Millenergy Laboratory Record
Chapter 8

On 21 October 2005 when I visited Bruce Perreault's basement lab in New Hampshire, he demonstrated to me what he called his "HF Box". This was a box that produced high frequency electrical voltage at two terminals on the front. Of great interest to me was that the attributes of the electrical output were very similar to that reported or demonstrated by both T. Henry Moray and Edwin V. Gray. The attributes in common were

1. High frequency and somewhat high voltage
2. Brilliant white light from an incandescent bulb (lamp) acting as load driven by the HF Box
3. Lamp could be shorted and still operate when properly tuned
4. Lamp could be submersed in tap water and still glow with no short circuit (like Gray only)
5. Load could be driven when connected with fine 30 gauge wire with the wires remaining cold (This was not demonstrated in Bruce's lab, but later in ours.)

Here are a couple of photos of this box in Bruce's lab. The first photo also includes Bruce.

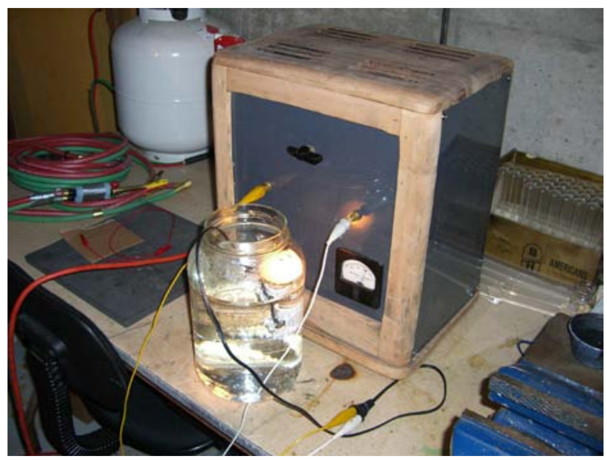

Figure Dec05 – Photo 1A. Bruce with His Box **Figure Dec05 – Photo 1B. Lamp in Tap Water**

Note in the left photo the light bulb appears quite yellow. To the eye it was actually much more brilliant than it appears in this photo. In the right photo the bulb is submersed in tap water.

After discussing this box with the Millenergy team we decided to negotiate the shipment of this box to our lab for testing. We did this so we could (a) familiarize ourselves with the kind of technology present in Henry Moray's time, (b) see the kind of energy output his devices seemed to produce (as indicated above), and (c) confirm that there was only HF EM radiation and nothing else unusual about the box (no 'overunity' or 'free energy' produced).

In mid-December 2005 the box arrived at the lab, and on 22 December 2005 Jay, Dave, Steve, and Dennis unpacked the box, put things in working order after shipping, and began examining and testing the box. These investigations are described in detail on the next pages.

HF Box Physical Description

Figure Dec05 – Photo 2. HF Box Front View

The HF Box is a wooden structure with dark gray acrylic plastic sides and front as shown in the photos on the previous page and at left. As can be seen, the controls are simple—just a toggle switch to turn the box on and off in the lower left, and a pointer knob to tune a variable air capacitor for optimal load conditions, such as maximum lamp brightness.

The meter in the lower right was found to be an ammeter, reading 0 to 5000, that indicated a maximum when an incandescent lamp load was at maximum brightness. The two screw terminals in the middle of the front provided the HF voltage source.

Not shown in the photo at the left, are vent slits in the wooden top and on the removable back cover.

The next 3 photos show—from left to right—the HF box left, rear, and right sides with the rear and side plastic panels removed. *Note that all references consistently reference directions as viewed from the front,* i.e., the left side is the left side as viewed from the front (control panel) side, regardless of the perspective from which the figure or diagram is drawn or photographed.

Figure Dec05 – Photo 3-Left, 3-Rear, and 3-Right. Open views of the HF Box internals.

HF Box Internal Physical Details

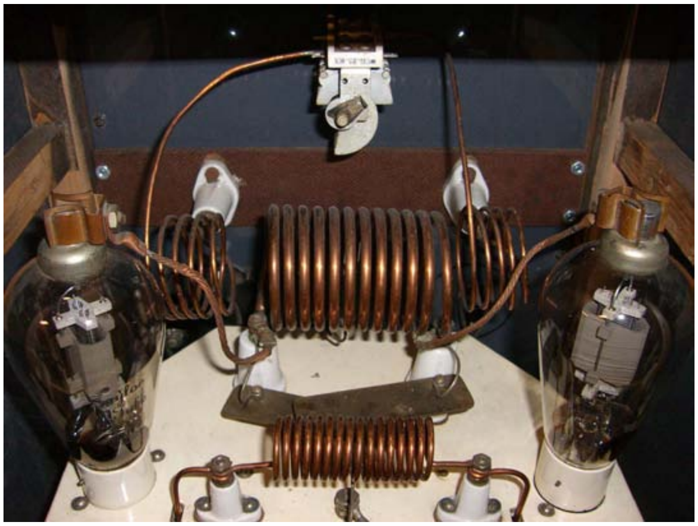

Figure Dec05—Photo 4. Upper RF Internals of HF Box.

In the photos *Dec05 – Photo 4 and 5*, at left, we see two views of the upper internals from rear perspective. Photo 4 shows all of the components of the HF section. The white plate into which several of the components are mounted is made of ceramic. Everything on or above this plate we will call the upper portion of the HF Box. The two plates near the bottom hinge on screws mounted in posts near their outer edges. These constitute a small variable air capacitor C_T found to tune the fundamental resonant frequency of the HF Box.

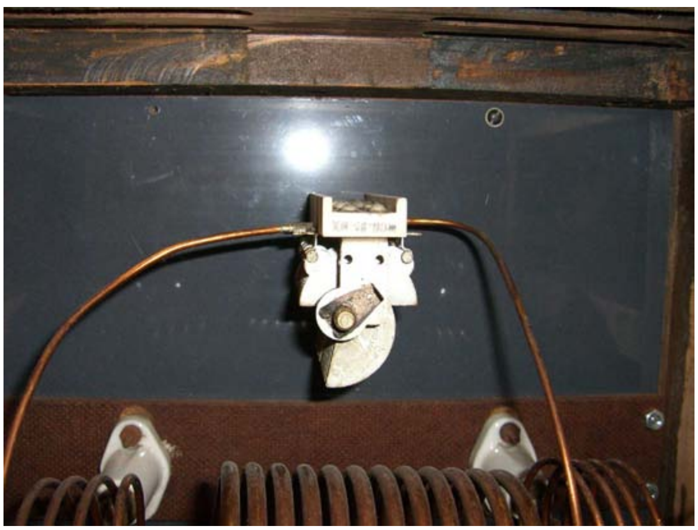

Figure Dec05—Photo 5. Close-up of Capacitor C_{VC}.

