ETHERWAVE® THEREMIN

USER'S MANUAL

SETTING UP AND PLAYING THE MOOG MUSIC® ETHERWAVE® THEREMIN

INTRODUCTION

The theremin is an electronic musical instrument played by the free movement of the performer's hands in the space surrounding it. This method of playing gives the theremin tone its unique ethereal and dramatic quality, while at the same time allowing the performer a measure of artistic freedom that other musical instruments do not offer. The techniques of playing the theremin can be mastered by anyone who has a good musical ear, and who is willing to invest a modest amount of practicing time. Two motions are involved. Movement of the right hand toward the pitch antenna controls pitch, while movement of the left hand toward the volume antenna controls loudness or volume.

The Moog Music ETHERWAVE theremin is powered by a special adapter which plugs into a standard 110-125 volt grounded power outlet or alternatively a 220 volt supply is also available. It is designed to operate with a wide range of amplifier-speaker combinations.

PREPARING THE ETHERWAVE THEREMIN FOR PLAYING

If you've purchased the ETHERWAVE theremin kit, please turn to the section on Assembling Your ETHERWAVE Theremin Kit at the end of this manual.

A) PLACING THE INSTRUMENT ON A STAND:

The ETHERWAVE theremin requires either a standard microphone stand (preferred) or a small table 36" to 42" high. If a table is used, no objects on the table should be within a foot or two of the theremin, and the theremin itself should be positioned so that the the volume antenna will overhang the edge of the table. Whichever type of stand is used, the ETHERWAVE should be securely mounted, and away from walls and other large stationary objects. *Large objects located close to the volume antenna will silence the instrument's output.*

B) ATTACHING THE TWO ANTENNAS:

The pitch antenna, which is the long straight tube, is placed in the elbow (right angle) fitting on the right end of the instrument, with the brass compression ring down. The mounting nut is slipped over the antenna and screwed onto the fitting. The nut need be only finger-tight, but should be tight enough so that the antenna is firmly in place.

The volume antenna, which is the tubular loop, is placed in the straight fittings on the left end of the instrument, with the bulge in the loop facing forward and down. The mounting nuts already on the antenna are screwed onto the fittings. The nuts need be only finger-tight, but should be tight enough so that the antenna is firmly in place.

C) CONNECTING THE POWER ADAPTER:

In order to provide optimum sound and playability of your Etherwave Theremin, it is imperative to properly ground your instrument to complete the signal path. For North American 110VAC instruments use the special Moog Supplied AC adapter connected to a grounded power receptacle or a three wire extension cord which provides a good ground connection. For 220-240VAC operation, use the 230VAC Moog Power adapter and ensure that your Etherwave has a solid ground connection either through an instrument cable connected to a properly grounded amplifier (such as the Moog TB-15/TB-16), or a properly grounded mixing console. If using a Direct Box, ensure that the ground lift switch is set to the grounded position.

If using headphones on the Etherwave, make sure the audio out is connected to a grounded amplifier or mixer. There is no need for these devices to be powered if using headphones only but the earth ground connection stabilizes the Etherwave's operation.

D) CONNECTING THE AMPLIFIER-SPEAKER:

The ETHERWAVE may be used with a wide variety of musical instrument, stereo, or public address amplifier systems. The nominal level of the ETHERWAVE's audio output is one-half volt RMS and the nominal output impedance is 2.4 Kilohms.

We suggest a small but high-quality portable 'keyboard amplifier' of the sort that synthesizer players frequently use for practicing. Use a shielded audio cable with a conventional 1/4" phone plug on one end, to be plugged into the ETHERWAVE's audio out jack. The other end of the cable should be equipped with whatever kind of plug your sound system requires, and should be plugged into a jack labeled line in, instrument, or aux on your sound system.

E) SETTING THE TUNING ADJUSTMENTS:

Like many musical instruments, a theremin must be tuned each time it is played. Turn on both the ETHERWAVE and your sound system. Set the loudness or volume control on your amplifier about one third of the way up. Touch the pitch antenna of the ETHERWAVE and slowly rotate the ETHERWAVE's VOLUME tuning knob clockwise. A high note will be heard. At one setting of the VOLUME tuning knob, the volume will be at a maximum. Starting from this setting, turn the VOLUME tuning knob counterclockwise until the loudness of the tone begins to decrease. Now bring your left hand near the volume antenna. Note that the tone's loudness decreases smoothly, and finally

becomes silent when your left hand is two to three inches from the volume antenna. Then remove your left hand from the volume antenna but, still touching the pitch antenna, adjust the volume control on your sound system so that the tone is as loud as you will want it to be.

Now remove your right hand from the pitch antenna. Turn the ETHERWAVE's PITCH tuning knob fully counterclockwise. You will hear a high pitch. Now slowly turn the PITCH tuning knob clockwise. You will hear the tone's pitch go down. When it is about an octave below middle C, step back from the instrument. You should hear the pitch decrease further until the tone stops completely ('zero beat'). Adjust the PITCH tuning knob carefully so that, when your right shoulder is about 24" from the pitch antenna and your right hand is down at your side, the tone's pitch is audible but lower than two octaves below middle C. (Two octaves below middle C is the lowest note on a cello, and slightly below the lowest note on a guitar.) *Note: The Etherwave theremin is sensitive to objects and conditions around it. The tuning adjustments may vary with any change in its location. Learn to make these tuning adjustments, as they are used every time you set up to play.*

PLAYING THE ETHERWAVE THEREMIN

Pitch and volume of the ETHERWAVE sound is controlled by the free movement of the player's hands in the space in the electric fields which surround the two antennas.

Changes in pitch are produced by moving the right hand nearer to or farther away from the pitch antenna. Moving the right hand nearer to the antenna raises the pitch; moving it away lowers it. Changes in volume are produced by moving the left hand nearer to or farther away from the volume antenna. Bringing the hand nearer the antenna weakens the sound; moving the hand away from the antenna strengthens the sound.

Since any moving body will influence the theremin's pitch and volume, it is important that only the player be near the theremin when he is performing. Other people should be at least four to six feet from the pitch antenna.

Timbre, or quality of the tone may be varied by changing the settings of the WAVEFORM and BRIGHTNESS knobs. The WAVEFORM knob adjusts which harmonics are strong and which are weak, while the BRIGHTNESS knob adjusts the overall amount of harmonic content.

CORRECT PLAYING POSITION:

Position yourself slightly left of center of the instrument. When your right arm is fully extended, your knuckles should just touch the pitch antenna. The right hand is moved horizontally toward and away from the pitch antenna. The left hand is moved vertically over the volume antenna.

The PITCH and VOLUME tuning adjustments should now be checked. Without moving your feet, place both hands at your side and stand erect. The instrument should produce a very low-pitched tone, or be completely silent ('zero beat'). Now bring your right hand up to your shoulder. The pitch should be about one to two octaves below middle C. If this low note is not heard, then adjust the PITCH knob until the desired condition is obtained. Note that the PITCH knob is a tuning adjustment. It sets the distance that you have to stand away from the pitch antenna in order to obtain zero beat. When you turn the PITCH knob clockwise, the distance is reduced, thus compressing the distance between musical intervals.

Check the volume adjustment as follows: Place your left hand eight inches above the volume antenna. This should produce a noticeable reduction in the loudness of the tone. If it does not, then turn the VOLUME knob counterclockwise until the desired effect is obtained. On the other hand, turning the VOLUME adjustment knob too far counterclockwise will prevent you from producing loud tones. Note that the ETHERWAVE's VOLUME knob is a tuning adjustment. Its purpose is to adjust how the instrument's volume changes as your left hand approaches the volume antenna. This knob is not a 'volume control'. That is, it does not simply make the tone louder or softer. It should not be used to set the instrument's maximum volume. The volume control on your sound system is used for that purpose.

You will rapidly develop a feel for these adjustments. After a few practice sessions, you will be able to tune the theremin rapidly and accurately.

TECHNIQUES OF PRACTICING:

Like any expressive musical instrument, the theremin takes some practice. Start with the following simple exercises:

1. Stand slightly left of the center of the instrument, with your right shoulder about 24" from the pitch antenna. Relax your wrists. Think of a note and hum it to yourself. Then move your right hand toward the pitch antenna until the theremin pitch coincides with what you're humming. Now hold the note. This is not as easy as it sounds, but is an important technique to learn. You will find at first that it is actually hard to stand still, but a few hours' practice will work wonders.

