µMHOs but reach only 15% of the 3GK5's power, in my circuit. The 3GK5 is a high-Mu (78) "gain-controlled" triode boasting dual cathode leads, 4.7 dB noise figure, 2.8 V heater (450 mA), and dissipation of 2.5 W.

The 3GK5 uses "frame grid" construction: wire one ten-thousandths of an inch in diameter is wrapped tightly around a sturdy picture-frame structure (photo above). Normally grids are self-supporting and spot-welded to supports. The rigid frame grid supports each grid wire via notches. A vacuum tube's gain is inversely related to distance from its cathode to grid, as well as cathode surface area. Frame grids allow production of consistently high gain (Gm) tubes. The tubes have low noise figures since noise is inversely related to Gm. Capacitances are lowered due to a shield existing between the grid and plate. Basically these are beam triodes. Frame grids are technology from 1958 when transistors started taking off. These rugged bottles were used for video / radar.

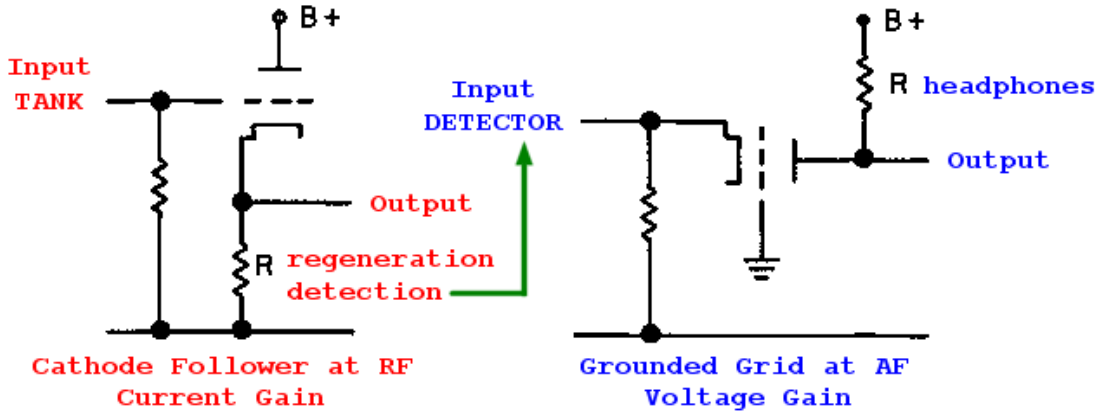


3. 1AD DESIGN MUSING



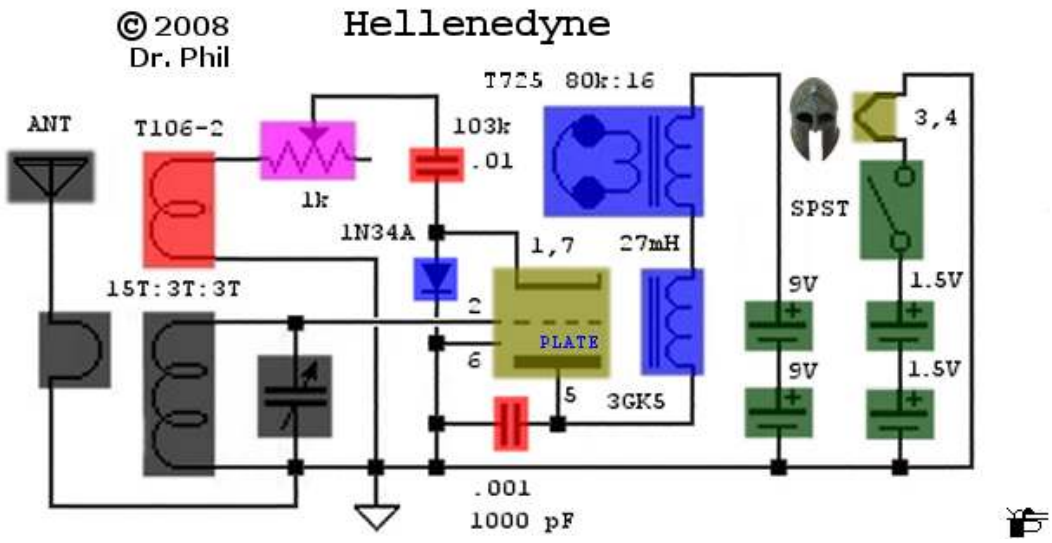
Most 1AD radios fall into three groups: superheterodyne, regenerative, or *Harkness*-style regen-reflex. Some designs simply chop off an existing radio beyond the first gain stage and rely on sensitive albeit intricate sound-powered phones. I felt 1AD superheterodynes were uninviting: complex, low overall gain, and single "*can*" selectivity. Contrary to common belief a regenerative radio does not have infinite gain. Gain of ~78 dB can be achieved before breaking into oscillation; another 7 dB for using a regen in "CW" (beyond oscillation ala direct-conversion) mode. Regen is only powerful enough to boost up an S0 (0.1 μV) signal 5:1 antenna coupled to about 3.875 mV.