Photo 5 shows a close-up rear view of the variable control capacitor C_{VC}, accessible from the tuning control knob on the front control panel. As seen here, it has two electrical connections of 10-gauge bare copper wire, each going to one side of inductors L_L and L_R. These are shown in Photo 5 at the bottom on either side of L_M, the main 6-gauge RF inductor. The other side of L_L and L_R are attached to the white output terminal posts, also shown here at the bottom of Photo 5. These penetrate the control panel and appear there as the brass #10 screw terminal lugs, visible in Photo 2.

One thing that is difficult to see in the prior photos is the center tapping and end shorting in the main (L_M) and center (L_C) inductors. The end shorting is shown more clearly in Photo 6 at the right for the main inductor (center of photo). Note that one turn is shorted with solder. Also, the plates of the tuning capacitor C_T are shown again near the bottom of Photo 6.

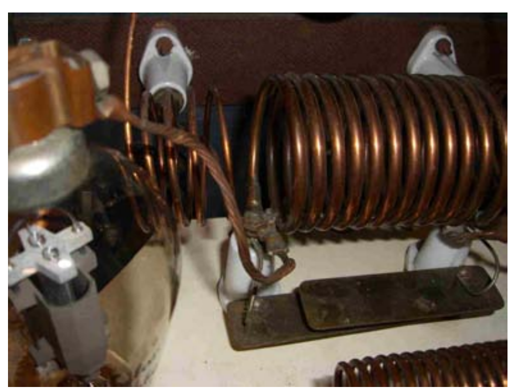

Figure Dec05—Photo 6. End turn of main inductor shorted with solder.

Photo 7, at left, shows the open right side of the HF Box, revealing several components and connections not seen in any other shot. First is the vertical inductor, L_V at the center of the photo. The top of L_V is wired to the center tap of L_M with the silver colored wire. Second is the internal workings of C_{VC}, near the top of the photo.

Moving now from the upper RF portion to the lower power supply portion, we can see the old heavy wire of ammeter AM1 in the lower left of Photo 7 along with the parallel adjustable metering resistor, shown in the schematic as P1 (not actually a potentiometer). Lifted-lead resistance measurements confirmed that this was, indeed, an ammeter and not a voltmeter. Finally we can see the side of the HV terminal board of the power transformer, just under L_V and the ceramic plate. And we can just barely make out that the bottom of L_V is connected to the transformer.

Figure Dec05 – Photo 7. Right side of HF Box with L_V and Ammeter.

To further examine the power supply we need to look more closely at Photos 3-Rear and 3-Left. In 3-Rear we can clearly see the power transformer (center bottom), supply power terminal pins on the bottom left (on the right as seen from the front), and old-style screw-in 30A power fuse F1 on the other side. The low voltage input terminal board of the transformer is clearly seen on the bottom with the wires going to terminals labeled 0 and 115, obviously to receive 115 Vac, 60 Hz voltage.

One side of the ammeter is connected to power resistor R_P. This resistor is shown in Photo 3-Left at the bottom, horizontally oriented. It got quite warm with circuit operation.

One thing that can't easily be seen from photos is the transformer windings and the various taps. The construction and inputs of the transformer reveal a silicon steel laminated core, typical of 60 Hz power transformers. By testing both open-circuit winding resistance values and 60 Hz voltages we found that the transformer has 3 windings. The primary is the input at 120 Vrms, shown in Photo 3-Rear. With 120 Vrms primary input, the secondary voltage is 1.41kVrms. The tertiary winding is only 8 Vrms, intended to drive tube filaments/heaters, which is what the winding does in this circuit. Both the medium voltage secondary and the very low voltage tertiary taps have terminals on the forward (inner-facing) side of the HF Box.

Finally we come to the tubes in the HF Box. These are Taylor T55 Triode tubes, shown in the photos below.

Figure Dec05 – Photos 8a & 8b. Taylor T55 Tube; logo in socket (a) & tube held in hand (b).

Figure Dec05 – Photos 9a & 9b. Tube rear angle view (a) and tube filament top close-up (b).

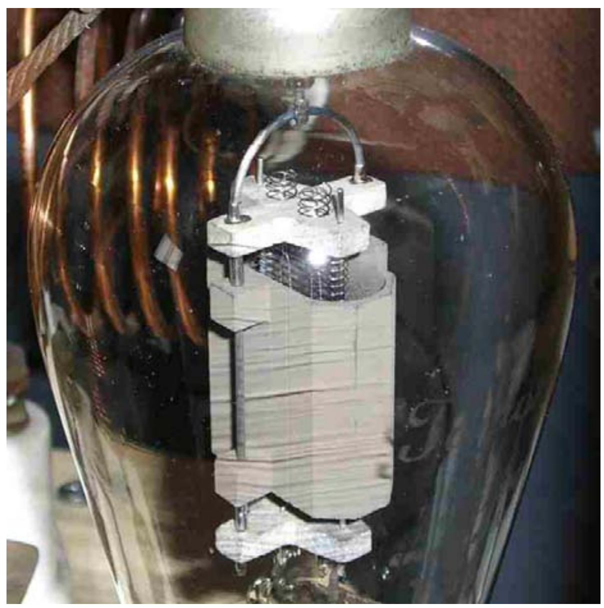

Photo 9a shows that two of the pins are thicker than the other two. These are the filament/heater pins shown as pins 2 & 3 in the sketch on the next page. In photo 9b we see that the actual filament is somewhat buried inside the grid. The 'grid' is the horizontal wires inside the dull gray surface (plate) surrounding the wires. However, inside the grid wires are some vertical wires that are held vertical by two spring 'tensioners' on the top and one on the bottom (not viewable). These vertical wires are the filament. Note that the plate is connected to the top terminal of the tube, not any of the bottom pins. The nearly horizontal striations across the plate are artifacts of the way the photograph was taken.