2. Hum two different notes, one after the other. Find the first note on the theremin, hold it, and then slowly glide to the second.

3. Repeat the above exercise, but bring your left hand near the volume antenna while your right hand glides from one note to the next. Move the left hand slowly at first, and then more rapidly as you learn to move your left hand independently of your right. This exercise teaches you to 'feel' where the notes are, and to impart expressive dynamics.

4. While playing a note, introduce a vibrato by moving your right hand back and forth from your wrist, several times a second. Concentrate on making the vibrato even and steady.

The above exercises will give you basic skills of theremin playing: finding notes, playing intervals, articulating notes, and introducing a vibrato. With these basic skills, you can play slow melodies. Practicing regular scales and arpeggios will increase your proficiency. Focus on accuracy of pitch and precise control over dynamics.

Once you've mastered the basic moves, it will be time for you to develop your own style. Pay particular attention to shaping envelopes and dynamics with your left hand. Alternate audible gliding from note to note with discrete separation of pitches. Also, avoid producing vibrato continuously. Instead, impart expressive nuance by continuously shaping the amount and rate of vibrato. These considerations are important components of theremin musicianship.

The instructional video MASTERING THE THEREMIN, starring theremin virtuoso Lydia Kavina, shows you how to perform these and other exercises. Study this video closely to learn proper theremin-playing technique.

The ETHERWAVE theremin is designed to meet the needs of musicians who wish to explore the artistic resources of space control. Your instrument will provide many years of reliable service. Practice it with diligence and you will provide enjoyable music for yourself and your audiences. And finally, give an occasional thought to the spirit of Leon Theremin, to whom we owe so much.

MAINTENANCE

The ETHERWAVE theremin requires no routine maintenance. Many years of trouble-free, reliable performance may be expected. The ETHERWAVE theremin is guaranteed to operate properly for one full year after purchase, if the following common-sense precautions are observed:

1. Never expose the instrument to extremely hot, cold, or damp environments.
2. Don't allow inexperienced people to tamper with the instrument's controls or internal mechanism.
3. Don't drop the instrument, or subject it to excessive vibration.

In the event of improper operation, call Moog Music tech support at 1-800-948-1990 or 828-251-0090; or email tech support at moogmusic.com.

UNDERSTANDING YOUR ETHERWAVE® THEREMIN

UNDERSTANDING:

INTRODUCTION

We'll first explain how the ETHERWAVE converts hand movements into changes in pitch and volume of a musical tone. We hope that this explanation will help you to understand the ETHERWAVE'S operation, and will provide the information necessary for you to add to and modify your ETHERWAVE to meet your individual requirements. Following our explanation of the Etherwave's circuit, we'll describe the adjustment of the Etherwave's internal pitch and volume circuitry.

HOW THE ETHERWAVE WORKS

There are several *resonant circuits,* or *tuned circuits,* in the ETHERWAVE theremin. Since resonant circuits are not as common or accessible in today's electronic gear as they used to be, we'll define some basic terms and concepts that will help you understand how the theremin circuit works.

A resonant circuit consists of a capacitor (sometimes called a condenser) and an inductor (sometimes called a coil). A capacitor is a device consisting of two conductive plates separated by insulating material such as air or polyester. The capacitance of a capacitor depends on the size of the plates and the distance

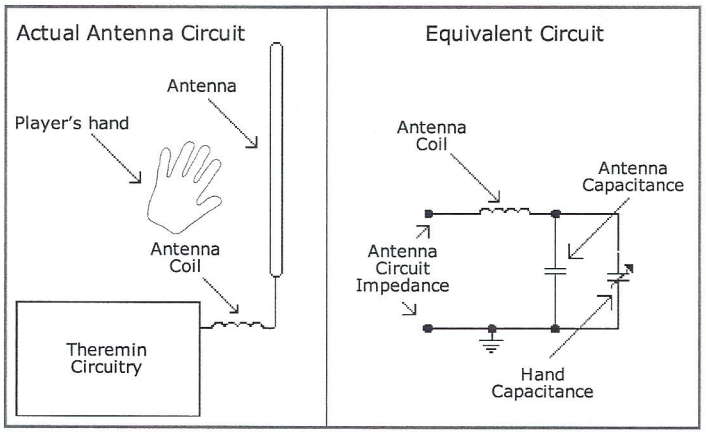
between them. An inductor is a device consisting of a coil of wire, sometimes wrapped around an iron or ferrite core. The inductance of an inductor depends on the number and size of the turns of wire and the material of the core. A resonant circuit has the property that its electrical impedance changes radically within a narrow frequency band, the middle of which is called the *resonant frequency* of the circuit.

HAND CAPACITANCE

When you bring your hand near a theremin antenna, you are actually forming a variable capacitor in which the antenna is one 'plate' and your hand is the other. For the high frequencies and very low currents that we're talking about, your hand is effectively grounded by being attached to your body, so the antenna and your hand form a variable capacitor to ground. We call this variable capacitance *hand capacitance.* You increase the hand capacitance by bringing your hand nearer to the antenna. In normal theremin playing, hand capacitance is less than one picofarad, a very small capacitance change indeed! In addition to hand capacitance, a theremin antenna has a fixed capacitance to ground, which we'll call the *antenna capacitance.* Antenna capacitance depends mostly on the size of the antenna, and is typically 10-15 picofarads.

A large inductor, called the antenna coil, is connected to each antenna inside the theremin. The antenna coil, antenna capacitance, and hand capacitance form a resonant circuit **(Figure 1)**. In our design, the resonant frequencies are about 285 kHz for the pitch antenna, and about 450 kHz for the volume antenna. At or near the resonant frequency, a tiny change in hand capacitance results in a larger change in the impedance of the antenna circuit as a whole.

Figure 1 – Equivalent Circuit of Hand Capacitance



THE ETHERWAVE CIRCUIT

Figure 2, shown on the following page, is a block diagram showing all the ETHERWAVE theremin's circuit functions.

TONE PRODUCTION AND PITCH CONTROL

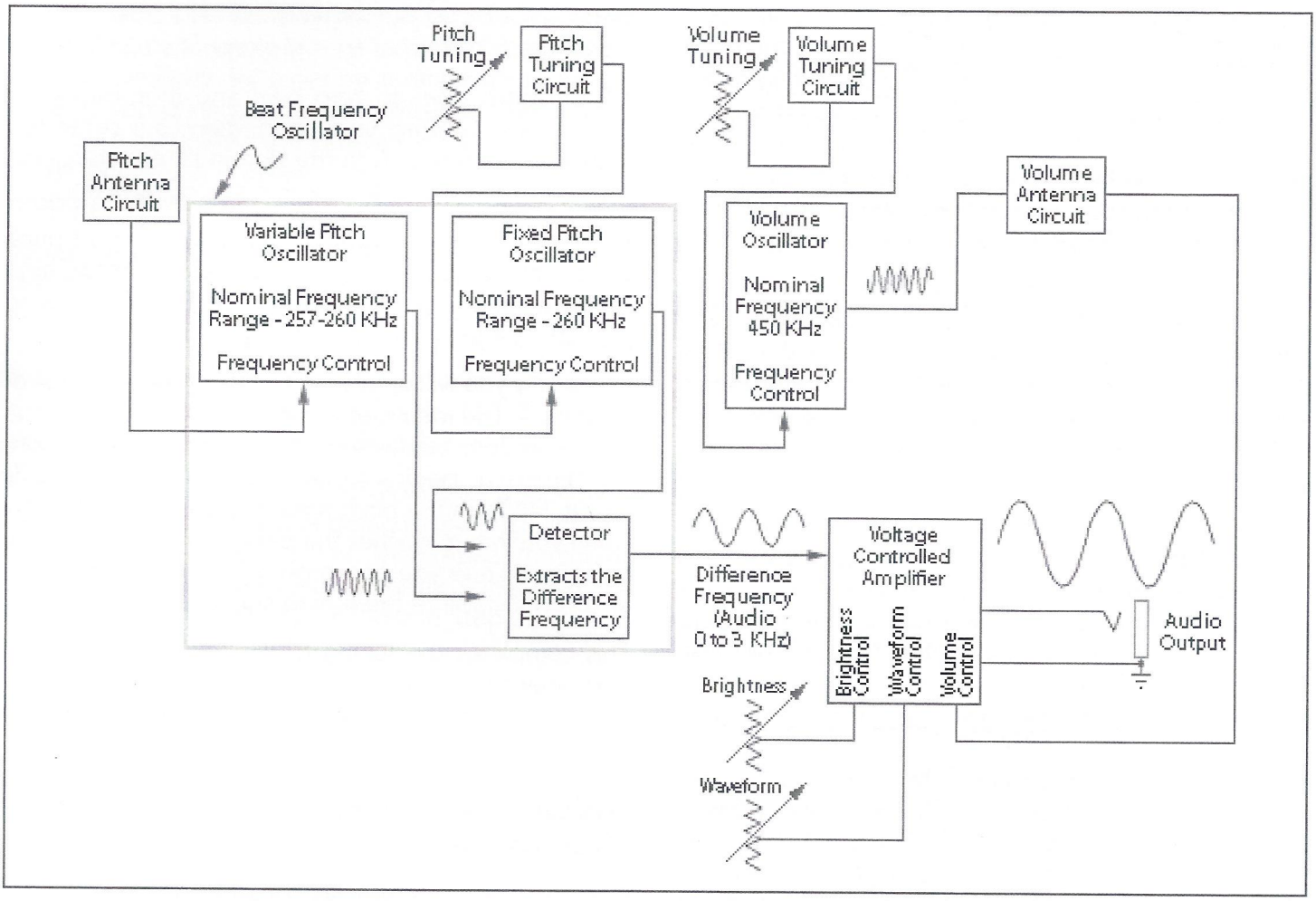
The ETHERWAVE'S tone is produced in a circuit configuration called a beat frequency oscillator. It consists of two high-frequency oscillators, plus a detector circuit which extracts the difference frequency, or beat frequency. One of the high-frequency oscillators (called the fixed pitch oscillator) operates at about 285 kHz, while the other high-frequency oscillator (called the variable pitch oscillator) operates over a range of about 282 - 285 kHz. The difference frequency ranges from zero to about 3 kHz, which is three and a half octaves above middle C.

