

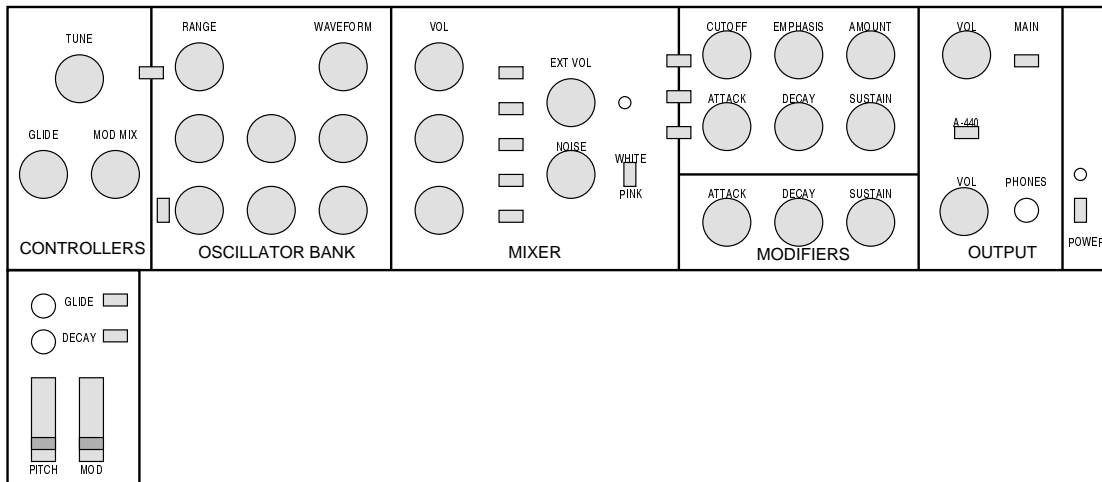
The

# minimoog

## MODEL D

### TECHNICAL SERVICE MANUAL

by R. J. Folkman



# moog

MUSIC INC.

the first sound in synthesizers

# MINI-MOOG Field Service Manual

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## **Section I: Precautionary Measures**

In the **Mini-Moog**, as in any electrical device, shock hazards exist. All lethal voltages are confined to the area around the power switch and the A.C. fuseholder. Always unplug the instrument while servicing the electronics. Keyboard cleaning and adjusting may be done with the unit turned on.

When a fuse blows, replace it only with the proper size as indicated on the label directly below the fuseholder. If the fuse continues to blow, it is an indication that a definite electrical problem has developed. Never try a larger fuse; this will only result in further internal damage.

Avoid making adjustments at random. Each adjustment is critical and should be made in accordance with the procedures outlined herein. If a sub-assembly is found to be defective, we recommend exchanging it rather than attempting to repair it. Unless a qualified technician is available, with special test fixtures, more harm than good may result and possibly void any remaining warranty.

## **Section II: Sub-assembly Description**

### 93-113 Oscillator (Board 1)

This assembly contains three tone oscillators, summing amplifiers, exponential current generators, waveshaping circuits and a -5 volt reference source. The three oscillators are independent and non-synchronous. Each oscillator is voltage controlled from external sources such as the keyboard. Linear input voltages are converted to exponential currents which are used to control the frequency or pitch of the tone produced. The basic sawtooth signal is processed to derive triangle and variable width rectangular waveforms. Oscillator #3 has a wide range capability which enables it to be used for modulation purposes. The -5 volt reference source is used to establish the precise voltage steps on the octave range switches.

### 93-114 Contour Generator (Board 2)

This assembly contains two identical contour or envelope generators, and the keyboard circuitry. Upon triggering, the contour generators produce a voltage envelope with variable attack, decay, and sustain. The output is used to control the gain of the first voltage controlled amplifier or the cutoff frequency of the voltage controlled filter.

The keyboard circuit contains a constant current source which feeds the keyboard resistor string. This insures the proper voltage drop across each of the 43 keyboard resistors. Also contained on this assembly is the sample-hold circuit which measures the voltage from the keyboard and maintains it until a different key is depressed. The output of this circuit is the control voltage for the oscillators and the filter. The glide feature is a function of the sample-hold circuit.

### 93-115 Power Supply (Board 3)

This assembly contains the plus and minus 10 volt regulators, the headphone amplifier, the noise generator and the modulation mix amplifier. The plus supply uses a temperature compensated zener diode for a voltage reference. The minus supply is referenced to the regulated plus voltage causing the two supplies to "track". Both supplies employ remote voltage sensing for optimum stability.

The headphone amplifier is an A.C. coupled emitter follower with a push-pull output. The noise generator uses a reverse biased transistor junction for a noise source. The output of this transistor is processed through three filter circuits to derive the white, pink, and red noise outputs. The modulation mix amplifier takes signals from Oscillator #3 and the noise generator, sums them and supplies an output which is used for modulation.

### 93-116 Filter (Board 4)

This assembly contains the voltage controlled filter, the external input pre-amplifier, the overload lamp driver, the first and second voltage controlled amplifiers and the A-440 reference oscillator. The filter is a voltage controlled low pass type which employs the Moog patented ladder network. It is capable of regenerating (oscillating) over a wide frequency range. The scale is adjustable so the filter can be set to track the keyboard.

The external pre-amp is a three transistor high-gain amplifier. The output of the pre-amp is monitored by an overload indicator. The overload driver circuit is a Schmitt trigger which turns the overload light on when external signal levels become excessive.

The first and second voltage controlled amplifiers are two nearly identical circuits. Their gain is controlled by varying the voltage which supplies the current source transistors. A buffer or output amplifier follows the second VCA stage.

