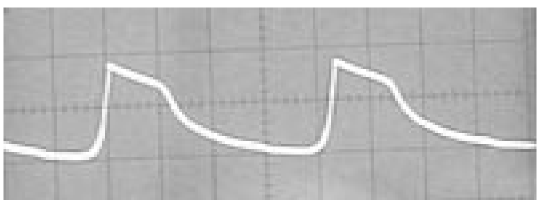
Phoenix RF Oscillator Theory of Operation

hFE is another expression of Forward Current Gain or Beta, it is current gain. From something I learned long ago biasing the transistor properly takes this out of play. If I have learned anything over the years it is biasing and my approach is the standard and good.

It is my belief due to the thermal sensitivity of a bipolar transistor that untouched at room temperature and identifying two that have the same "rough" measurements of **hFE** will have similar behavior to resist thermal drift, much needed in theremin design. Vacuum tube theremin's have much less drift.

My own follow up theory to this is you can minimize thermal drift by balancing or shifting the current in each transistor. This is done **with Pot-3 1k** on the **L2** side of the board. The **L1** circuit uses the resistor **R9 470** ohms to keep in balance with **Pot-3 1k** set half way.

I observed long ago while experimenting I could shift the direction of drift; if the Pitch would rise with temperature rise I could adjust **Pot-3** and make the Pitch drift go lower or in the opposite direction. Somewhere in-between is balance. Even if not perfect adjusting the **Pot-3** to one side or the other will be much better than no adjustment.



The use of the **MPSA42-AP** transistor has special qualities discovered by experimentation. In theremin design to get a more natural sound my thought was let's make the RF section more sluggish, this idea comes from my vacuum tube design in how it had a **better droop** at the bottom of the wave shape. The skew on top is the even harmonics. This is the throatier sound; transistors are too dam snappy. That is why with the **D1 1N914** diode uses a micro current. The transistors also run at very low current but this is to limit the intensity of the magnetic field around the inductors **L1 & L2,** so they do not interact. An **original idea** was to pick up the magnetic fields of both inductors using a third inductor **L3**. It worked outstanding, isolating the **L1 & L2** from one another with no need to add extra buffering components. This approach by placing **L3** closer to **L1** increases the amplitude through **D1**, 0v-750mv. It is here I adjust the sine wave that works best for the sound I want. The follow up original opto-Isolator with the transformer does the final wave shaping for an ideal theremin voice.

For the Volume Control we want **L1 & L2** to interact. There is a switch **S1** for this, the right wave shape creates the **P**ulse **W**idth **M**odulation that works for Volume Control.

Read about the **Becker Electrodeum,** another remarkable discovery for Pitch linearity.

Important: If you used my values in the parts and swapped the **MPSA42-AP** transistor with a **2N3909** the **Pot-4** sweep range to find Zero-Beat will increase by more than double. The 2N3909 has much more junction capacitance prone to thermal drift. The reason this method of tuning works is by varying the voltage across the transistor junction, this shifts the junction capacitance, like a varactor diode. Adding a **470** ohm or lower value of resistor at **R25** in parallel with **Pot-4** is how you narrow the Zero-Beat tuning range. When experimenting I like a large sweep range, Thereminist want just enough for easy tuning.

The Phoenix works at **900 kHz** and an ideal way to monitor what is going on is to tune an "analog" old school **AM Radio** till you hear the heterodyne tone around 900 kHz. It is a beautiful first experience. This sound & discovery is what led Lev Sergeyevich Termen to development the theremin. This method also allows you to hear at what approximate frequency the two oscillators are at. You will hear a blank spot in the radio static. To get the heterodyne tone both frequencies must be tuned to be on top of one another.

Christopher – oldtemecula 4.15.20 www.Hwy79.com