The pitch antenna circuit is connected to the variable pitch oscillator in such a way that increases in hand capacitance will decrease the variable pitch frequency as much as 3 kHz. This is how the pitch antenna circuit, in conjunction with the beat frequency oscillator circuit, enables the player to cover a usable pitch range of some five octaves (two octaves below to three octaves above middle C) simply by moving her right hand through a distance of two feet or so.

VOLUME CONTROL AND TIMBRE CONTROL

The volume antenna circuit consists of the volume antenna itself, in series with several inductors. It's connected to the output of the volume oscillator, which provides a high frequency signal. When the antenna circuit resonant frequency is at or near the volume oscillator frequency, a high frequency current flows through the inductors, which induces a high frequency voltage across each of the inductors. These voltages are at a maximum when the antenna circuit's resonant frequency is exactly the same as the frequency of the volume oscillator, and decrease when the antenna circuit's resonant frequency is decreased by the addition of hand capacitance to the volume antenna. The volume antenna circuit also includes a detector, which converts the high frequency voltage across one of the inductors to a direct (DC) voltage. This voltage, which is called the volume control voltage, controls the gain of a voltage-controlled amplifier (VCA). Thus, as the player brings his left hand near the volume antenna, the volume control voltage decreases, the VCA gain decreases, and the audio

Figure 2 – ETHERWAVE Block Diagram



output signal goes from loud to complete silence. The audio output signal is line level, and may be fed to a line input of a power 7 amplifier or mixing console.

Front panel controls include four potentiometers: two for antenna tuning and two for timbre control. The PITCH TUNING potentiometer is connected to the pitch tuning circuit, which adjusts the frequency of the fixed pitch oscillator over a small range. Similarly, the VOLUME TUNING potentiometer is connected to the volume tuning circuit, which adjusts the frequency of the volume oscillator over a small range. These circuits provide the player with a way of fine-tuning the antenna responses during performance. In earlier theremin designs these tuning functions were implemented with large variable capacitors. Such variable capacitors are no longer generally available at reasonable prices.

The VCA is deliberately designed to distort the difference frequency waveform, thereby adding desirable harmonic content. The BRIGHTNESS and WAVEFORM potentiometers vary the biases on the VCA input, which change the way in which the audio waveform is distorted. The BRIGHTNESS potentiometer determines how much the waveform is distorted, and therefore the amount of the total harmonic content. The WAVEFORM potentiometer determines which harmonics will be strong, and which will be weak. It is similar to a Rectangular Width control on analog synthesizers.

The entire theremin circuit runs on ± 12 volts, which is supplied by a simple, small power supply. Total current consumption is about 30 milliamperes.

TUNING THE PITCH CIRCUIT

The circuit board of your ETHERWAVE theremin has been assembled, tested, and adjusted at the factory. However, you may find it desirable or necessary to trim the adjustments of the variable inductors in the oscillator circuits: L5, L6, or L11. (refer to **figure 3** for the location of these components). For instance, you may want to set your ETHERWAVE to cover a slightly different pitch range, or the finish you used for your cabinet might have slightly different electrical properties than that which we adjust the boards for at the factory.

Now included with your ETHERWAVE Theremin is a red calibration tool (Moog Part # ACC-TUNE-0001) with a 2mm hex head. This can be used if you need to calibrate the theremin's oscillators according to the procedures on page 6 (Pitch Tuning) or page 8 (Volume Tuning). The parts L5, L6 and L11 (adjustable inductors) now require the hex adjustment tool supplied. Should you lose this tool, replacements are available from Moog Music for $6 plus shipping and handling.

Before tuning, clean off your workbench and move aside large conductive objects like desk lamps and test gear. Leave a clear space of two or three feet around your work area. Place the cabinet base in the middle of the cleared space, and put the pitch antenna in place.

Using a clip lead or a temporarily-soldered wire jumper, connect the two leads of C28 together. (C28 is a small capacitor, about 3" to the left of the PITCH ANTENNA connection on the ETHERWAVE circuit board.) Then connect the instrument's audio output to headphones or a monitor amplifier. Now follow these steps to adjust L5 and L6:

1. Set P1 (the Pitch Tuning control) to its mid-position.

2. Grasp and hold the pitch antenna with one hand. With the other hand, adjust L6 for zero beat. *Note: If the slug in L5 is fully counterclockwise, you have to turn it clockwise a turn or so in order to hear zero beat.) Then carefully turn L6 counterclockwise until you hear a pitch of about 3 kHz (3-1/2 octaves above middle C.*

3. Let go of the pitch antenna. Slowly retract your hand from the vicinity of the antenna. You will hear the pitch go down.

• If the pitch does not go down to zero beat when you've retracted your hand completely and stepped back, then L5 is set to too low an inductance. Advance the slug in L5 (that is, turn it clockwise) a small amount – perhaps 1/10 turn or so – and repeat steps 2 and 3.

• If the pitch goes to zero beat and then begins to ascend as you retract your hand, then L5 is set to too high an inductance. Turn the slug in L5 counterclockwise a small amount, and repeat steps 2 and 3.

• If the pitch jumps abruptly to a very different pitch as you retract your hand, then L5 is set to far too high an inductance. Turn the slug in L5 counterclockwise perhaps 1/4 turn, and repeat steps 2 and 3.