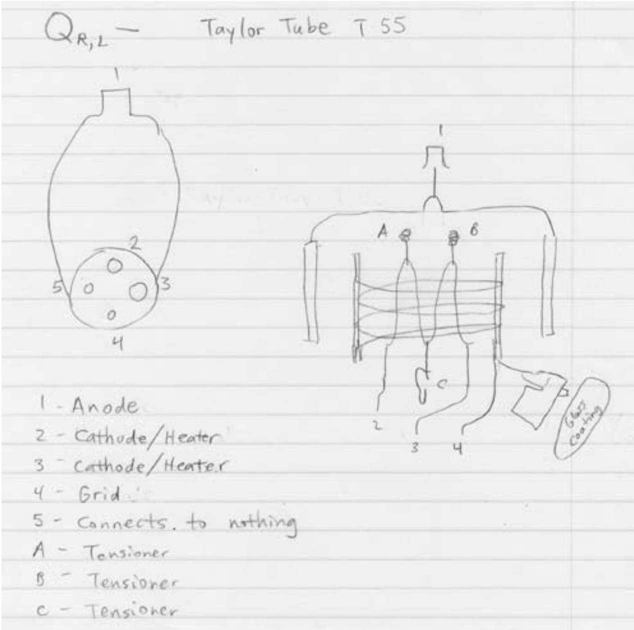

Figure Dec05 – Sketch 1.

The sketch at the left shows the internal wiring and pin layout of the tubes pictured on the previous page.

Photo 10 at the right shows the Taylor T55 tubes while operating. The glow from the filaments is evident. Although it is hard to capture with a camera, one can tell if closely viewed, that the grid wires do not heat up as much as the vertical filament wires. The glow of the filament is more intense than the glow of the adjacent grid.

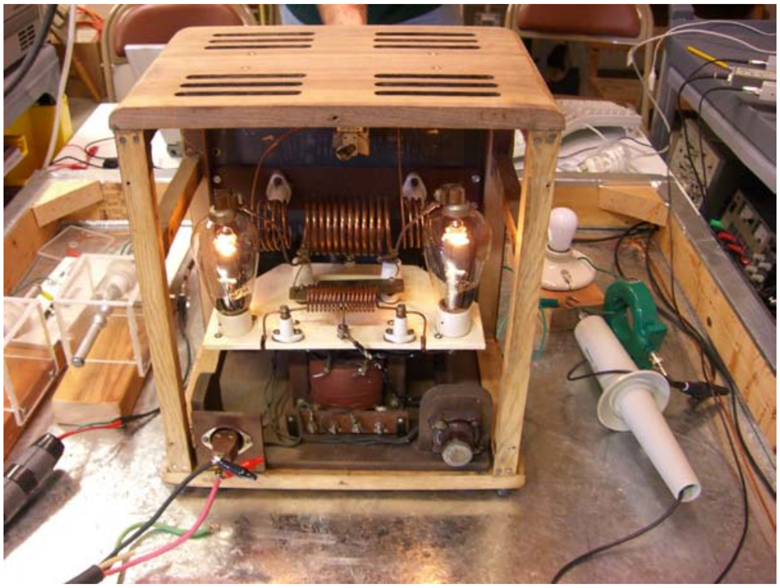

Figure Dec05 – Photo 10. Glow of filaments while operating.

The description of the HF box would not be complete without a schematic diagram. This is shown on the next page. It was drawn using standard electrical symbols available in an electrical circuit SPICE modeling program. It is followed by a Legend with more detailed component information. The original schematic sketch that shows a few more details is next, though not as neatly drawn. This sketch, is followed by a freehand wiring diagram of the HF Box.

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Laboratory Record

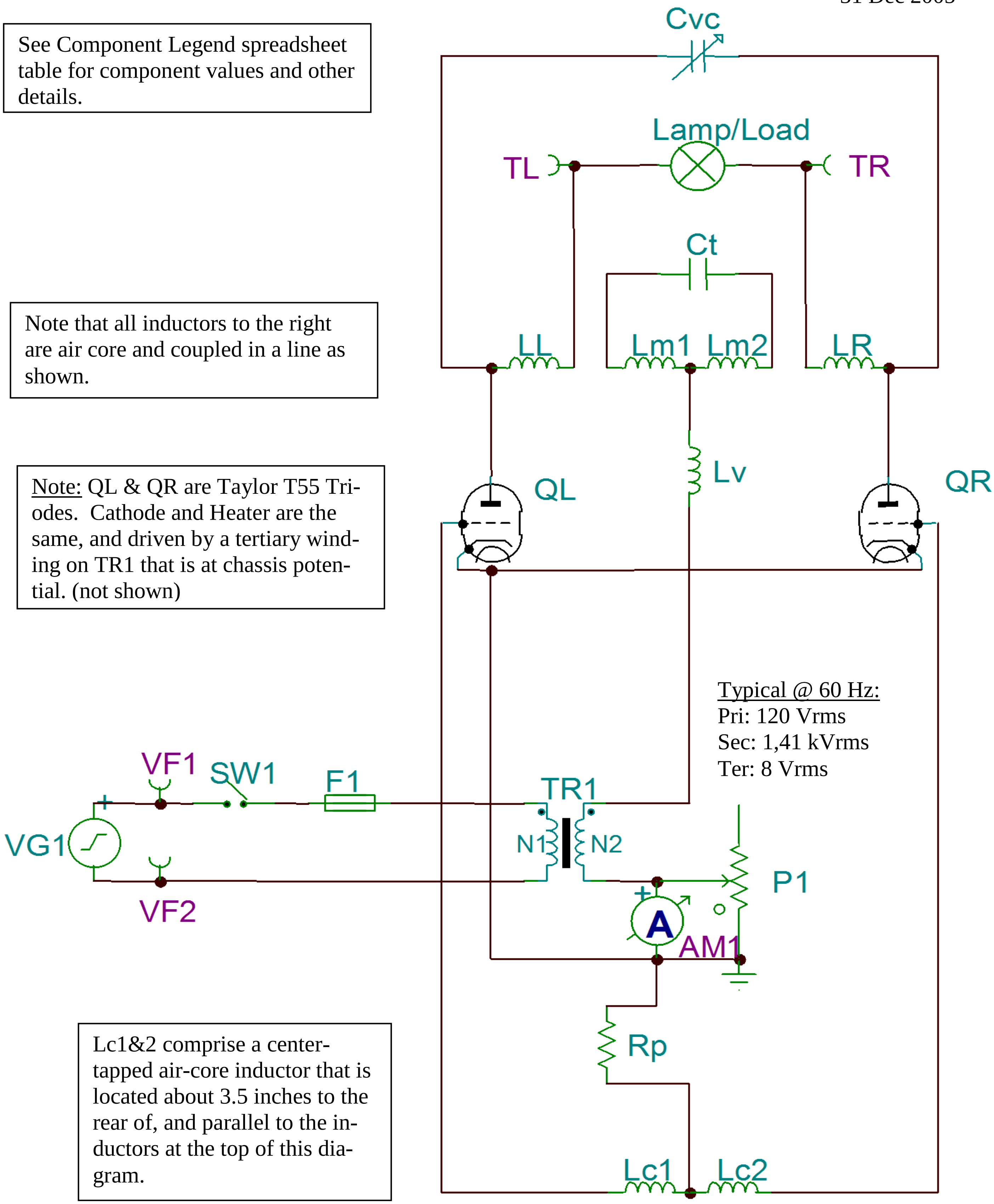
Perreault High Frequency Box Schematic

Diagram drawn 31 Dec 2005

See Component Legend spreadsheet table for component values and other details.