The A-440 reference source is a highly stable Wein Bridge oscillator circuit. It produces a somewhat imperfect sinewave which increases its harmonic content. These harmonics or overtones assist in tuning to the reference, especially when the source being tuned is one or two octaves away from the reference frequency. The output of this circuit is coupled to the VCA buffer amplifier.

### 93-118 Rectifier Board

This assembly contains the input bridge rectifier diodes and the unregulated D.C. filter capacitors.

### 93-060 Left Hand Controller

This assembly contains the PITCH wheel, MODULATION wheel, GLIDE and DECAY switches, and two jacks for remote switching of glide and decay. The PITCH wheel has a mechanical detent which allows it to be easily returned to a pre-set tune point.

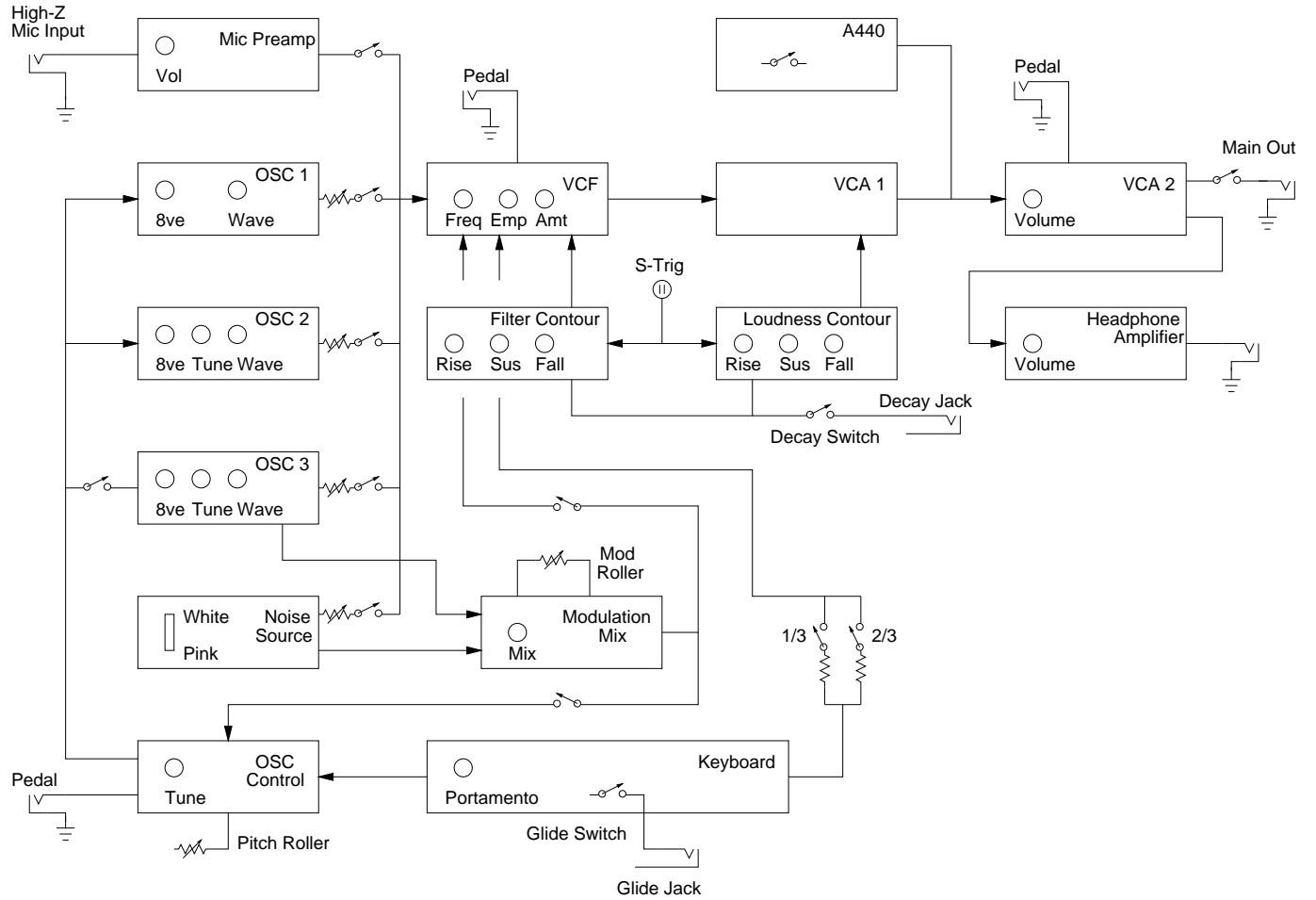
To service this assembly, remove the two mounting screws and lift the unit out. All connections to this assembly are through a 12 prong plug to simplify servicing and replacement.

### 93-061 Keyboard

The Mini-Moog keyboard is a standard three and one-half octave removable sub-assembly. All electrical contacts are gold plated for high reliability. The keyboard is held in place by four (4) mounting screws which are accessible when the bottom cover is removed. All connections to this assembly are through a 6 prong plug to simplify servicing and replacement.

### Section III: Block Diagram

(This block diagram is a simplified version of the one from the User's Manual. The diagram from the service manual fits on a single 11"x17" sheet.)



## Section IV: Trouble Analysis Guide

Use this chart along with the block diagram (Section III) to determine which assembly or component is defective.

