

THEREMIN for TUBE Enthusiasts

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As an electronic instrument using tubes, a Theremin may be constructed at a very nominal cost, especially if you use salvaged parts. And give completely satisfactory performance. In the instrument about to be described, the tone is produced by two RF oscillators beating at an audible frequency. The addition of hand capacity to the pitch control antenna lowers the frequency of one of the RF oscillators, and the pitch of the beat frequency is correspondingly changed. The outputs of the two radio frequency oscillators V1, and V2 in the schematic are mixed, and the RF components of the resultant signal removed by means of a diode detector.

In the volume control circuit, the addition of hand capacity to the volume control antenna causes a change in the frequency of a third oscillator, V6. The output of this oscillator is fed through a series of tuned circuits, T4 and T5, and then rectified. The rectified voltage is used as grid bias to control the gain of a variable mu amplifier tube. A change in the oscillator frequency will vary the grid bias and therefore, the output of the amplifier. The output of this amplifier is fed directly into the power amplifier and from there into a loudspeaker.

The variable pitch oscillator uses the triode section of V1 and its frequency is determined by two tuned circuits, L1-C1, and L3-C4. L1 is a variable coil of high inductance, and has only its distributed capacity and a small variable capacitor C1 across it. Therefore, the resonant frequency of this tuned circuit will be appreciably lowered by a slight addition of hand capacity. On the other hand, L3 has much less inductance and is tuned to resonance by a large fixed capacitor C4. The two coils are coupled so that the tube oscillates at the average of their resonant frequencies. This pitch control oscillator is extremely sensitive to changes in hand capacity, but because of the low impedance of L3-C4, changes in input capacitance of the tube have no effect on it. Naturally, this stability is an extremely desirable feature in an electronic musical instrument.

The pentode part of V1 acts as a buffer amplifier to further isolate the oscillator from extraneous disturbances. The output frequency is about two hundred kHz.

Except for the absence of an antenna coil, the operation of the fixed oscillator V2 is identical with that of the variable oscillator. The outputs of the two oscillators are fed through isolating capacitors into a buffer/mixer V4a stage. This is passed on to the three RF transformers, which pass or reject the harmonics produced by the oscillators. These high frequency harmonics produce corresponding overtones in the beat note and by controlling these harmonics, distinctive qualities of tone are produced by the instrument.

The volume control oscillator is identical to the pitch control oscillator, except for the tuned circuit values. The output is passed through two conventional I.F. transformers, T4 and T5, and then rectified by the tube diode V4b. When the transformers are tuned to the same frequency as the oscillator, a maximum voltage difference of about eighty volts exists across R12. The oscillator frequency is then raised to a point where the voltage across R12 is about one half maximum, or forty volts. This provides operation on that portion of the sensitivity curve those results in the greatest change in voltage across R12

for a given slight variation in the oscillator frequency. To take advantage of this maximum sensitivity, the positive end of R12 is placed at a point on the voltage divider R10-R11 which is about forty volts above ground. Therefore, the negative end of R12 is at zero volts in relation to ground. With a slight addition of hand capacity to the volume control antenna, the junction of R16 and R12 will become negative in relation to ground. This negative voltage is used as grid bias to control the gain of the pentode section of V3. The amplifier will be completely cut off when the grid bias exceeds minus ten volts. R16 and C14 make up a time constant which eliminates clicks and pops resulting from sudden hand movements. The diode connected across C14 prevents the grid bias from accidentally going positive. The sensitivity of this volume control is such that the amplifier is completely cut off when the hand is a few inches from the antenna, and full volume is obtained with the hand about eighteen inches from the antenna. R9 is used to set the maximum volume.

The power supply uses a 6BM8 tube to regulate the voltage to supply the oscillators and the control amplifier and mixer stages of the unit, thereby adding to the over-all stability of the instrument.