Note that all inductors to the right are air core and coupled in a line as shown.

Note: QL & QR are Taylor T55 Triodes. Cathode and Heater are the same, and driven by a tertiary winding on TR1 that is at chassis potential. (not shown)



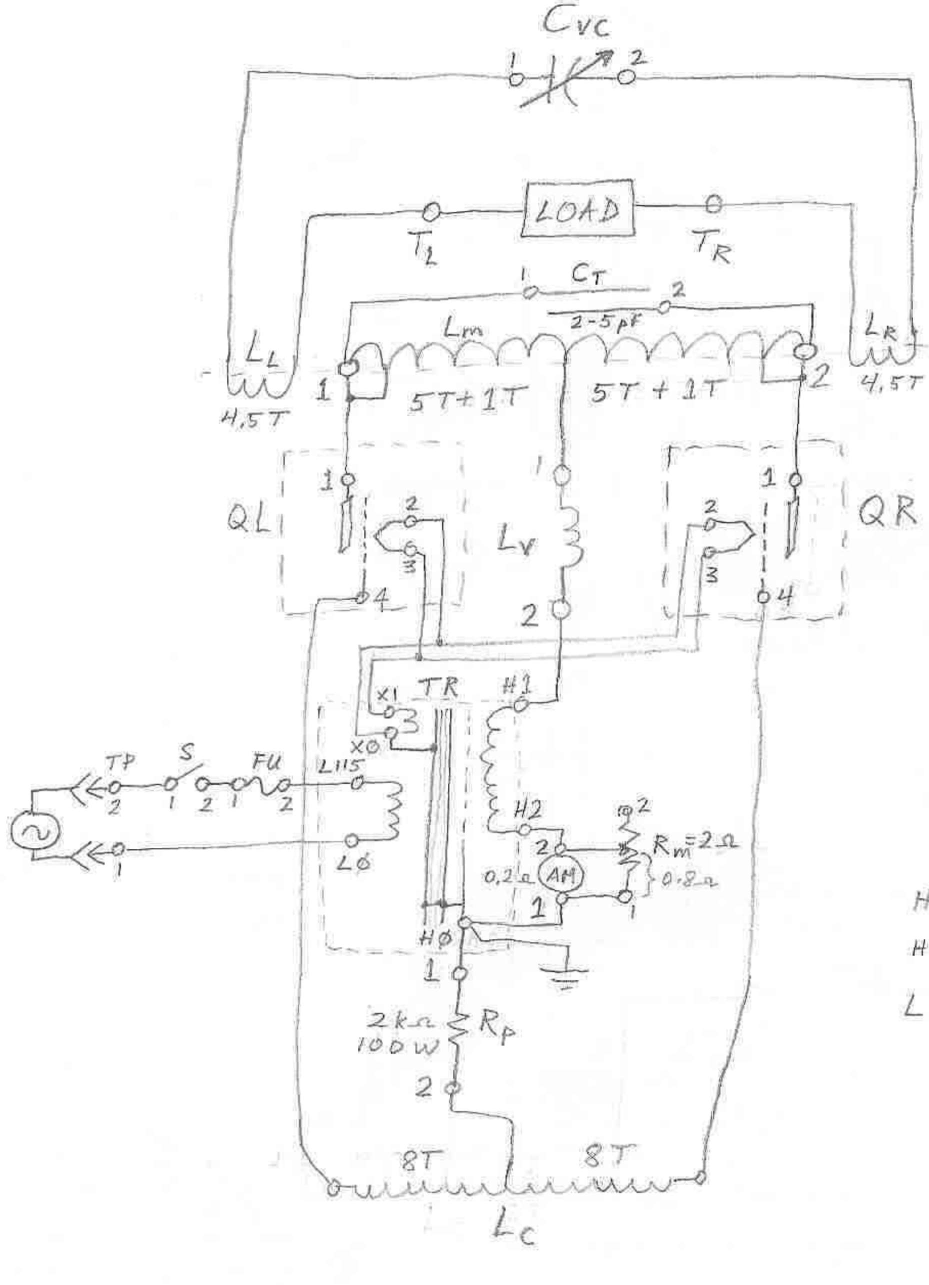
Typical @ 60 Hz:
Pri: 120 Vrms
Sec: 1,41 kVrms
Ter: 8 Vrms

Lc1&2 comprise a center-tapped air-core inductor that is located about 3.5 inches to the rear of, and parallel to the inductors at the top of this diagram.