<b>MALFUNCTION</b>	<b>PROBABLE CAUSE AND CURE</b>
Unit dead (no pilot light)	<ol style="list-style-type: none"> <li>1. Blown A.C. fuse</li> <li>2. Defective power switch</li> <li>3. Defective line cord or plug</li> </ol>
Unit dead (pilot light on, overload light off)	<ol style="list-style-type: none"> <li>1. Defective power supply (board 3)</li> <li>2. Defective power transformer</li> <li>3. Defective output amplifier (change filter board 4)</li> </ol>
Unit dead (pilot light and overload light on)	<ol style="list-style-type: none"> <li>1. Blown D.C. fuse</li> <li>2. Defective power supply (board 3)</li> </ol>
Excessive hum and constant modulation of all signals	<ol style="list-style-type: none"> <li>1. Defective rectifier diode on 93-118 assembly</li> <li>2. Defective filter capacitor on 93-118 assembly</li> <li>3. Defective power supply (board 3)</li> <li>4. Broken ground wire</li> </ol>
No output from any mixer source (A-440 output works)	<ol style="list-style-type: none"> <li>1. Defective contour generator (board 2)</li> <li>2. Defective VCA or filter (replace filter board 4)</li> </ol>
No oscillator output (noise works)	<ol style="list-style-type: none"> <li>1. Defective oscillator (board 1)</li> </ol>
One oscillator dead or malfunctioning, other two operating normally	<ol style="list-style-type: none"> <li>1. Defective oscillator (board 1)</li> </ol>
Oscillators drift and exhibit poor tracking	Refer to Section XII - Modifications under Oscillator Assembly
Oscillator 3 modulates oscillator 1 or 2 with modulation switches off	Refer to Section XII - Modifications under Power Supply Assembly
Improper or missing waveform (any oscillator)	<ol style="list-style-type: none"> <li>1. Defective oscillator (board 1)</li> <li>2. Defective waveform switch</li> </ol>
Noise source dead or producing poor quality noise	<ol style="list-style-type: none"> <li>1. Defective noise transistor (Q15 on board 3)</li> <li>2. Defective noise generator (replace power supply board 3)</li> </ol>
External input dead	<ol style="list-style-type: none"> <li>1. Defective pre-amp (replace filter board 4)</li> </ol>
Filter inoperative or malfunctioning	<ol style="list-style-type: none"> <li>1. Defective filter board 4</li> </ol>
Filter regeneration weak or absent (EMPHASIS at 10)	<ol style="list-style-type: none"> <li>1. Defective filter (board 4)</li> <li>2. Regen. Cal. not adjusted properly</li> </ol>

**MALFUNCTION****PROBABLE CAUSE AND CURE**

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Excessive drift or pitch change after key is released (greater than 1 semitone per minute)

1. Defective keyboard circuit (replace board 2)

Loudness and/or filter contour generator operate improperly

1. Defective contour generator (board 2)

No output at phones headphone jack (main output normal)

1. Monaural plug in stereo jack
2. Defective headphone amp (replace power supply board 3)

Overload light fails to operate when excessive signal is applied

1. Defective bulb
2. Defective lamp driver circuit (replace filter board 4)

Thumping sound heard when depressing a key (AMOUNT OF CONTOUR at 0)

1. First VCA out of balance  
Refer to Section VII - Adjustments
2. Defective VCA (replace filter board 4)
3. Refer to Section XII - Modifications, under contour generator assembly

Keyboard glides when glide is off

1. Defective keyboard circuit (replace contour generator board 2)

Unit cannot be tuned (A-440 on frequency, within 1 Hz)

1. Defective oscillator (board 1)
2. Defective keyboard circuit (replace board 2)

Unit cannot be tuned (A-440 off frequency more than 5 Hz)

1. Power supply voltages improperly adjusted
2. Defective power supply (board 3)

A-440 reference oscillator dead (other outputs normal)

1. Defective reference oscillator (replace filter board 4)

No modulation (filter or oscillator)