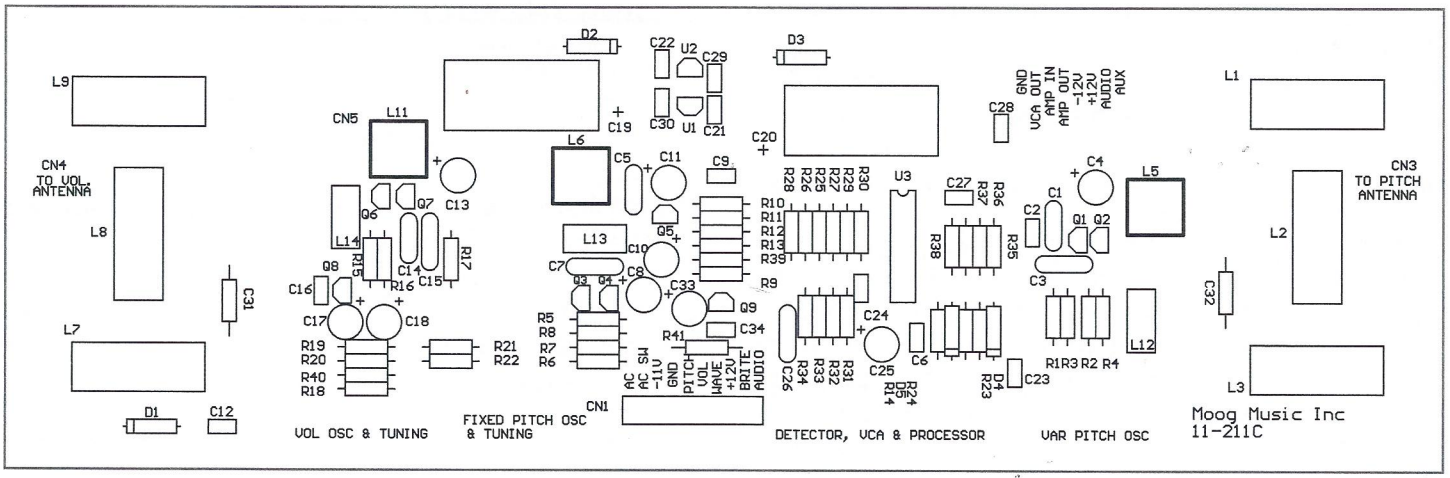
Eventually you will converge on the proper settings of L5 and L6. The idea is to achieve settings in which the pitch is at zero beat when you've stepped away from the theremin, begins to ascend when your body is about 24" from the pitch antenna, and is about 3 kHz when your hand touches the pitch antenna. Tap lightly on L5 and L6 as you converge on the proper settings, as this will stabilize the tuning slug positions.

This completes the tuning of the Pitch Oscillators. In performance, the exact pitch tuning is achieved by adjusting the Pitch Tuning control.

TUNING THE PITCH CIRCUIT FOR DIFFERENT PITCH RANGES

With L5 and L6 set as described above, your ETHERWAVE will cover a musical pitch range of five octaves - two octaves below middle C to three octaves above middle C. (Of course, it will produce tones below two octaves below middle C, but this part of the pitch range is not particularly useful for theremin playing.) You can retune the ETHERWAVE's pitch section to cover a smaller or a larger pitch range. By covering a range up to two octaves above middle

Figure 3 – Component layout of ETHERWAVE circuit board



C for instance, your instrument's range will be only four octaves, but the intervals will be spaced farther apart and it will be easier for you to play a desired interval. Similarly, by covering a range of up to four octaves above middle C, your instrument will cover a six octave range, but the intervals will be spaced very close together and proper interval production will be proportionally more difficult.

To retune your ETHERWAVE for a four-octave range, first reposition the heavy wire going to the pitch antenna connector, so that it is close to the aluminum foil. (This will lower the resonant frequency of the antenna circuit.) Then repeat the tuning procedure given earlier, substituting 1.5 kHz (2-1/2 octaves above middle C) for 3 kHz in Step 2.

Similarly, to retune your ETHERWAVE for a six-octave range, raise the heavy wire going to the pitch antenna connector as high as possible. Then repeat the tuning procedure, substituting 5 kHz (slightly higher than four octaves above middle C) for 3 kHz in Step 2.

TUNING THE VOLUME CIRCUIT

A. Using a voltmeter:

Remove the temporary shorting connection across C28. Connect a voltmeter from pin 12 of U3 to ground and install the volume antenna. Position your ETHERWAVE so that the volume antenna is at least a foot from table tops, furniture, etc. Follow these steps to adjust L11:

1. Set the VOLUME knob to its mid position.

2. Carefully turn the slug in L11 counterclockwise until it is out as far as it will go. The meter should read about -12 volts.

3. Slowly turn the slug clockwise. At some point you will see the voltage begin to rise from -12 volts. Stop when the voltage goes through zero and becomes positive. You should then notice that bringing your hand near the volume antenna lowers the voltage; the meter should read about minus 12 volts when your hand is two or three inches from the volume antenna.

This completes the tuning of the Volume Oscillator. In performance, the exact volume tuning is achieved by adjusting the Volume Tuning control.

B. Adjusting L11 without a voltmeter:

Remove the temporary shorting connection across C28. Install the volume antenna. Position your ETHERWAVE so that the volume antenna is at least a foot from furniture and other large objects. Follow these steps to adjust L11:

1. Set the VOLUME knob to its mid position.

2. Carefully turn the slug in L11 counterclockwise until it is out as far as it will go. Then turn on your amplifier and set its volume control so that the theremin tone will be audible but soft.

3. Slowly turn the slug clockwise. At some point you will hear the theremin tone. As you turn the slug in L11, the tone will get louder, reach a maximum loudness, and then get softer. Turn the slug back to the maximum loudness, and notice how loud the tone is.

4. Slowly turn the slug counterclockwise until the tone is about half its maximum loudness. You should then notice that bringing your hand near the volume antenna lowers the volume, and the tone is complete silent when your hand is two or three inches from the volume antenna.

This completes the tuning of the Volume Oscillator. In performance, the exact volume tuning is achieved by adjusting the Volume Tuning control.

WHY IS THE POWER ADAPTOR GROUNDED?

In order for any hand-capacitance device to work properly, there has to be a good path for high frequency currents to flow to ground. Older vacuum tube theremins used large power transformers, and these provided high frequency ground paths because of the large capacitances between windings.

Transistor theremins use much less power than their vacuum-tube ancestors, and their power transformers are therefore much smaller. Under certain conditions, a supplementary ground path is needed for stable operation and good tone color. For this reason, the power adaptor that is supplied with your ETHERWAVE provides a direct connection to ground. That is the purpose of the third prong on the power adaptor.

If you are using your ETHERWAVE with an amplifier that also has a direct connection to ground (i.e. a three-prong power plug), you may experience a small amount of hum from the ground loop, especially if your amplifier is plugged in to a different power circuit than your ETHERWAVE. If this happens, simply use a 'ground-lifter' 3-prong-to-2-prong adaptor on your ETHERWAVE power adaptor.

Assembling an ETHERWAVE kit is a fun, educational, and relatively easy project for those with basic soldering and assembly skills. We recommend that you read through all of the instructions now, before you begin to put the kit together. We also recommend that you check off each instruction as you complete it. This will

ASSEMBLING YOUR MOOG ETHERWAVE THEREMIN KIT

help you do all of the assembly in the correct order.

WHAT'S IN THE KIT

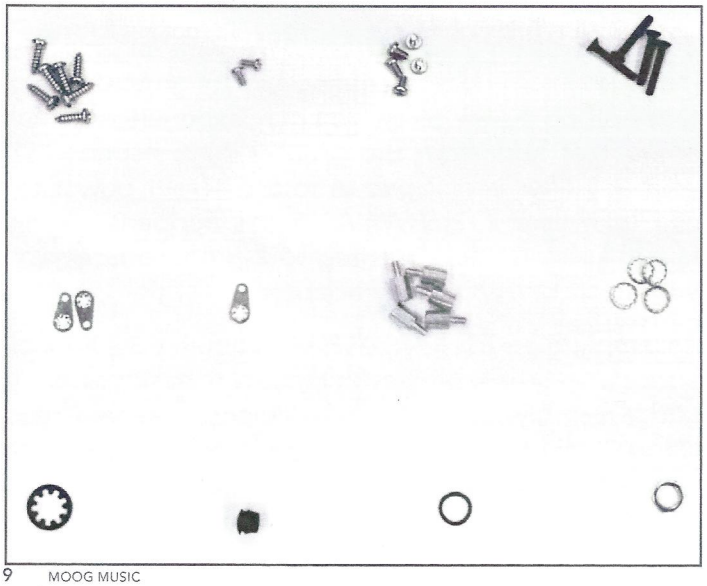
Your ETHERWAVE kit contains the following items. Verify that they are all present and in good condition.

Wood Cabinet
Assembled Circuit Board
Anodized Aluminum Panel
Pitch Antenna (18" straight tube)
Volume Antenna (loop tube)
DVD: Clara Rockmore: The Greatest Theremin Virtuosa and Mastering the Theremin by Lydia Kavina
Wall-mount Power Transformer
Small Plastic Bag of Parts
Large Plastic Bag of Parts
8" length of heavy (18AWG) solid copper bus wire (for connecting the antennas to the circuit board)
15" length of green hookup wire for panel wiring
8" length of black hookup wire for panel wiring
This booklet, including Label and piece of Adhesive-Backed Aluminum Foil

Also in small parts bag (not pictured):
Qty 5 - #6 external tooth lockwasher.

Use with ¼" x 6-32 machine screws for mounting the printed circuit board.