This page true and accurate as of ____________ Attest _____________

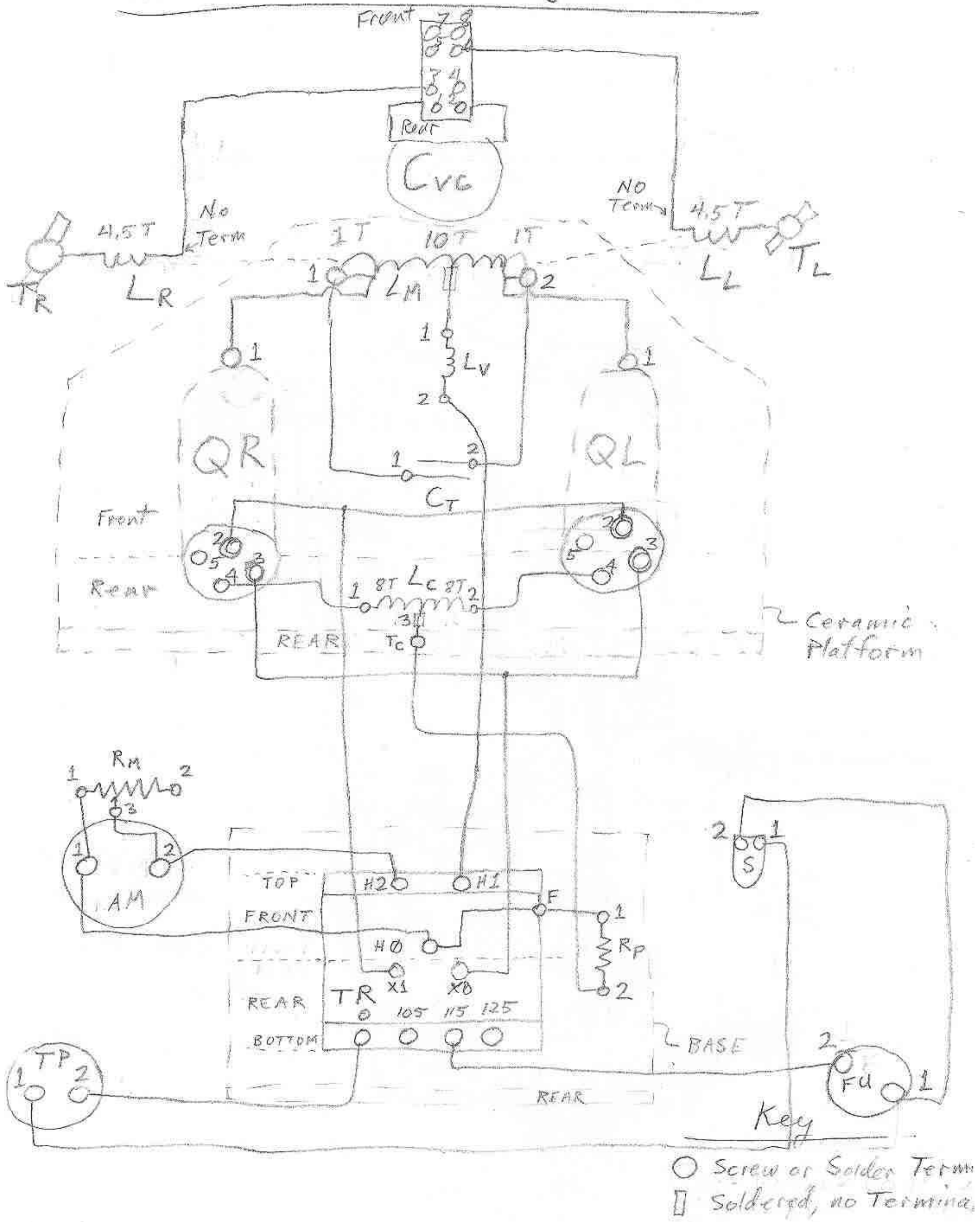
PERREAULT HF BOX COMPONENT LEGEND		
Symbol	**Name**	**Specifications or Measured Values**
T_R	Terminal, Right	#10 brass
T_L	Terminal, Left	#10 brass
C_{VC}	Capacitor, Variable Control	Double capacitor set tied together. Variable from 2.1 to 5.3 pF jointly. This is a measured value with right and left inductors in the circuit.
C_T	Capacitor, Tuning	1.0" x 3.5" Plates 0.05" Thick. 0.365" Separation, Approx. 2.25" Maximum Overlap.
L_R	Inductor, Right	1.8" ID, 0.105" D bare copper wire, 0.222" spacing, 4.5 turns, 3.7 µH
L_L	Inductor, Left	1.8" ID, 0.105" D bare copper wire, 0.222" spacing, 4.5 turns, 3.2 µH
L_M	Inductor, Main	2.425" OD, .188" D bare copper wire, 0.1" spacing, 10 turns to solder points, 1 turn external to solder points on each side. 7.2 µH and 3.5" end to end.
L_V	Inductor, Vertical	0.54" OD, 0.02" D (approximately) insulated copper wire, 48 turns. 31 µH
L_C	Inductor Center	1.08" OD, 0.105" D bare copper wire, 0.06" spacing, 8 turns per side of solder point (16 total). 4.9 µH end to end. 3.7 µH per side
R_P	Resistor, Power Supply	2 KΩ, est 100 Watts
R_M	Resistor, Metering	2 Ω full, 0.8 Ω to tap., est 50 Watts
AM1	Ammeter	0 to 5000 scale, labeled Bristow & Company, Los Angeles. Patent #2,051,399 Simpson Electric. 0.2Ω measured across.
BOX	Housing Box	17-7/8" Tall, 14-1/2" Wide, 10-1/4" Deep, outside dimensions
TR1	Power Transformer	Est. 150 W, 50-60 Hz, 3-windings. Primary 120 Vrms, Secondary 1.41 kVrms, Tertiary 8 Vrms

HF Box Schematic 12-28-05



H1 : 1.41 kV @ 60 Hz
H0 = H2 ≈ 0 V
L115 : 120 V @ 60 Hz

BAP HF Box Wiring Diagram 12-28-05



(Rear View)

Operation of HF Box

Figure Dec05 – Photo 11. Basic Loaded Operation.

Power was first applied to the HF Box on 22 Dec 2005. A 60W conventional frosted light bulb in a ceramic screw socket was used as the load. Immediately the light bulb lit, and tuning with the capacitor C_{VC} made the emitted light brighter. Photo 11 at left shows the result of this test.

We next tried a variety of things in rapid succession. Those doing these tests were Dave and Jay, pictured here in Photo 12, along with Steve and Dennis. Shown here is the HF Box relocated from benchtop to the base of our Faraday cage with an equipotential plane ground.

This particular test shows the light bulb lit while a test lead is shorting across the light bulb. Both tests were also done in Bruce Perreault's lab. Also at Bruce's lab the bulb was immersed in tap water without shorting (see Photo 1B).

Figure Dec05 – Photo 12. Dave and Jay in lab with shorted bulb test.

Other tests included various lengths of conductors or test leads to the load. We also noticed that when we held the test leads with our fingers our fingers began to warm, but just where we held the lead, not anywhere else (cold conductor?). This same effect occurred with various gauges of wire. When we tried it with fine 30-gauge wire with lacquer insulation the conductor once again stayed cool (or at least did not warm) and its temperature seemed to not change with lamp load. However, the conductor rapidly heated under the place where fingers touched it.

In Photo 13 below, we see the general setup we used for HF box tests with the box sitting in the base of the Faraday Cage, the HV probe on the left. Note the 30-gauge wire clipped to the output terminals. This is the wire that never got hot.

Figure Dec05 – Photo 13. General Lab Setup with 30-gauge wire from HF terminals to lamp wires.

We also noticed that a mild HF spark occurred when we made or broke connections while the HF box was operating. All these effects were new to us and very interesting. So the next thing we tried was to connect our high voltage probe and scope to the box, along with our Pearson current monitor to capture the current trace on the scope.

Oscilloscope Data

Our first measurement with the scope via the Tektronix 6150 HV probe was with just one channel from the left terminal to ground. We measured the waveform shown on the right in Capture 1. Here we can see the ungrounded HF box riding up and down at 60 Hz at about 35 Vrms. However, near the top of that wave we have a very high frequency wave envelope bursting every cycle.