1. Defective mod. mix amp. (replace power supply bd. 3)
2. Defective MODULATION wheel control

Range switches have little or no effect

1. Octave Range misadjusted
2. -5 volt source defective (replace oscillator board 1)

Noise or static when turning a control

1. Control dirty – spray clean
2. Control worn-out; replace

Noisy or intermittent switch

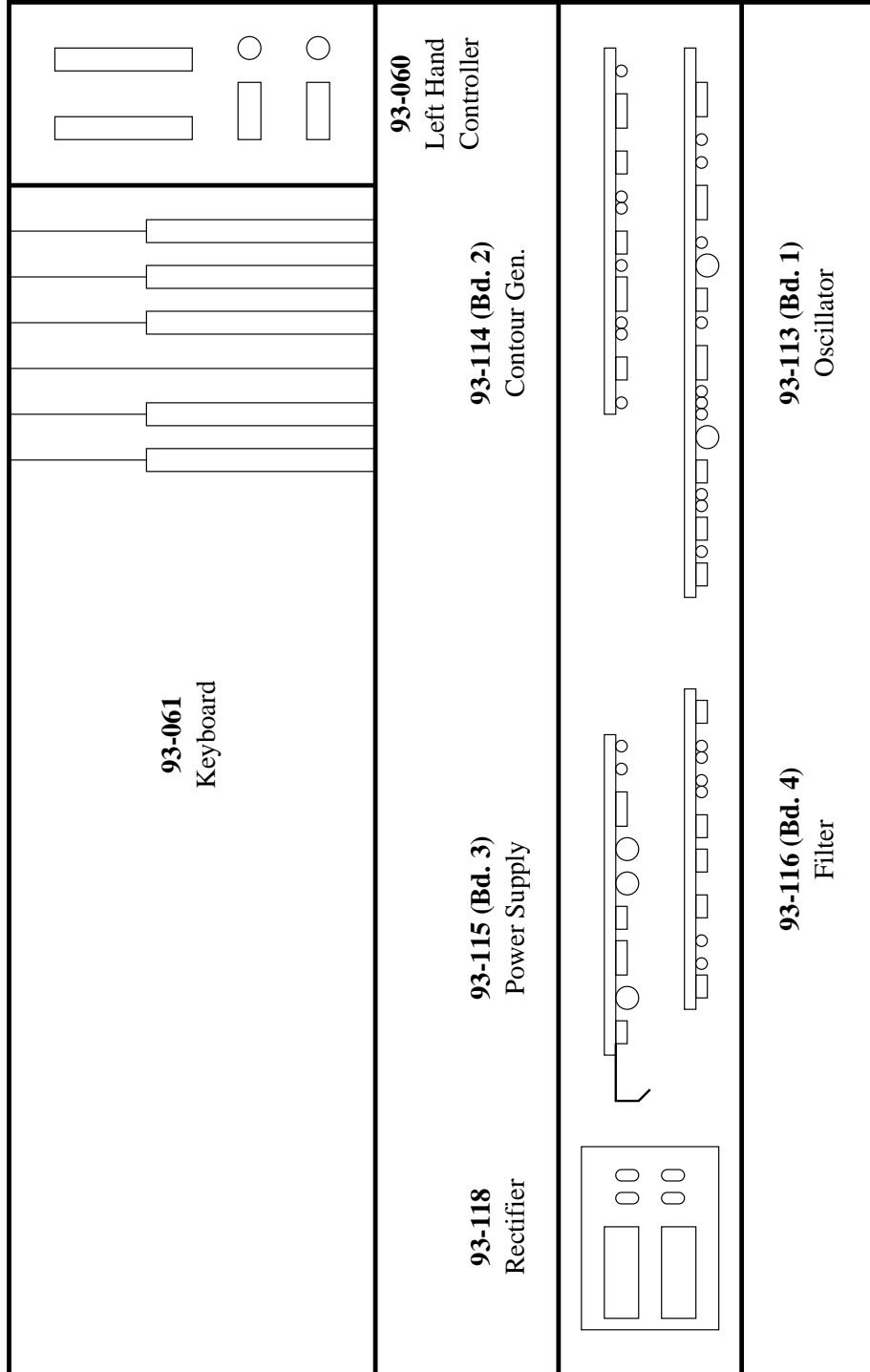
1. Switch dirty – spray clean
2. Switch worn-out; replace

Intermittent operation or loss of some functions

1. Clean circuit board contacts with a pencil eraser
2. Tighten tension on circuit board sockets



# Section V: Sub-Assembly Locations



## **Section VI: Cover Removal and Sub-assembly Replacement**

In order to service the Mini-Moog circuitry, it is necessary to remove the rear cover assembly.

### **CAUTION:**

Be sure the unit is unplugged before removing the cover.

Remove 18 screws (5 top, 5 lower back, and 4 each end of cover); then lift the cover off.

Circuit boards are plugged into sockets at the bottom and secured at the top with two mounting screws. To remove a circuit board, first remove the screws then unplug from the connector.

When replacing, be sure board is firmly seated in the connector before tightening the mounting screws. Remember to re-install the fiber washers between the boards and the frame.

After board replacement, refer to Section VII: Adjustment Procedures and Locations, to determine which adjustments should be made.

## Section VII: Adjustment Procedures and Locations

Each time a Mini-Moog is serviced, it should be tuned. When a board has been replaced it will be necessary to make additional adjustments. Refer to the table below to determine which adjustments must be made according to the board that has been replaced.

<b>WHEN REPLACING</b>	<b>MAKE THESE ADJUSTMENTS</b>
93-113 (Board 1) Oscillator	<ol style="list-style-type: none"><li>1. Oscillator 1, 2, and 3 tuning</li><li>2. Octave range trimmer</li></ol>
93-114 (Board 2) Contour Generator	<ol style="list-style-type: none"><li>1. Check tuning (adjust if necessary)</li></ol>
93-115 (Board 3) Power Supply	<ol style="list-style-type: none"><li>1. +10 volts</li><li>2. -10 volts</li><li>3. Noise level</li><li>4. Check tuning (adjust if necessary)</li></ol>
93-116 (Board 4) Filter	<ol style="list-style-type: none"><li>1. VCA balance (1 and 2)</li><li>2. A-440 frequency</li><li>3. Regeneration cal.</li><li>4. Filter range</li><li>5. Filter scale</li></ol>
93-060 Left Hand Controller	<ol style="list-style-type: none"><li>1. Check tuning (adjust if necessary)</li></ol>
93-061 Keyboard	<ol style="list-style-type: none"><li>1. Check tuning (adjust if necessary)</li></ol>

## ADJUSTMENT PROCEDURES

### NOTE:

The tuning and other functions rely heavily on accurate power supply voltages. Always be sure the + and - 10 volt supplies are properly set before making other adjustments.

\* Digital voltmeter with 0.1% accuracy

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TO ADJUST ...	FOLLOW THIS PROCEDURE ...
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+10 volts	Connect an accurate D.C. voltmeter* to pins 1A and 2A on the oscillator (board 1). Adjust the +10 volt trimpot on the power supply (board 3) for +10.00 volts.
-10 volts	Connect an accurate D.C. voltmeter* to pins 2A and 3A on the oscillator (board 1). Adjust the -10 volt trimpot on the power supply (board 3) for -10.00 volts.
A-440 Ref. Oscillator	Turn on A-440 and allow to warm up for two minutes. Adjust A-440 trim-pot on the filter (board 4) for zero beat with an "A" tuning fork. By bringing the struck tuning fork in physical contact with the shell of a pair of headphones, while listening to the A-440 output, the beat note becomes more audible.
Oscillator Tuning (With Equipment)	Connect a frequency counter to the High Main Output jack. Set the PITCH WHEEL to center, TUNE control to 0, RANGE switches to 2 ft., WAVE-FORM switches to SAWTOOTH. Set MIXER VOLUME controls to 4, turn OSCILLATOR MODULATION switch off, and OSCILLATOR 3 CONTROL switch on. Set Oscillator 2 and 3 FREQUENCY controls to mid-position. Turn on OSCILLATOR 1 mixer switch. Adjust Oscillator 1 <u>Range Trimpot</u> for 3520 Hz while holding high "A" key down. Depress low "A" and hold while adjusting Oscillator 1 <u>Scale Trimpot</u> for 440 Hz. Repeat until no further improvement is attainable. Turn off OSCILLATOR 1 Mixer switch. Turn on OSCILLATOR 2 and repeat the procedure -- then OSCILLATOR 3. Finally, check tracking between any two oscillators and make any necessary touch-up adjustments to improve tracking.