Figure 4 – Contents of small parts bag



The Small Plastic Bag of Parts contains the following: (See **Figure 4** to identify the parts)

4 – 1/2" x #6 wood screws (for mounting the panel and the microphone stand flange, and for grounding the foil shield - 7 are shown in **fig. 4**)
2 – 1/4" x 4-40 machine screws (for mounting solder lugs to the antenna connectors)
5 – 1/4" x 6-32 machine screws (for mounting the printed circuit board)
4 – 7/8" x 6-32 flat head black machine screws (for mounting the cabinet top to the base)
2 – #4 locking solder lugs (for providing electrical connection to the antenna connectors)
1 – #6 locking solder lug (for providing electrical connection to the aluminum foil)
5 – Threaded standoffs (for holding the printed circuit board)
4 – 5/16" inside diameter lockwashers (for mounting the potentiometers)
1 – 3/8" inside diameter heavy lockwasher (for mounting the audio output jack)
1 – 3/8" diameter black plastic cap (for pitch antenna)
1 – 3/8" inside diameter flat washer (for mounting audio output jack)
1 – 3/8" nut (for mounting audio output jack)
3 – 8-32 x ¾" machine screws (for installing mic stand adapter **not shown in fig. 4**)
3 – 8-32 Tee-nuts (for installing mic stand adapter **not shown in fig. 4**)

The Large Plastic Bag of Parts contains the following: (See **Figure 5** on the following page to identify the parts)

2 – 5 Kilohm Potentiometer (numbered B5K)
2 – 50 Kilohm Potentiometer (numbered B50K)
1 – Microphone Stand Flange (marked Atlas AD-11)
4 – Black Knobs
1 – 1/4" Phone Jack
1 – Black plastic rocker switch
1 – Nickel-plated Elbow Pipe Connector - 3/8" Pipe to 3/8" Tube
2 – Nickel-plated Straight Pipe Connectors - 3/8" Pipe to 3/8" Tube
3 – Brass Compression Rings (shipped attached to pipe connectors)
3 – Nickel-plated Compression Nuts (shipped attached to pipe connectors)
2 – Self-adhesive Felt Strips
1 – Ten-wire female connector

Look over and identify all of the above parts. Be sure not to mix up parts that look similar. Note that one of the straight pipe connectors has a small tapped hole and the other doesn't. Also note that the hole in the #6 locking solder lug is slightly bigger than the hole in the #4 lugs.

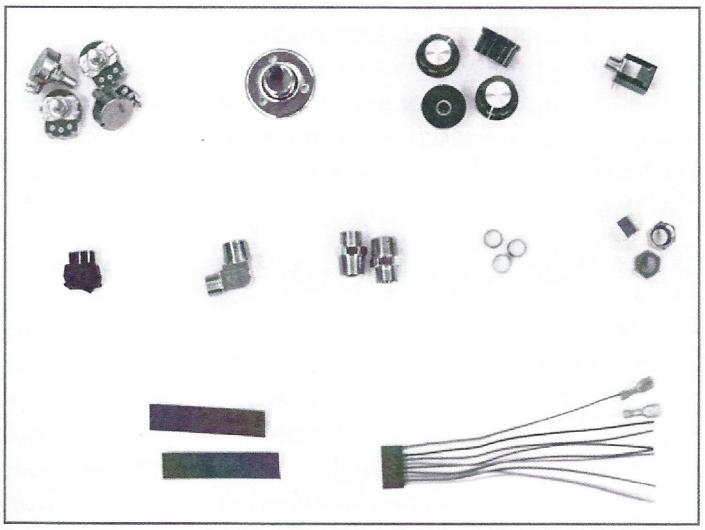
WHAT YOU WILL NEED TO SUPPLY

You will need the following tools and materials:
#1 (small) Phillips Screwdriver
#2 (medium) Phillips Screwdriver
1/8" (small) Regular Screwdriver
Wire Cutting Pliers
Needle Nose Pliers
Utility Pliers
Wire Stripping Tool
Adjustable Open End Wrench
Small Soldering Iron and Rosin-Core Solder
Small Quantity of Two-Part Epoxy Cement, with Toothpicks or Paddle to Apply It
Wood Finish of Your Choice, with Brush or Rag to Apply It
Pieces of Medium (80 grit) and Fine (120 grit) Sandpaper and a Sanding Block
Carpenter's Square or Draftsman's Triangle
The following tools, while not absolutely necessary, will make your assembly job easier:
1/4", 5/16", 7/16"and 1/2" Nut Drivers
5/8", 11/16"and 3/4" Open End Wrenches, or Total of Two
Adjustable Open End Wrenches
Vise or clamp

ASSEMBLY INSTRUCTIONS

Assembly of the ETHERWAVE is divided into four main steps: Finishing the wood cabinet; Mounting the fittings onto the finished cabinet; Assembling and wiring the front panel; and Final assembly and test. Each of these steps should take an hour or two. Allow a day or so for the cabinet finish to dry thoroughly, and another day for the glue on the fittings to set up hard.

Figure 5 – Contents of large parts bag



1. FINISHING THE WOOD CABINET

The cabinet of your ETHERWAVE Theremin is made of cabinet-grade hardwood that looks good with virtually any wood finish that you care to apply. Here are some suggestions:

**** It is extremely important that the finish you choose be non-conductive.*** The pigment in many black paints and stains in composed of carbon, which conducts electricity. A finish of this sort will load the Etherwave's antennas, thereby disabling the instrument. If you want to paint your cabinet black, it's a good idea to select a lacquer or varnish with a label that lists the pigment materials. The list of ingredients should not include carbon or graphite. One black lacquer that has proved non-conductive is Plasti-Kote® Super Lacquer. Two black spray enamels that have proved non-conductive are Rust-Oleum®, and Great Day Enamel (made by Sherwin-Williams).

* Use an aerosol spray can of lacquer or enamel to paint the cabinet a color of your choice. Lacquer is most convenient because it dries fast and is easy to build up with several coats. One 12 oz spray should be good for three or four coats.

* For high visual impact, spray-paint the cabinet a bright color, or hand-paint it with a design of your choice. If you choose to hand-paint your cabinet, you should first coat the cabinet with a coat of wood primer.

* For a high quality furniture finish, first apply wood stain with a rag. When the stain is thoroughly dry, spray-coat the cabinet with two or three coats of Gloss or Satin Urethane Varnish.

* Penetrating wood finishes are easy to apply and require no spraying. A good example is MINWAX® Wood Finish, which is readily available in a wide variety of colors. Penetrating finishes produce a 'natural, hand-rubbed' look.

Assemble the following materials and tools: medium and fine sandpaper; a sanding block, and a brush or rag. If practical, set up a workbench in a workshop or utility area, or outdoors. Cover your work area with a large, old cloth.

Wrap the medium sandpaper around the sanding block. Sand the entire cabinet, making sure that you move the sandpaper with the grain. That is, sand all pieces

the long way. Once the cabinet surfaces are uniformly smooth then carefully sand the edges and corners.

Wrap the fine sandpaper around the sanding block. Sand the entire cabinet until all exterior surfaces have a uniformly-finished feel.

Using a brush or soft rag, remove all sanding dust from the cabinet. Then shake out the work cloth and vacuum up your work area. Put the sandpaper and sanding block away, and cover your bench with a drop cloth or newspapers. Assemble your wood finishing materials. Read all of the instructions on the wood finish containers.

Apply one coat of finish to the interior surfaces of the cabinet. Although the interior surfaces are not visible when the ETHERWAVE is completely assembled, it is important that they be sealed by having at least one coat of finish.

Following the finish manufacturer's instructions carefully, apply at least two coats of finish to the exterior surfaces of the cabinet. At this point it's a good idea to place small scraps of wood (broken pencils, small blocks, etc.) between the cabinet parts and the drop cloth (or newspapers), so that the finish on the cabinet does not tend to stick to the drop cloth.

If you have the time and the inclination to do a truly first-class finishing job, wait until the first couple of coats are dry, then rub it down with very fine (00, 000, or 0000) steel wool, or with very fine waterproof sandpaper that you've wetted with water. Wipe the cabinet off thoroughly after rubbing it down, and apply a couple more coats of finish in accordance with the manufacturer's instructions. Allow the final coat to dry thoroughly then rub it down carefully with #0000 steel wool followed by guitar polish.

2. INSTALLING THE FITTINGS

The purpose of the next two steps is to set the compression ring on the pitch antenna.