As a musical instrument, the Theremin should be as compact and portable as possible. However, a distance of at least eighteen inches should separate the two antennas. The unit is assembled on a chassis about 17 x 7 x 3 inch. The antennas are mounted on the wooden covering, on top of the chassis. The pitch control antenna is made of whip, and the volume control antenna is a piece of a 6 x 9 inch plate. C1 and C24 are 15pF variable capacitors which are used to "tune up" the instrument and should be placed on a convenient part of the front panel. The unit must be adequately ventilated to prevent an extreme temperature rise that might otherwise result in frequency drift from the tubes. A small fan should work nicely. Transformers T2, T3, T4, and T5 are all conventional AM broadcast i.f. transformers and may be either of the shielded or unshielded type. If unshielded transformers are used, they should be mounted under the chassis and holes drilled for adjusting the trimmer capacitors. Placement of parts is not critical, since the oscillators work at low frequencies, and all circuits are of fairly low impedance. The oscillator coils should be carefully constructed however, since these are the "heart" of the instrument. In constructing the pitch control coil assembly (L1, L2, L3) a ring with an outside diameter of 1-1/2 inches and inside diameter of 13/16 inch is cut from 3/4 inch wood. On this form, L3 is wound. A layer of insulation is placed over L3 and L2 is wound over the insulation. L1 is then placed in the hole in the coil form. With L1 in place, the entire assembly is coated with cement or coil dope.

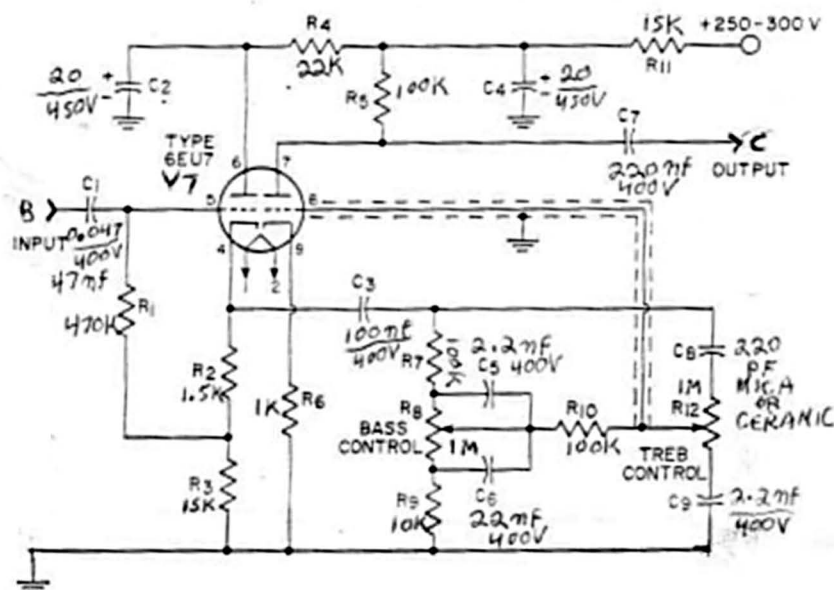
The same procedure is done for the volume control coil assembly (L6, L7, L8), but the dimensions are different, L8 is a coil of the same type as L1, except that enough wire is removed from L8 so that its outside diameter is just under 9/16 inch and its resistance is 30 ohms. The wooden ring for this assembly has an outside diameter of 1-1/4 inches and an inside diameter of 9/16 inch.

The fixed oscillator coil (L4, L5) is wound directly on a 3/8 inch slug tuned coil form. L5 is wound and covered with insulation. L4 is then wound over the insulation.