**TO ADJUST ...****FOLLOW THIS PROCEDURE ...**

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Oscillator Tuning  
(Without Equipment)  
"Visualign"

Turn all MIXER switches off. Set MIXER VOLUMES at 1. Turn on MAIN OUTPUT switch and set OUTPUT VOLUME to 8. Set ATTACK and DECAY times to 0, SUSTAIN to 10. Turn FILTER MODULATION and KEYBOARD CONTROL switches off. Set EMPHASIS and AMOUNT OF CONTOUR to 0. Set PITCH WHEEL to center, TUNE control to 0, RANGE switches to 2 ft., WAVEFORM switches to TRIANGLE. Turn OSCILLATOR MODULATION switch off, and OSCILLATOR 3 CONTROL switch on. Set OSCILLATOR 2 and 3 FREQUENCY controls to mid-position. Connect a short patch cord from the HIGH MAIN OUTPUT jack to EXTERNAL SIGNAL INPUT jack. Turn on A-440 and rotate EXTERNAL INPUT VOLUME control slowly clockwise until the OVERLOAD light is just visible. Turn OSCILLATOR 1 Mixer switch on. Depress low "A" key and hold, OVERLOAD light should be blinking. Depress and hold high "A" key. Adjust OSCILLATOR 1 Range Trimpot (on oscillator board) for slowest possible blink rate. Depress and hold low "A" key. Adjust OSCILLATOR 1 Scale Trimpot (on oscillator board) for slowest possible blink rate. Monitor the output with headphones while tuning. Repeat this procedure for OSCILLATOR 2 and 3. Then check tracking between any two oscillators.

Octave Range Trimmer

Turn OSCILLATOR 1 Mixer switch on and set RANGE to 2 ft. Turn on A-440. Depress and hold second "A" key from the bottom. Adjust TUNE control for zero beats. Switch RANGE to 8 ft. Depress same key and adjust Octave Range trimpot (on oscillator board) for zero beats.

Noise Level

Noise level is factory-set to yield -5dB maximum in the white position. If the level becomes low it may be increased by counterclockwise rotation of the Noise Level Trimpot (on Power Supply board). It may be necessary to use an offset screwdriver to reach this trimpot.

VCA Balance

Turn all MIXER switches off. Connect headphones and set VOLUME fully CW. Connect a jumper from point "A" on the Filter Board (see Fig. 3) to point "A" on the oscillator board (see Fig. 1). While listening to the headphones, adjust the 2nd VCA Balance trimpot (on the filter board) for the minimum audio signal. Depress and hold a key. Adjust the 1st VCA Balance trimpot for minimum audio signal. Remove the jumper.

**TO ADJUST ...****FOLLOW THIS PROCEDURE ...**

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Regeneration Cal.

Turn all MIXER switches off. Monitor output with headphones. Set CUTOFF FREQUENCY control to -1. Insert an S-Trigger plug. Rotate EMPHASIS control clockwise. Regeneration should start when the EMPHASIS control is between 7 and 8. If it does not, set EMPHASIS control to 7.5 and rotate the Regeneration Cal. trimpot (on filter board) slowly clockwise until regeneration starts.

Filter Range

Turn KEYBOARD CONTROL switches 1 and 2 off. Set CUTOFF FREQUENCY at -1, EMPHASIS at 10. Turn on A-440 and adjust filter Range Trimpot (on filter board) for zero beats.

Filter Scale

Set CUTOFF FREQUENCY to -1, EMPHASIS at 10, AMOUNT OF CONTOUR at 0. Turn KEYBOARD CONTROL switches 1 and 2 on. Turn on A-440 and depress third "A" key from the bottom. Adjust CUTOFF FREQUENCY for zero beats (two octaves above 440). Depress low "A" key and adjust filter Scale Trimpot (on filter board) for zero beats. Repeat these adjustments until the filter will track three octaves.

Pitch Wheel

Loosen the Allen head set screw in the PITCH wheel. Rotate PITCH wheel until it drops into the center detent. Unplug the Left Hand Control connector. Connect an ohmeter to the orange and green wires on the pitch potentiometer. Adjust the pitch potentiometer for a reading of 15.3 kilohms. Tighten the set screw and check to see that the resistance is still between 15 and 15.6 kilohms when in detent.

Modulation Wheel

Loosen the Allen head set screw in the modulation wheel. Rotate the modulation potentiometer fully counterclockwise. Turn modulation wheel down to its physical limit. Re-tighten the set screw.