Examine the elbow pipe connector. One threaded end is of larger diameter than the other. The larger end will be screwed into a hole on the cabinet, while the smaller end will hold the pitch antenna. Note that a small hole has been drilled at an angle in the larger threaded end. This hole is tapped with a 4-40 thread.

Hold the elbow pipe connector with a vise, clamp, or 3/4" wrench, with the small threaded end facing up. (Protect the connector from being scratched by the clamp or vise, if necessary.) Set the pitch antenna (straight tube) in the small threaded end of the pipe connector. Slip a compression ring over the antenna and down onto the connector. Then slip a compression nut over the antenna and screw it onto the connector. Use a 5/8" open-end wrench to tighten the compression nut. Tighten it so that it squeezes the ring onto the antenna so tightly that, when the compression nut is removed, the ring is firmly in place on the antenna. *NOTE: You will be able to turn the compression nut more easily if you apply a small amount of household oil to the threads.*

Remove the pitch antenna by unscrewing the compression nut from the elbow pipe connector, but leave the elbow connector in the vise. Place the two remaining compression nuts onto the ends of the volume antenna, one on each end. Slip the remaining two compression rings onto each end of the volume antenna. Thread one of the nuts lightly onto the elbow. Tighten it using a 5/8" wrench so that it squeezes the ring onto the the antenna, as you did with the pitch antenna. Unscrew the compression nut, and repeat with the other end of the Volume antenna. When you are finished, the rings should be held tightly on the ends of the volume antenna, holding the compression nuts on the antenna as well.

Select a 4-40 X 1/4" machine screw and a #4 locking solder lug. Place the lug on the screw. Using a small Phillips screwdriver, insert the screw into the small threaded hole in the elbow. Insert the screw from the inside of the connector. *Note: The hole for this screw is at an angle, so you can use an ordinary straight screwdriver to advance the screw.* Advance the screw only two turns or so; do not tighten the screw at this time. The purpose of the next two steps is to set the compression rings onto the volume antenna.

Examine the two straight pipe connectors. Note that one of the connectors has a small threaded hole at its larger diameter end, but the other connector does not. Select the connector with the small threaded hole.

As you did with the elbow connector, select a 4/40 X 1/4" machine screw and a #4 locking solder lug, place the lug on the screw, and then insert the screw into the small threaded hole in the straight connector. (Note: The hole for this screw is at an angle, so you can use an ordinary straight screwdriver to advance it.) Insert the screw from the inside of the connector, and advance the screw only two turns or so.

Examine the cabinet base. There are two large holes in one end and one large hole in the other end. The end with two holes is the left end of the base. The straight connector with the small threaded hole will be installed in the rear (higher) hole, while the other straight connector will be installed in the front (lower)

hole. The elbow connector will be installed in the hole in the right end. All three pipe connectors will be installed by screwing them into the wood ends on the base of the cabinet, from the outside.

Assemble the following materials and tools: epoxy cement and something to mix and apply it with, 11/16" and 3/4" open end wrenches (or an adjustable open-end wrench), small Phillips screwdriver, the pitch antenna (straight tube), the elbow pipe connector and a compression nut. *Note: The next five steps should be done within the shortest time possible, to ensure that the epoxy does not begin to set up before all antenna mounts are properly in place.*

Following the manufacturer's instructions, mix a small quantity (one teaspoon or so) of the epoxy cement. Apply a small amount to the inside surface of the rear (higher) hole of the left side. Select the straight connector with the small threaded hole and the solder lug attached. Apply a small amount of the epoxy to the beginning part of the larger threads of the straight connector. Avoid applying too much epoxy; do not apply the epoxy to the two or three threads nearest the middle of the straight connector. Holding the straight connector in your fingers, carefully insert it into the upper left hole, and turn it clockwise. Once you're sure that the connector is going in straight, use the 11/16" wrench to turn it. Turn it a total of six or seven turns. Stop turning the connector when there is a gap of about 1/8" between the cabinet and the hexagonal middle of the connector, and when the 4-40 screw holding the solder lug is down near the bottom of the cabinet base.

When you are satisfied that the connector is installed properly, position the solder lug so it points out away from the connector, and tighten the 4-40 screw that holds it.

In a similar manner, apply epoxy to the front (lower) hole of the cabinet base, and to the larger-diameter threads of the remaining straight connector. Insert the connector into the cabinet hole, first with your fingers and then with the 11/16" wrench. Stop when the gap between the cabinet and the hexagonal middle of the connector is about the same size as the already-installed connector.

Select the elbow connector. Apply a small amount of epoxy to the inside surface of the large hole on the right side of the cabinet base. (Mix some more epoxy if you're running out of mixed cement, or if the mixed cement you are using is beginning to thicken.) Holding the elbow connector in your fingers, carefully insert it into the right hole, and turn it clockwise. Once you're sure that the connector is going in straight, use a 3/4" wrench to turn it. Stop turning the connector when there is a gap of 1/8" - 3/16" between the cabinet and the square part of the connector, and when the smaller diameter end of the connector is pointing straight up.

Place the pitch antenna in the smaller diameter end of the elbow connector. Screw down the compression nut to hold the antenna in place. Using a carpenter's square or draftsman's triangle, verify that the pitch antenna is vertical. Adjust the position of the elbow connector with the 3/4" wrench if necessary. When the antenna is exactly vertical, position the solder lug so it points out away from the elbow connector, and tighten the 4-40 screw that holds it. Then carefully remove the pitch antenna.

Look at the inside of the cabinet base. The three holes along the front edge are for mounting the front panel, and the three holes that form a triangle in the middle of the base are for mounting the microphone stand flange. In addition, there is one hole that is 3" from the right end, which you will use to ground an aluminum foil shield. This leaves five holes, which are for the threaded standoffs that will hold the circuit board. Place a little epoxy in each of the five holes, then use a 1/4" nut driver or a pair of utility pliers to insert a threaded standoff. (The holes in the base are just the right size to accept the external threads of the standoffs.) Be sure that all five standoffs are seated firmly on the base.

Select three 8-32 Tee-nuts, three 8-32 x ¾" machine screws and the microphone stand flange. Note that the three holes that form a triangle in the middle of the base match the mounting holes of the flange. Insert the Tee-nuts pointy side down into the holes in the base. Turn the base over. Align the holes in the mic stand flange with the mounting holes in the base of the cabinet. Carefully insert the screws through the holes in the mic stand flange and start threading them into the Tee-nuts. Use a medium Phillips screwdriver to tighten the screws that fasten the flange to the underside of the base.

Select the two self-adhesive felt strips. Remove the paper backing. Apply the strips to the bottoms of the wood feet that are at either end of the base.

Select the self-adhesive label that is packed with these instructions. Remove the paper backing. Carefully apply the label to the bottom of the base.

Examine the cabinet base. Note the hole positioned in the right front corner, about 3" from the right end and about 3/4" in from the front of the base. Select the 2" x 4" piece of selfadhesive aluminum foil that

is packed with these instructions. Remove the paper backing. Carefully position the foil at the right end of the base so that the front edge is 1/4" from the front of the base, and the right edge is 1 1/4" from the right edge of the base. Press the foil down so that the screw hole is visible through the foil.

Select the #6 locking solder lug, and one of the 1/2" x #6 wood screws. Secure the lug to the foil with the wood screw. Position the lug so that it faces to the left and makes good contact with the aluminum foil.

This completes the "Installing the Fittings" section. Set the cabinet base aside, clean your work area, cover it with a soft cloth, and select the front panel. Refer to **Figures 6 and 7** while performing the steps in the next section.

3. ASSEMBLING THE FRONT PANEL

Select the four rotary potentiometers. Note that each potentiometer has a tab next to the mounting bushing. Use pliers to break off the tabs. Note that two flat washers and a nut are included with each potentiometer. Remove the nut and flat washers. Discard one of the washers. Place a 5/16" lockwasher on the mounting bushing of each potentiometer.

Two of the potentiometers are numbered B5K and two are numbered B50K. Select the two that are numbered B50K. Place their bushings through the holes for the BRIGHTNESS and WAVEFORM controls. From the front of the panel, place the flat washers and nuts back on the bushings. Position the controls as shown in Figure 5a. Tighten the nuts with a 7/16" nut driver or a pair of utility pliers. Tighten the nuts just enough to keep the potentiometers from turning. Do not overtighten.

Similarly, mount the two potentiometers numbered B5K through the holes for the PITCH and VOLUME controls. Position the potentiometers as shown in **Figure 6**.