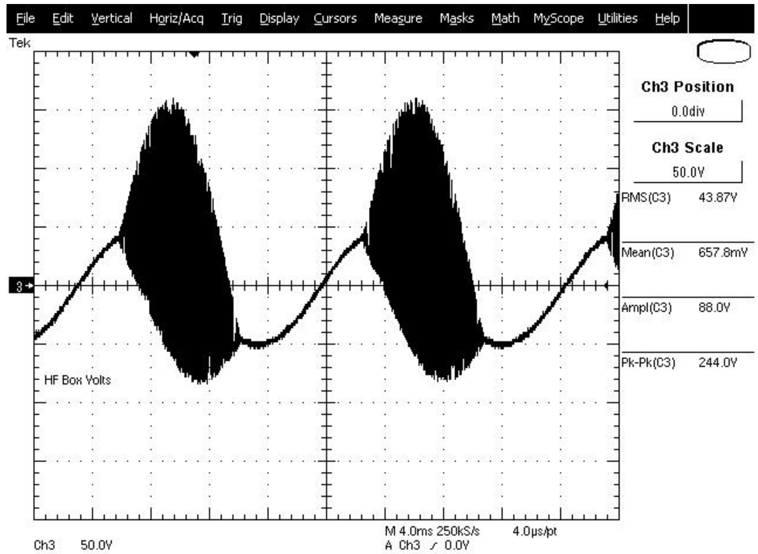
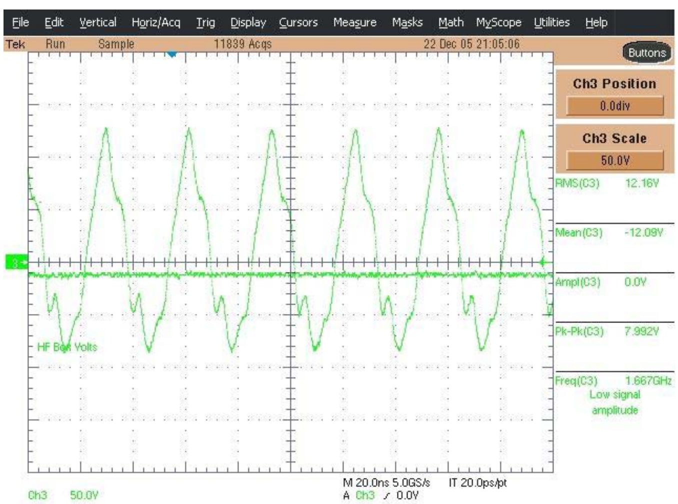


Figure Dec05 – Capture 1. Basic single channel envelope.



We next triggered on the base HF wave within each envelope and found it to be about 32 MHz* and non-linear as shown in Capture 2 at the left. This actually makes it VHF as it is over the 30 MHz HF-VHF boundary. Both of these traces were captured while the lamp was glowing moderately.

Figure Dec05 – Capture 2. Base HF Waveform.

*Note that tuning capacitor C_T (shown in Photo 14 at right under center-tapped L_C inductor) was found to control the fundamental frequency of RF oscillation to a small extent. With plates fully overlapped (maximum capacitance) the frequency was about 30.2 MHz, as measured on the scope. With the plates swung out to minimum overlap the fundamental frequency was about 32 MHz.

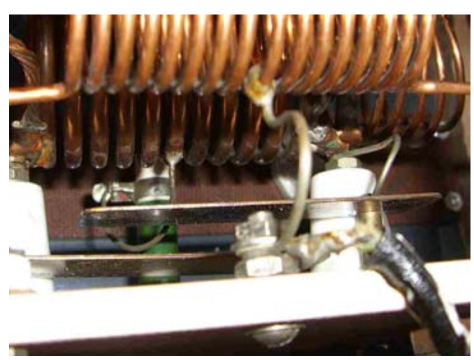


Figure Dec05 – Photo 14. Cap C_T & Center-tapped Inductor L_C

Capture 3 at the right shows both the current and the voltage on the lead going between the left output terminal T_L and the lamp. Time is set for slow traces to capture the 60 Hz component and VHF envelope shapes. We grounded the opposite terminal of the lamp. This caused the 60 Hz sinusoid to disappear even though the 60 Hz trigger for starting each envelope, remained. In this particular case, both sides of the lamp were grounded. Note that the lower current trace is scaled at 5 V / div which is actually 50 A / div.

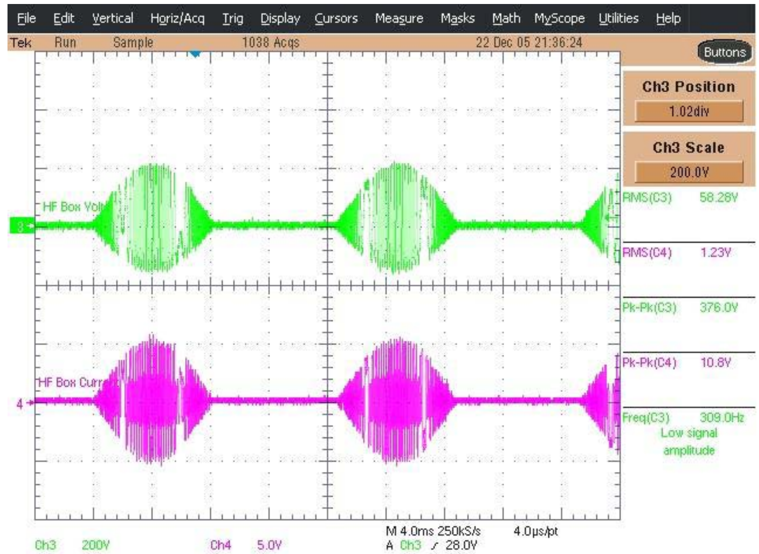
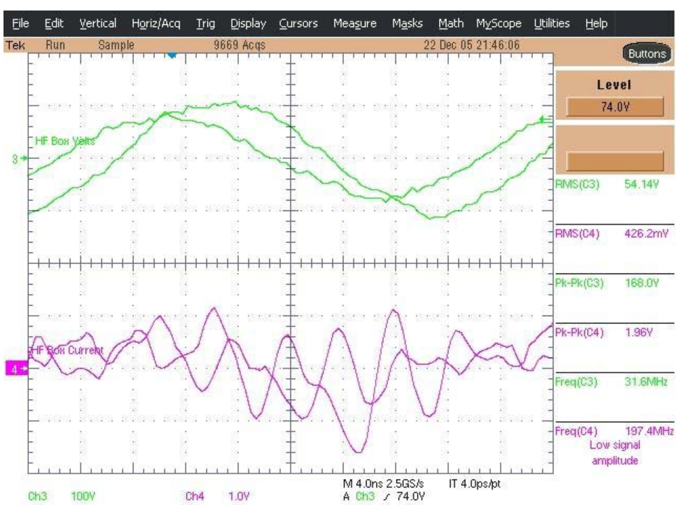


Figure Dec05 – Capture 3. Left lead with double ground.