# 93-113 Oscillator: Adjustment Locations

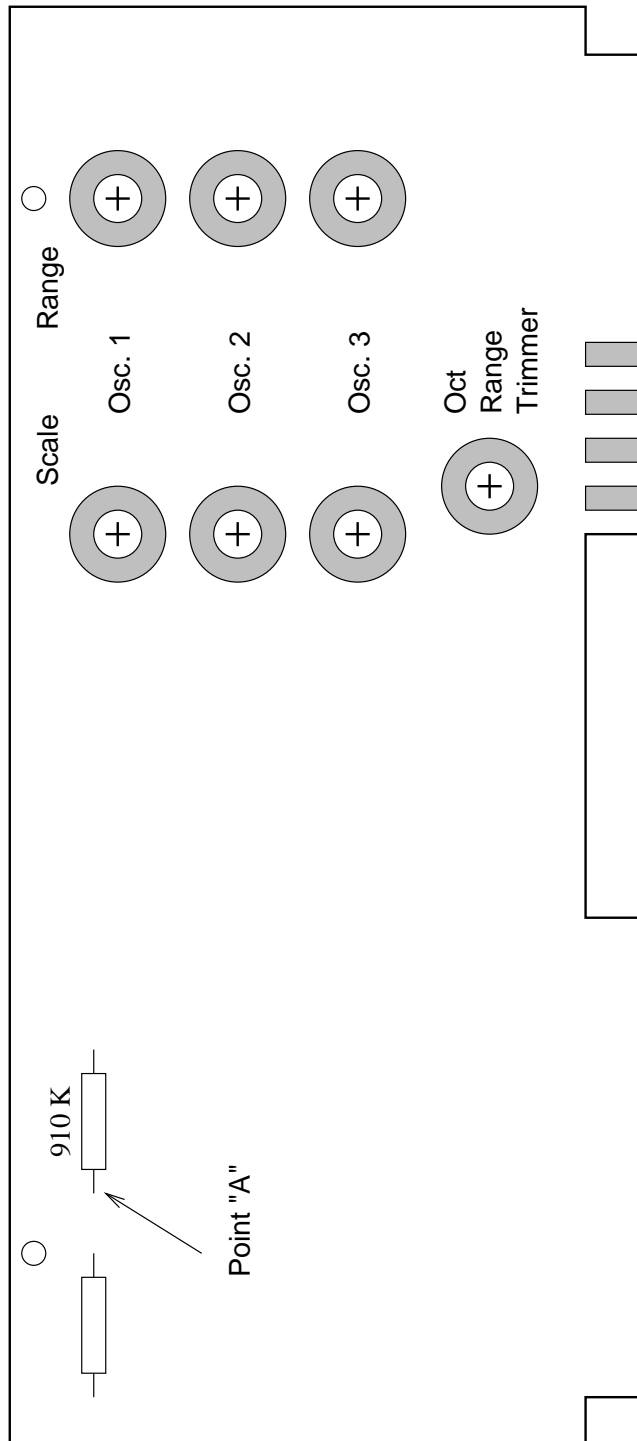


Fig. 1

**93-115 Power Supply: Adjustment Locations**

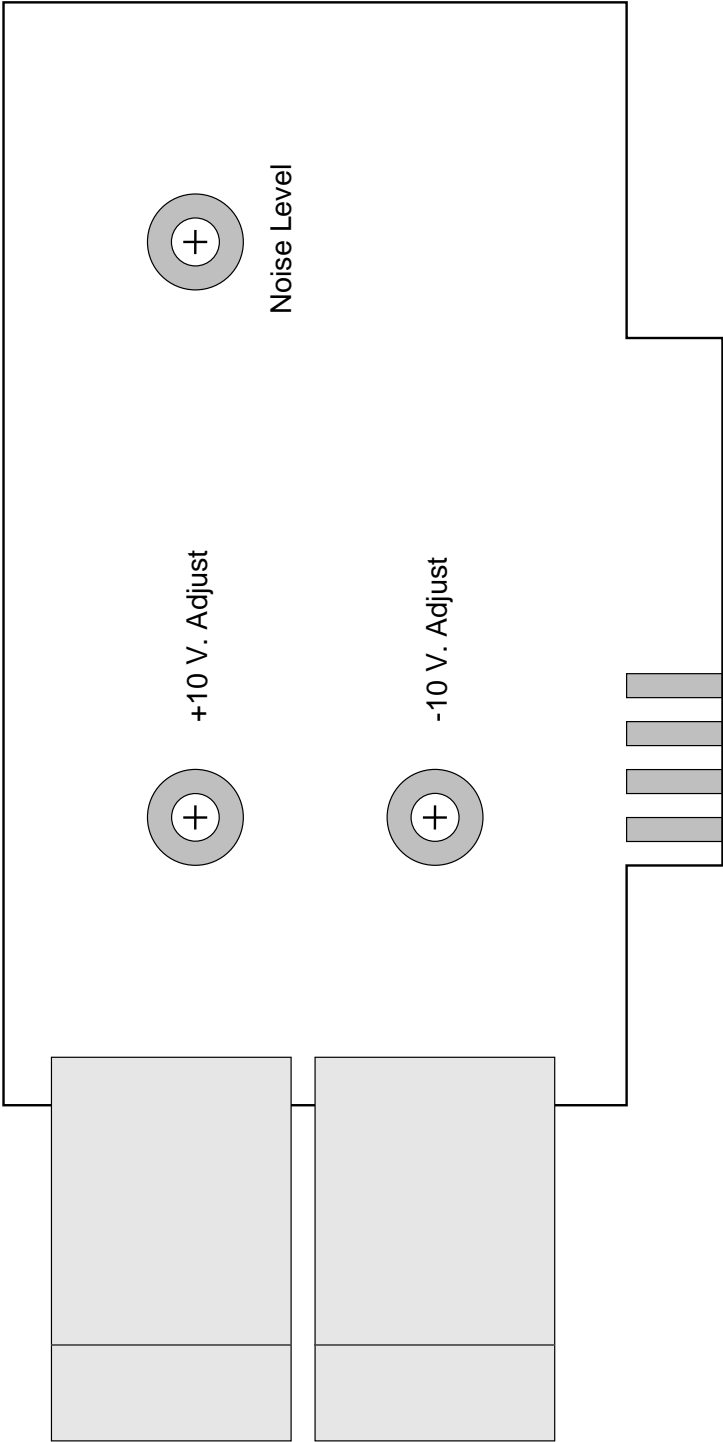


Fig. 2



# 93-116 Filter: Adjustment Locations

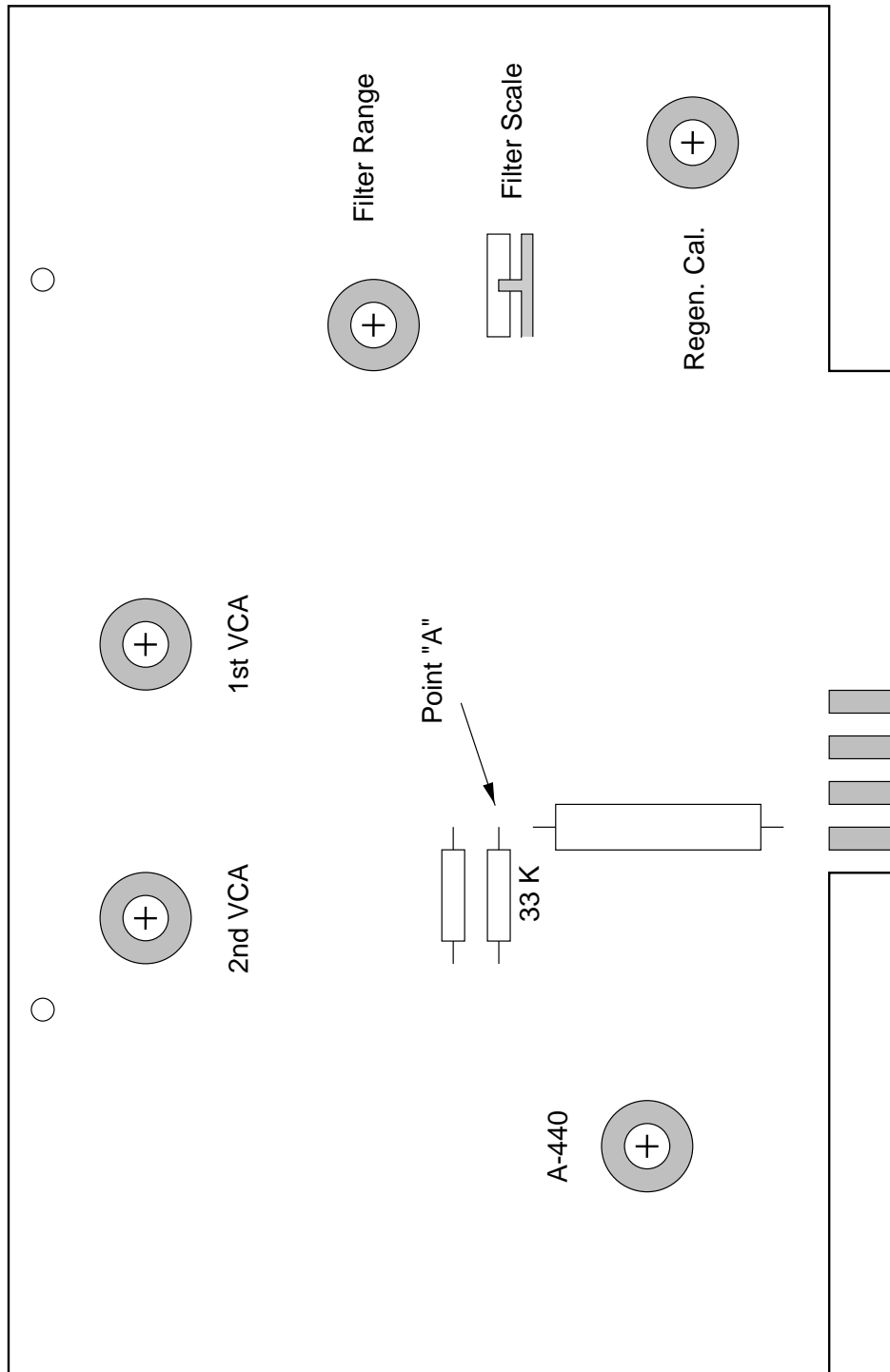


Fig. 3

## Section VIII: Keyboard Maintenance

Occasionally it will become necessary to clean and adjust the keyboard. The contacts, although gold plated, may become dirty, contaminated, or corroded. When contacts become poor, noises and erratic sounds may be generated while playing the instrument.

To service the keyboard, the bottom cover must be removed. This cover is held on with 8 wood screws. If the keyboard compartment is found to be excessively dirty, it should be blown out with air first.

Avoid touching the buss bars or the spring contacts with the fingers since hand oils and perspiration will cause corrosion. Under normal conditions, any dirt can be removed by spraying the assembly with a light coating of a high grade contact cleaner. At the factory, we use and recommend Cramolin®. If this is not available, TV tuner spray may be used. Do not under any circumstances use abrasives or abrasive tools, since this will destroy the gold plating. If spraying does not cure the problem, try wiping the buss bar with a cotton swab in the area of the problem key or keys.

Sometimes it is necessary to adjust the spring contacts for more tension. This is done by bending the spring so that it is closer to the buss bar. It is easiest to bend at the end nearest the mounting board. In all cases, the "pitch" contact must occur before the "trigger" contact. The pitch buss bar is nearest the front of the instrument. The trigger buss bar is in the center, and the third buss bar nearest the rear of the instrument is not used and therefore need not be cleaned or adjusted.