Considering modern receivers shoot for +150 dB of gain; it behooved me to reflex. I was impressed with transistor designs like Tom Polk's Macrohenrydyne (www.tompolk.com), Robert Bazian's circuits on Charles Wenzel's website (www.techlib.com), and the Harkness of Tim Kilboy. What I, unfortunately, found in my own designs was just how cantankerous transistors could be: especially at cutoff and saturation. Mixing this with sensitive earphones often proved painful. I like the Harkness medium-Mu triode receiver; although, I wanted to do away with both the AF and RF transformers. Ironically the design below, after trying hundreds, is rather simple. Is not it always that way? The simple circuit that asphyxiated the 1AD monster also eluded detection for 50 years.



4. HELLENEDYNE CONFIGURATION

The Hellenedyne design uses the triode as a cathode-follower (common-plate) at RF and as a grounded-grid amplifier at AF. It is common knowledge amongst enthusiasts that high-Mu tubes make poor regenerative receivers. However, this is mostly true because we are using the tubes in plate loaded configuration. The primary purpose of the regenerative stage of the radio is to boost current so that the tickler and detector can be powered. Cathode followers have input impedances of 500M ohms, which protects the tank's Q. Voltage gain on the high-Mu tube is reduced to about unity (one). This buffering coupled with the non-inverting output make for a smooth regeneration. The output impedance is low, current gain is high and nearly without distortion. After rectification the audio enters the tube in grounded-grid configuration. Input impedance is low, output is high, which matches the 80k ohm earphones setup or sound-powered phones or piezos. Output is very stable, voltage gain is high, current gain is near unity, and power gain is again medium. It should be noted that many older high-Mu tubes achieve gain by having high Rp and low Gm. These tubes cannot sustain the current necessary for this setup to work properly, especially at low plate volts.



5. HELLENEDYNE CIRCUIT

The Hellenedyne circuitry above uses a 3GK5 as cathode-follower at RF and as a grounded-grid amplifier at AF. This build-up uses a 3-turn antenna tap, T106-2 tank core (covering the 31M, 41M, 49M, and 60M bands), 25-foot antenna wire, 1000-ohm regenerative control (on/off switch), 1N34A diode, 3GK5 tube, 27 mH RF choke, Bogen T725 transformer, and 16-ohm Koss Sparkplug earphones (rated 112 dB SPL/mW). Yes, the tube is drawn inverted and pin 6 is the internal shield around the frame grid posts. The 3GK5 tube glows, runs hot, and takes ~15 seconds for warm up. Regeneration is slowly added until background "hiss" is heard. Lower pot values work even better.

There can be many circuit variations. The tank/tickler can be changed for use on BCB. On filamentary tubes utilize an RFC. The potentiometer and associated capacitor can be replaced with an air-variable capacitor; however, this might alter frequency. Other diodes can be used including thermionic ones, possibly enclosed in the same tube. The RF choke is replaceable with a "dual RC" network. The low-sensitivity 16-ohm phones can be replaced with sound-powered elements. This circuit can be run at higher plate voltages but I do not recommend anything over 45 volts as this can be dangerous and is unnecessary. Other workable tubes include: 2GK5, 4GK5, 6GK5, 6FQ5A, etc. Triode-strapped pentodes can be used but at low plate voltage they have *no advantage* in my circuit. The $40 US legendary 7788 at 70 V puts out only 50% the power of a 3GK5 in this design.

Performance is splendid: good volume, smooth regeneration, and capable of usage for DX. The receiver is cheap, simple, and easy to operate. The Hellenedyne is dedicated to my ancestors. Have a suggestion? Please write me! I will update this copyrighted PDF and credit all contributors.

REFERENCE

just_rtfm@<NOSPAM>yahoo.com
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He conquered the world by age 32.