The grounding of one side of the lamp removes the 60 Hz bias and improves triggering for better examination of the RF signals.



Capture 4 shows a fast trace of both V & I for the same left lead, but with just one ground on the right-terminal side of the load. This trace shows something that we saw quite often: a very strong frequency component of the current trace seemed to be at a frequency of six times the voltage. This is a bit difficult to see because both V&I triggering is confused by the noise. This also caused us to wonder what frequencies were actually present, and if there were multiple frequencies present.

Figure Dec05 – Capture 4. Fast traces of Voltage and Current.

To answer the question of spectral content of the RF envelope we activated the math traces on the oscilloscope and put them in spectral mode. This is shown in Capture 5 at the right. Note that the time is set to 20 ns/div, but this only applies to the top two traces of voltage and current in the time domain. The bottom two traces are the upper two traces in the frequency domain at 125 MHz/div with the same linear magnitudes as their respective time domain channels (100 mV = 1 A / div for the two current traces)

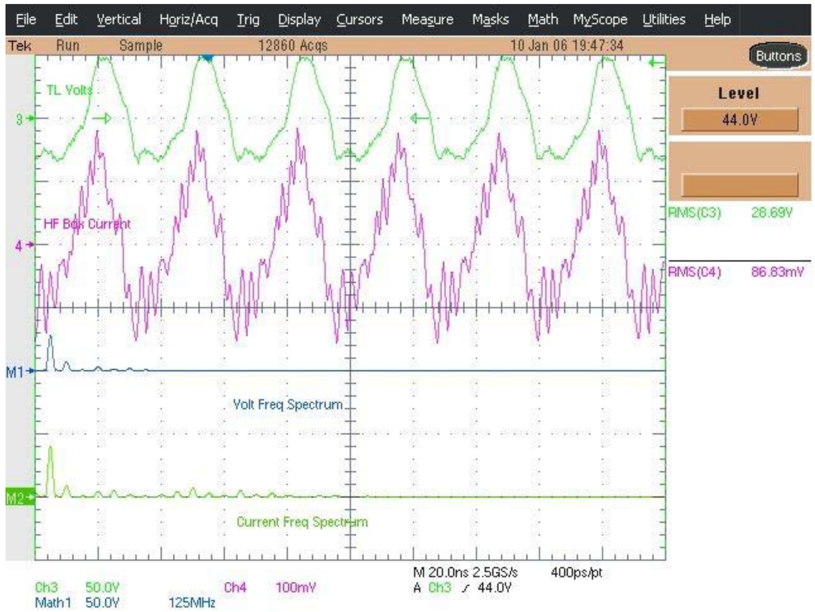


Figure Dec05 – Capture 5. Time and Frequency Domains of V & I.

In all the traces we see a strong fundamental at about 31 MHz. In the voltage we see detectable harmonics at a reduced level through the 7th (~217 MHz) with the 3rd harmonic damped. In the current we see the same thing, but with more detectable harmonics through the 21st (~651 MHz). This is consistent with the waveforms seen in the time domain. This is an interesting result as voltage waveforms are often richer in harmonics than their corresponding current waveforms. Finally, these waveforms are the result of grounding the system on the right terminal and measuring voltage on the left terminal of the lamp. The current monitor was around the 30-gauge wire conductor leading from the right terminal to the lamp.

In Capture 6, at right, we have basically the same time domain signals as Capture 5, but with frequency domain magnitudes in a dB log scale to better reveal lower level harmonics (and noise). Here, the reference scales for both spectra are merged into the same place (shown here as the horizontal axis labeled as M2). This is the 10 mV line. Recall that the conversion between dB and Volts is 20 dB / decade and in this case the current conversion is 100mV per Amp for the bottom trace.

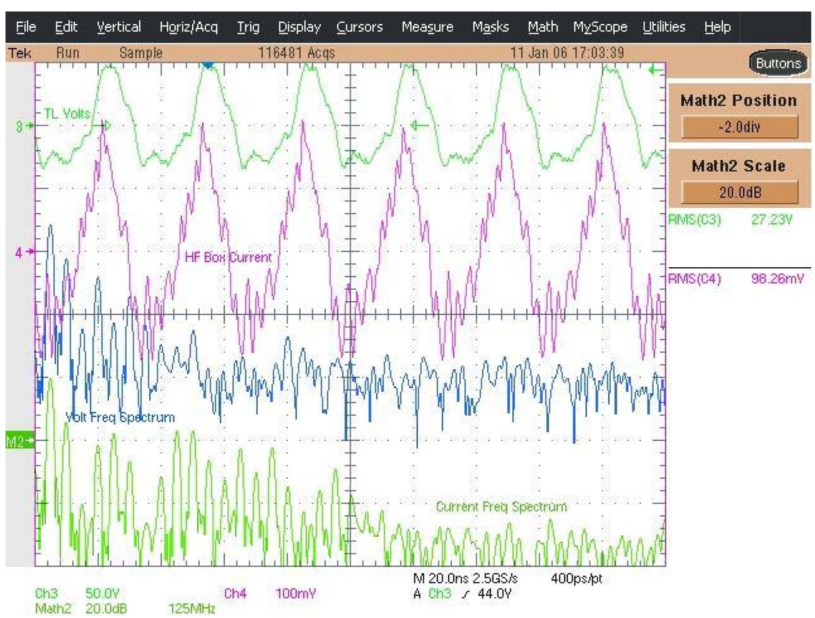
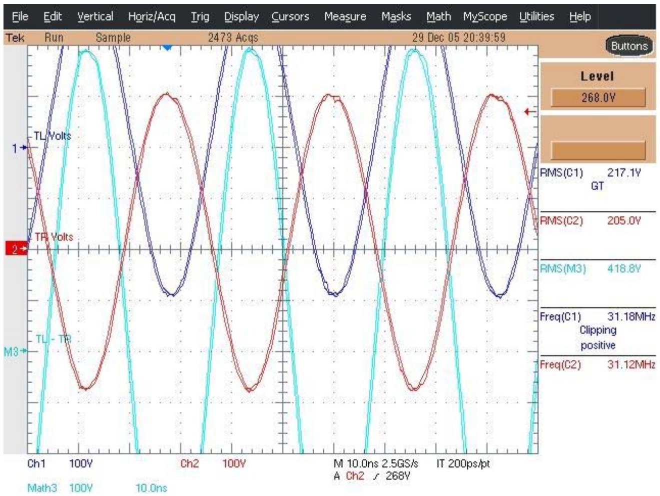


Figure Dec05 – Capture 6. V & I Time and Freq Domains in dB.