To clean the keys, use a soft cloth moistened with a mild soap solution. Never allow solutions or spray cleaners to run down between the keys. Avoid harsh solvents, since the keys are made of plastic and may be dissolved. Scratches may be removed with a plastic or automotive polishing compound. Waxing the keys is not recommended.

## **Section IX: Schematics**

(The circuit schematics are not available at this time.)

## **Section X: Component Locations**

(The component location diagrams are not available at this time.)

## Section XI: Replacement Parts

<b>Moog Part Number</b>	<b>Description</b>
93-113	Board No. 1 Oscillator
93-114	Board No. 2 Contour Generator
93-115	Board No. 3 Power Supply
93-116	Board No. 4 Filter
93-060	Left Hand Controller (Complete)
93-061	Keyboard (Complete Assembly)
99-104	Wooden Case With Bottom Cover
95-570	Back Cover Assembly
74-004	Power Cord
57-051	Fuse, 1/2 Amp slo-blo
57-026	Fuse, 1/4 Amp slo-blo
53-110	Lamp, Overload Indicator (16ESB)
43-160	Transformer, Power
37-010	Capacitor, 500 MFD 50 volts
61-112	Diode (Rectifier) IN4004
57-004	Fuseholder, A.C. Power
57-001	Fuseholder, D.C. Power
53-002	Knob, Standard
53-003	Knob, Large
53-021	Knob, Pointer
53-107	Pilot Lamp
65-005	Noise Transistor
51-20X	Switch, Rocker (Specify color)
93-067	Prop, Support
94-001	Modification Kit, Oscillator Board
94-002	Modification Kit, Filter Board
94-004	Modification Kit, Transformer Mounting

\* Order unlisted parts by description

## **Section XII: Modifications**

### 93-113 Oscillator Assembly (Board 1)

To improve tracking and pitch stability on Mini-Moog oscillator boards with serial numbers above 1300, make the following changes:

1. Change R-69, R-105, and R-141 from 6.8K to 15K 1/2 W 5% carbon
2. Replace R-78, R-106, and R-128 with RC Network, part number 65-032
3. Change R-181 from 56K to 51K 1/2 W 5% carbon
4. Change R-170 from 15K 5% to 15K 1% Metal Film
5. Change R-162 from 3K 5% to 3.01K 1% Metal Film
6. Change C-3, C-5, and C-7 from 47 pf to 100 pf

All parts listed above are available in kit form, part number 94-001.

### 93-114 Contour Generator Assembly (Board 2)

To reduce thumping which may occur when a key is depressed, add a 10 pF capacitor from pin 4B to pin 5B on the Contour Generator board.

### 93-115 Power Supply Assembly (Board 3)

To reduce oscillator bleed through and cross modulation, replace 10 ohm resistor next to the +10 V ADJ trimpot with a straight wire. Be sure wire does not touch the body of +10 V ADJ trimpot.

### 93-116 Filter Assembly (Board 4)

To reduce intermodulation distortion which occurs when mixing two or more signals:

1. Change R2 from 47K ohms to 160K ohms
2. Change R8 and R28 from 27 ohms to 4.7 ohms
3. Change R40 from 1K ohms to 10K ohms

## **Section XIII: Ordering and Shipping Instructions**

### **Ordering Parts**

Most commonly used parts are listed in Section XI. When ordering, please include the Moog part number. If the part is not listed, order by description. Be as accurate as possible when describing what you want.

Example:     Transistor, Q8 on board 2  
or:            Control, amount of contour

### **Returning Parts**

All parts being returned should be accompanied with a "Return Material Tag". Eight of these tags are supplied with this manual; additional tags are free upon request. Fill the tag out as neatly and accurately as possible. Package the part being returned so that it will not be damaged in shipment. Circuit boards should be double wrapped and enclosed in a rigid cardboard box. Attach the "Return Material Tag" to the part, not to the shipping carton. If the entire unit is being returned, it must be shipped in the original carton.

### **Address**

Use the following address for all orders and returns:

Moog Music, Inc.  
Academy Street P.O. Box 131  
Williamsville, New York 14221

**MOOG MUSIC, INC.**  
**SERVICE DEPARTMENT POLICY**

**MINIMUM CHARGE** (for non-warranty service) – is 1 hour (\$15.00). Additional charge per 1/2 hour (\$7.50). Update parts are free; all other parts are charged to the customer.

**WARRANTY ON REPAIR** – is issued as of date stamped on pink copy; only for parts or malfunction repaired. Warranty period is 90 days—we pay shipping both ways.

**DEALER WARRANTY SERVICE** – is to be reimbursed when we receive copy of his Service Report and defective components in the amount of \$10.00 for each unit so serviced. Units requiring the same service within 90 days are the responsibility of the authorized service center.

**SPEED OF SERVICE** – All units are to be repaired before the end of the second normal business day following the date of the receiving record. (Exceptions include case damage and large modular systems.)

**CUSTOMER HAND CARRY** – Units may be repaired at the factory while the customer waits only if appointment is made with Customer Service Manager at least one day in advance.

**MODIFICATION** – All units returned for whatever reason are to be updated to the latest or final design of their respective configurations.

**WARRANTY PERIOD** – All labor and parts are free for warranty service only if warranty card was received within one year preceding date of service.

**SHIPPING** – All shipping costs on warranty service are to be paid by Moog Music, Inc. Customer is responsible for freight to factory.

**RETURN TO STOCK** – All return to stock units are to be repaired and reconditioned to new specifications. Unreasonable damage is to be charged to dealer.

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