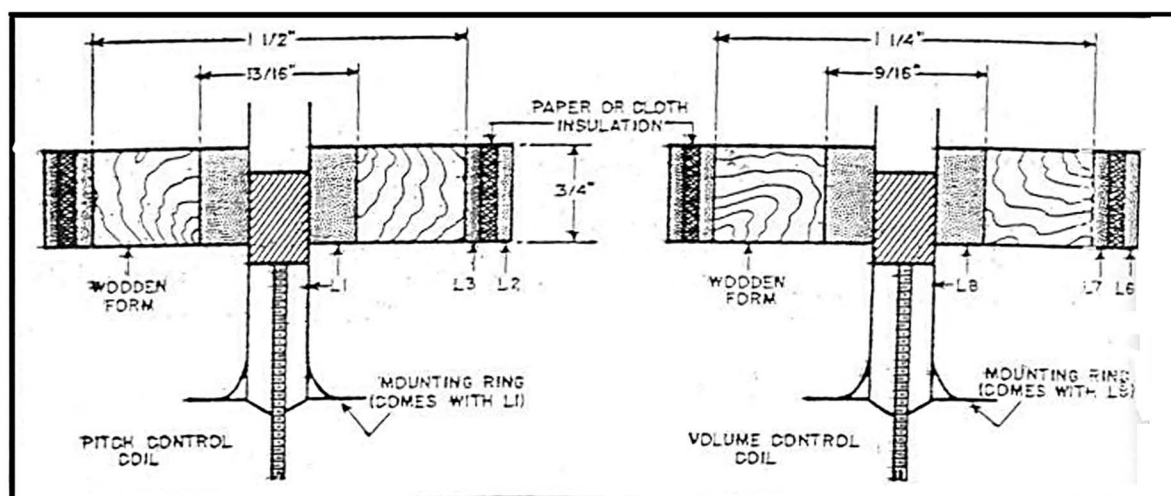
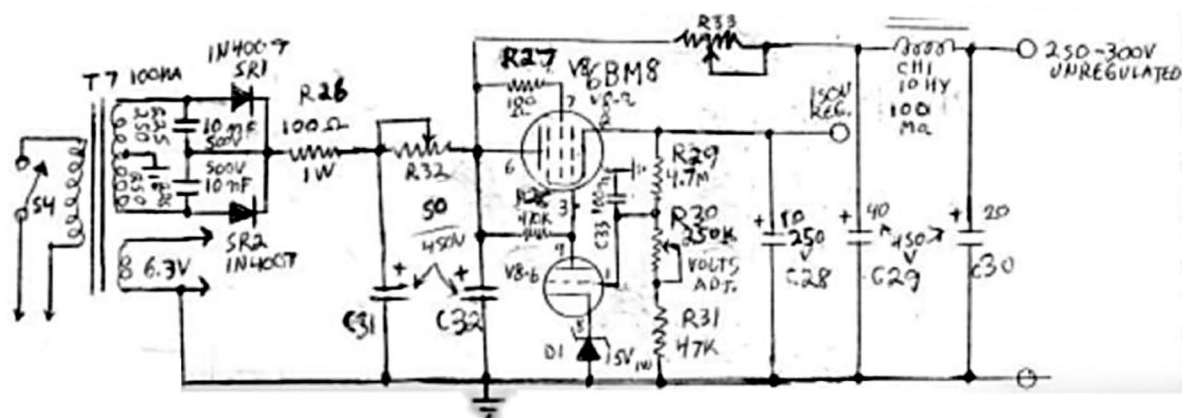
T1 is wound on a 7/8 inch wooden form. Both primary and secondary consist of 250 turns of No. 30 wire. The two windings are wound next to each other.