Select the audio jack (refer to addendum on page 16). Place the heavy 3/8" lockwasher on the mounting bushing. Place the bushing through the AUDIO OUT hole and place a 3/8" flat washer and a 3/8" nut on the bushing. Position the jack as shown in Figure 5a, and tighten the nut with a 1/2" nut driver or a pair of utility pliers.

Select the rocker switch. Press the rocker switch into the rectangular hole in the panel, with the "1" on top and the "0" on the bottom. The switch should snap firmly into place.

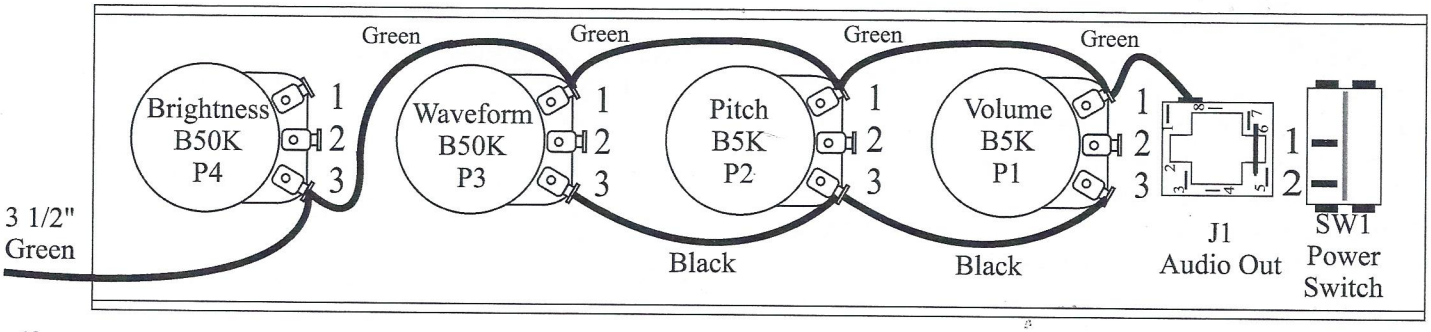
Cut pieces of hookup wire of the color and lengths listed below. Strip 1/4" of the insulation off both ends of each piece. Twist the strands of wire together and tin (lightly coat with solder) the twisted ends. Referring to Figure 5a and using a pair of needle nose pliers, feed the ends of the wires through the appropriate solder lugs, bend the end of each wire 1/2 turn, and then close the loop so that it stays in place on the appropriate lug. Do not solder any of the wires yet.

LENGTH	COLOR	FROM	TO
3-1/2"	Green	P4-3	Leave Free
2-1/2"	Green	P4-3	P3-1
2-1/2"	Green	P3-1	P2-1
2-1/2"	Green	P2-1	P1-1
1-1/4"	Green	P1-1	J1-sleeve
3-1/4"	Black	P3-3	P2-3
3-1/4"	Black	P2-3	P1-3

Select the 10-conductor connector. Feed the ends of the connector wires through the lugs as listed below. Bend the ends 1/2 turn and then close the loops so that they stay in place on the lugs.

WIRE COLOR	TO	WIRE COLOR	TO
Orange	P4-1	Black	P2-3
Brown	P4-2	Violet	P1-2
Red	P3-2	Yellow	J1-6
Green	P2-1	Blue	P2-2

FIGURE 6 - Rear of front panel



Check to verify that all wires are firmly on their lugs. Verify that the connections are placed properly. Then solder all the terminals on P4, P3, P2, P1, and J1

Push the lugs on the gray and white wires onto the two terminals of the rocker switch. (It doesn't matter which wire goes to which terminal.)

Turn the panel over. Select the four knobs. Turn the shafts of the four potentiometers fully counterclockwise. Place the knobs on the shafts of the potentiometers, position them so the white markings on the knobs point to the '7 o'clock' position, and tighten the set screws firmly.

Take care not to damage the set screw threads by overtightening.

4. FINAL ASSEMBLY AND TEST

Place the cabinet base on your work surface, with the pitch antenna connector to your right. Place the circuit board on the standoffs with the ten-pin header in front. *Note: The circuits on this circuit board may be damaged by ESD (Electro-Static Discharge). To prevent ESD damage, keep the board inside its anti-static packaging until it is ready for installation. Before handling, ensure you discharge any static charge built up on yourself by touching a grounded object such as a grounded metal chassis, or the screw on an AC outlet mounting plate. Handle the board only by its edges and do not touch the components with your fingers.* Select the five 1/4" x 6-32 machine screws. Fasten the circuit board to the standoffs with the screws, tightening them very lightly.

Place the cabinet top over the base so that the ends of the top are as flush as possible with the ends of the base. Look in the 3/4" hole to see if the power connector is centered in the hole. If it is not, then remove the top and move the circuit board left or right until the power connector lines up with the 3/4" hole. Once they are lined up, remove the cabinet top and tighten the screws holding the circuit board.

Select the 8" length of solid copper bus wire. Cut it into two 4" lengths.

Feed an end of one of the 4" wires through the solder lug on the pitch antenna connector. Feed the other end through the lug marked PITCH ANTENNA on the circuit board. Do not loop the ends of the wire. Solder the two ends in place.

Feed an end of the other 4" wire through the solder lug on the rear volume antenna connector. Feed the other end through the lug marked VOLUME ANTENNA on the circuit board. Do not loop the ends of the wire. Solder the two ends in place.

Set the panel on the front of the cabinet base, so that the bottom lip of the panel is on the underside of the base. Line up the three holes on the bottom lip of the panel with the three holes along the front of the base. Fasten the panel to the cabinet base with three 1/2" x #6 wood screws.

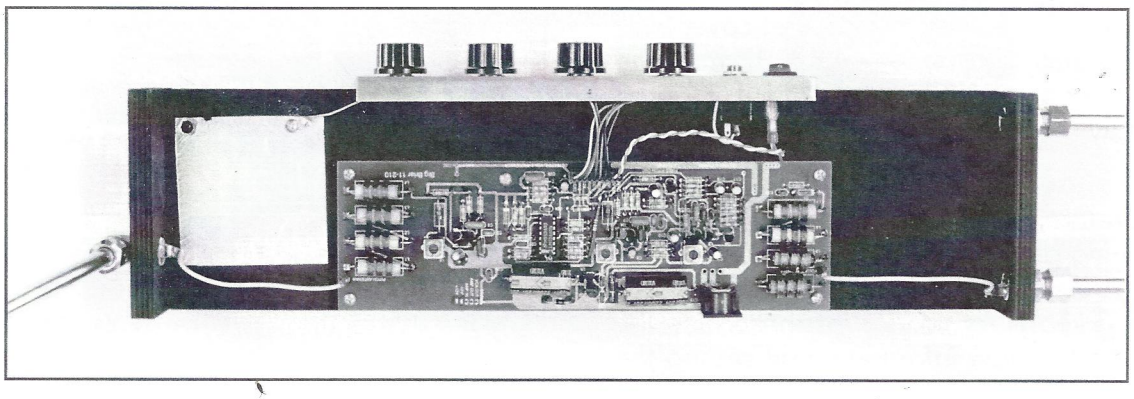
Feed the free end of the green panel wire through the solder lug on the aluminum foil. Solder the connection. Position the wire so that it is firmly against the bottom of the cabinet.

Plug the panel connector into the ten-pin header on the circuit board. Note that the end of the connector with the yellow wire goes to the right. Note also that the connector should be pushed on to the header so that the locking ramp on the connector is engaged by the locking tabs on the header.

Compare your base assembly with **Figure 7** to verify that the components are assembled correctly.

Set the base assembly on a microphone stand. Put the antennas in place and hand-tighten the compression nuts that hold them. If the connector threads are 'stiff' and it is difficult for you to tighten the compres-

FIGURE 7 - Completed ETHERWAVE Theremin



sion nuts with your fingers, then use a 5/8" wrench to tighten and loosen the nuts a few times, and apply a small amount of light oil or petroleum jelly to the threads to make it easier to tighten the nuts. It may be desirable to clean the threads after you've used the connectors a few times, in order to remove small particles of metal that may be present.

Plug the cord end of the wall transformer into the power connector on the back of the circuit board. Plug the power end of the wall transformer into an outlet box near the microphone stand. Run an audio cable from the front panel AUDIO OUT jack to a line level input on your monitor amplifier/speaker. Turn the ETHERWAVE'S POWER switch on. Then turn your amp on and set the input level down low. Touch the pitch antenna while turning the VOLUME tuning knob. You should hear a high-pitched note that gets softer and louder as you turn the VOLUME knob. Set the VOLUME knob at about its middle position.