In all the screen captures so far we have measured signals with respect to ground. In Capture 7 at left we measure the voltage from left and right terminals to ground, and then use the scope's math function to subtract the right terminal voltage from the left. To get a "line-line" voltage. This is at 10 ns/div, and thus on a fast sweep. The 419 V rms value seems consistent with the short arc length seen when making and breaking connections.

Figure Dec05 – Capture 7. Line-Line Voltage at Terminals.

Energy Considerations

With an Agilent 6812 power source we were able to closely control the applied voltage magnitude, waveshape, and frequency, and to monitor the voltage, magnitude and power input to the HF Box. We applied sinusoidal voltage between 30 and 90 Hz, and found that the VHF envelopes were each triggered by and phase locked to the input voltage waveform generated by the 6812. The waves in Capture 8 at the left show that the current drawn by the HF Box is nonlinear, but continuous with a traditional 60 Hz 117 Vac voltage applied. The magnitude of this current retained this basic shape, but grew or shrank in magnitude with adjustment of C_{VC}. Basically, when the light was brighter more real power was drawn from the 6812.

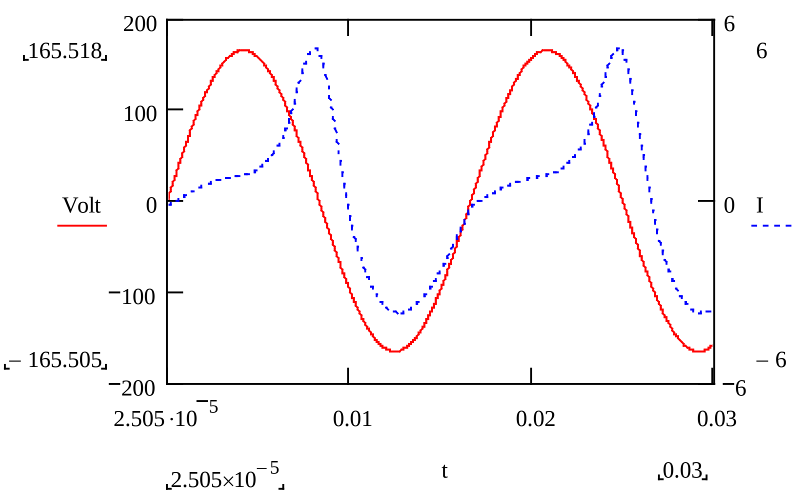


Figure Dec05 – Capture 8. HF Box Input Volts and Amps.

Although it was very difficult to measure output power, as much of it was emitted as RF EM radiation, we noted that the input power was at about 45 W when the light bulb was not lit and at about 250 W when two 100 W bulbs were on at full brightness. This indicates about 45 W of loss in the HF box, likely a great deal of it because of the heaters for the Taylor T55 triodes.

We also tried reducing voltage magnitude on the input to the HF Box. At about 65 Vrms the light bulb ceased to light and the real power consumption reduced to about 45 W.

Our final tests involved different loads. First we replaced the light bulb with a conventional resistive flat iron of 19 ohms. The power cord heated until it was warm and the forward part of the flat iron, itself, heated until it was quite warm. Power drawn was around 150 W. It did not seem to matter much whether or not the temperature switch was turned on, indicating it was RF energy doing the heating. We then energized a conventional floor fan to try an inductive motor load. We had similar results as with the flat iron, except the power drawn from our power source was greater (well over 250 W) with no sign of fan movement.

No energy anomalies of any kind were seen even though this device was very interesting, in general, as it combined moderately high voltage with high frequency in a fashion used by Henry Moray and others in the 1920's, and not seen around here in a long time.

Second Opinion

As none of the primary researchers were RF experts, two were brought in to render an opinion. One was an experienced RF Engineer, and the other was a seasoned Physicist, specializing in RF phenomena. Both had extensive experience with Tesla technology and were very familiar with Henry Moray.

After viewing the box's performance and reviewing the schematic, their opinion of the box was that it was typical of an oscillator in the 1920's. We were also told that we could probably find a similar circuit in a radio book of that vintage. So we found the first ARRL handbook, dated 1926. In that handbook on page 87, we found the schematic at left in Scan 1. Close examination will reveal that this Hartley oscillator bears many similarities to the HF Box circuit, even though it is not identical.

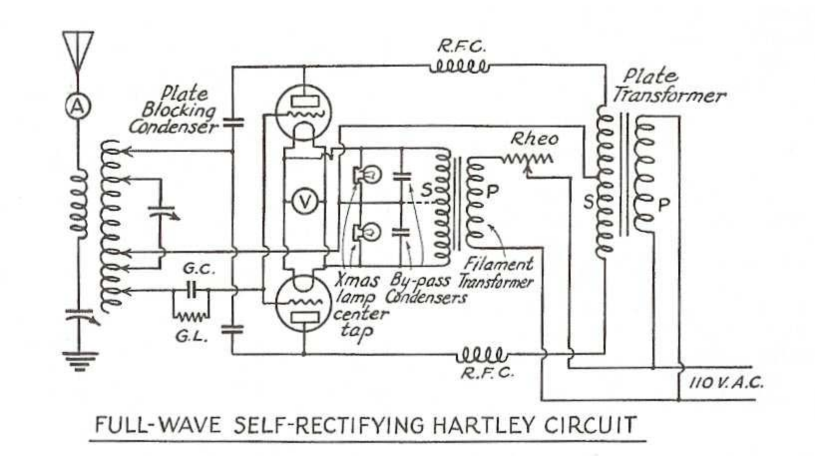


Figure Dec05 – Scan 1. Hartley Oscillator in 1926 ARRL Handbook, p. 87.

EMI Considerations

While we were testing the HF Box we spent some time examining electromagnetic interference (EMI) by turning on an AM radio and noting the response of a cable-driven television near the lab as well as a USB mouse adjacent to the Faraday Cage. We found that channel 3 of the TV was greatly affected about 25 feet away, and the adjacent mouse did not operate. However the laptop into which the mouse was plugged seemed to not be affected. The fine-copper-mesh Faraday Cage did not prevent the EMI, even though corners were well formed, but not soldered.