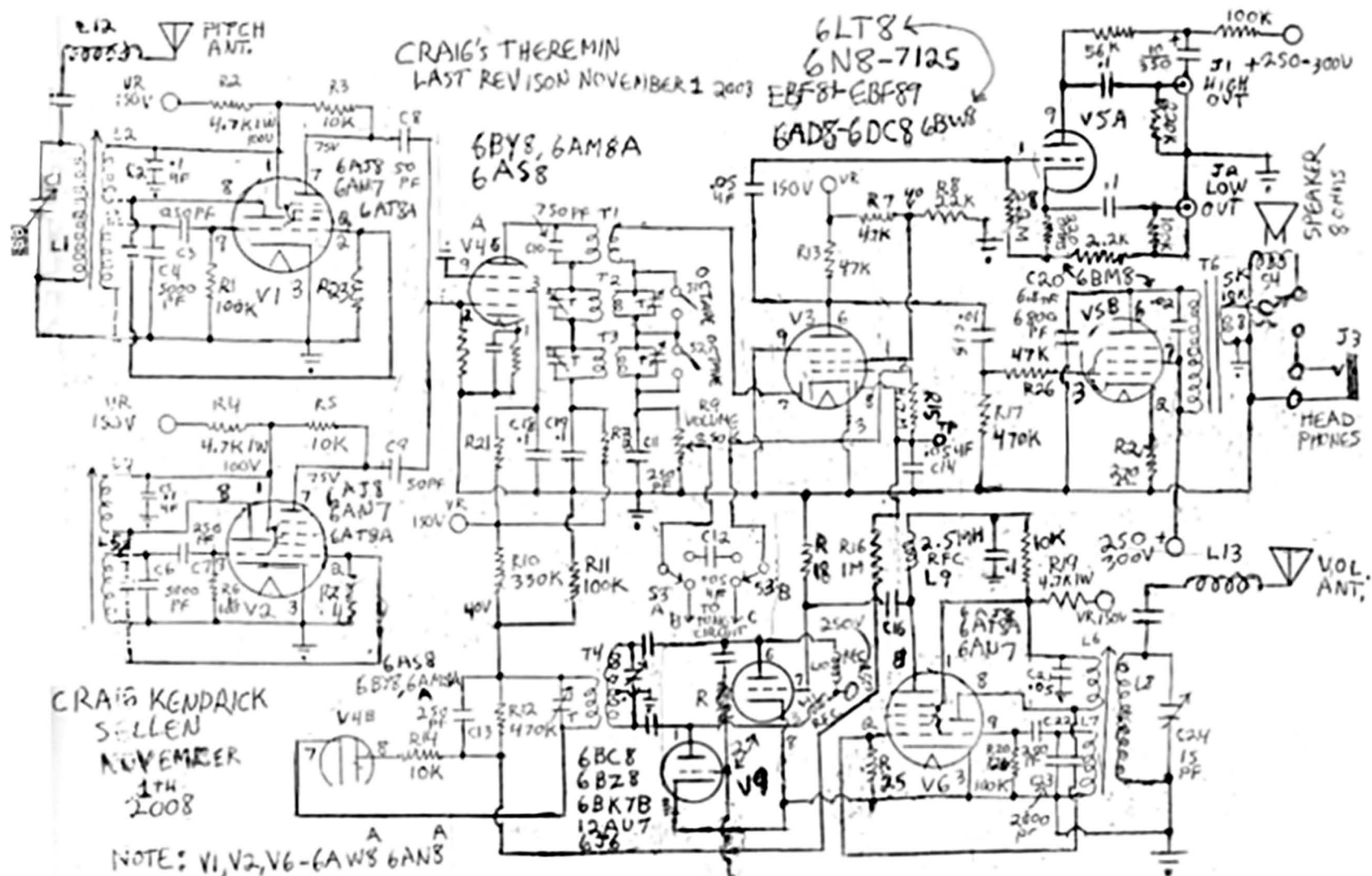
The two pitch oscillator coils should be placed at least six inches from each other and at right angles. This will prevent interaction between the magnetic fields surrounding the

BASS AND TREBLE TONE-CONTROL AMPLIFIER



Sensitivity=0.5 volt rms input for output of 1.25 volts with controls set for flat response.





C3, C4, C6, C7, C8, C9, C10, C11, C13, C16, C22, C23
ARE ALL MICA
ALL GROUNDS ARE BUSS GROUND
ALL RESISTORS ARE 0.5W 5% EXCEPT AS NOTED
ALL CAPACITORS ARE 400V MYLAR EXCEPT AS NOTED