Note: If the ETHERWAVE is on a table and not on a mic stand, position the ETHERWAVE so that the volume antenna hangs over the edge of the table. Also, no cables should be hanging near or over the volume antenna. (If any grounded object is close to the volume antenna, volume will be greatly reduced.)

Take your hand away from the pitch antenna. You should hear the pitch go down. Now set the PITCH tuning knob so that the pitch disappears ('zero beat') when your right hand is away from the pitch antenna, but starts as a low note when your hand comes within 18" - 24" of the antenna.

While holding your right hand near the pitch antenna, turn the VOLUME tuning knob counterclockwise with your left hand. You should hear the volume go from loud to soft. Set the VOLUME tuning knob so that the tone is loud when your left hand is away from the volume antenna, and begins to decrease when your left hand is within about a foot or so of the volume antenna.

When you are satisfied that your ETHERWAVE theremin is operating properly and is fully assembled, remove the power cord, place the cabinet cover over the base, and install the four 7/8" x 6-32 machine screws in the front and back of the cabinet. Tighten the screws lightly.

Note: The cover itself adds some capacitance to the antennas. Therefore, putting the cover in place will change the tuning of the ETHERWAVE. You may find it necessary to re-adjust the front panel PITCH and VOLUME tuning knobs for proper response. See the following section for more information on setting the front panel tuning knobs.

MOOG LIMITED WARRANTY

Moog warrants its products to be free of defects in materials or workmanship and conforming to specifications at the time of shipment for a period of one year from the date of purchase. During the warranty period, any defective products will be repaired or replaced, at Moog's option, on a return-to-factory basis. This warranty covers defects that Moog determines are no fault of the user.

RETURNING YOUR PRODUCT TO MOOG

You must obtain prior approval in the form of an RMA (Return Material Authorization) number from Moog before returning any product. Call us at (828) 251-0090 for the RMA#. All products must be packed carefully and shipped with the Moog supplied power adapter. The ETHERWAVE Theremin must be returned in the original inner packing including the foam inserts and the original outer packing. Sorry, the warranty will not be honored if the product is not properly packed. Once packed, send the product to Moog Music Inc. with transportation and insurance charges paid.

WHAT WE WILL DO

Once received, we will examine the product for any obvious signs of user abuse or damage as a result of transport. If the product has been abused, damaged in transit, or is out of warranty, we will contact you with an estimate of the repair cost. Warranty work will be performed and Moog will ship and insure your product to your United States address free of charge.

HOW TO INITIATE YOUR WARRANTY

Please initiate your warranty online at www.moogmusic.com. Click "Product Register". If you do not have web access, fill out all the information on the warranty card and mail to Moog Music Inc. Attn: New Product Registration. 160 Broadway St. Asheville, NC 28801

Specifications subject to change without notice.

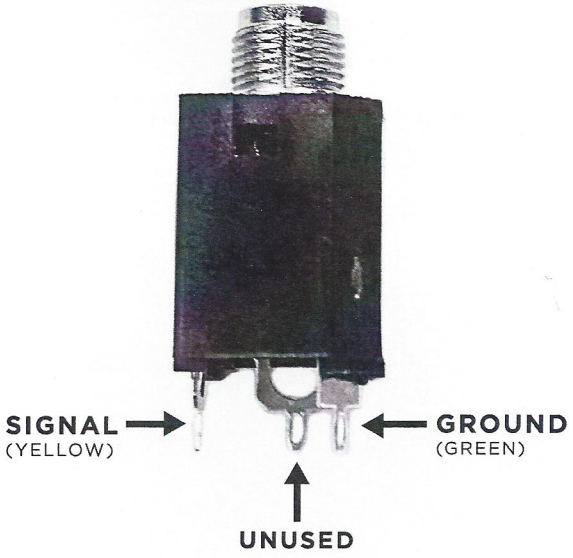
ADDENDUM FOR ETHERWAVE KITS (Effective June 19, 2012)

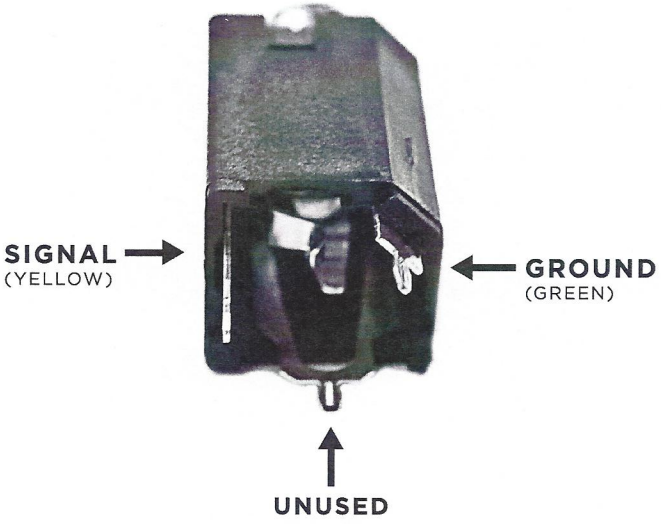
Please use the pictures & description below as guidance for wiring the headphone jack.

1. Hook the signal and ground wires around the jack terminals. **Do not feed the wires through the holes.** The third jack is unused. *Note: The terminal at the flattened corner of the jack is the one that receives the ground wire.*

2. Solder the two wires in place to the jacks.

3. If you have any questions or need additional assistance please call 828.251.0090





160 Broadway St. Asheville, NC 28801 | 828.251.0090. | www.moogmusic.com

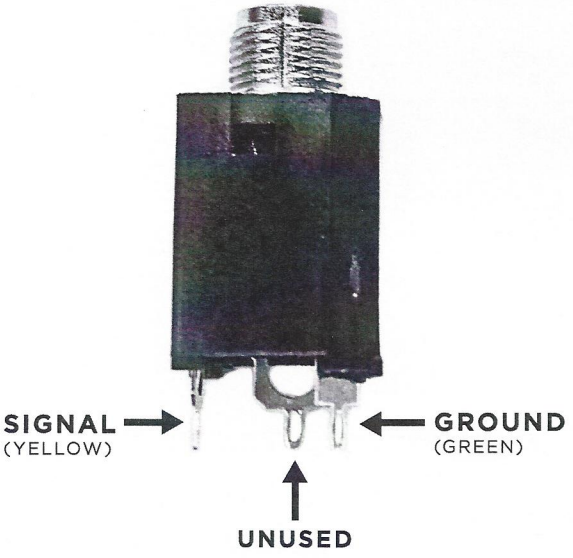
ADDENDUM FOR ETHERWAVE KITS (Effective June 19, 2012)

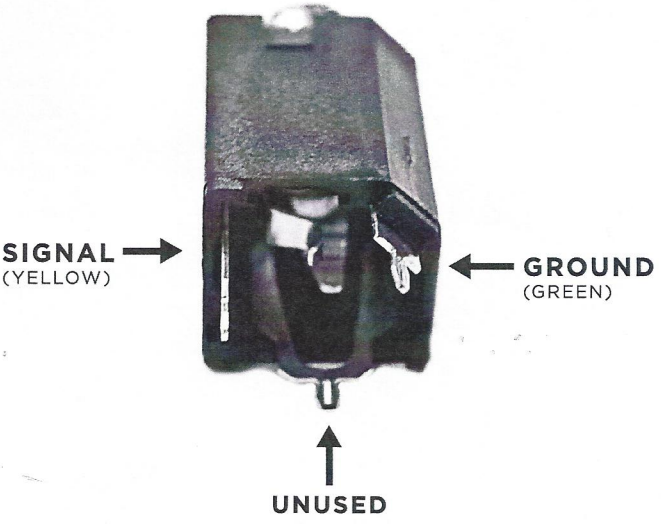
Please use the pictures & description below as guidance for wiring the headphone jack.

1. Hook the signal and ground wires around the jack terminals. **Do not feed the wires through the holes.** The third jack is unused. *Note: The terminal at the flattened corner of the jack is the one that receives the ground wire.*

2. Solder the two wires in place to the jacks.

3. If you have any questions or need additional assistance please call 828.251.0090





160 Broadway St. Asheville, NC 28801 | 828.251.0090. | www.moogmusic.com