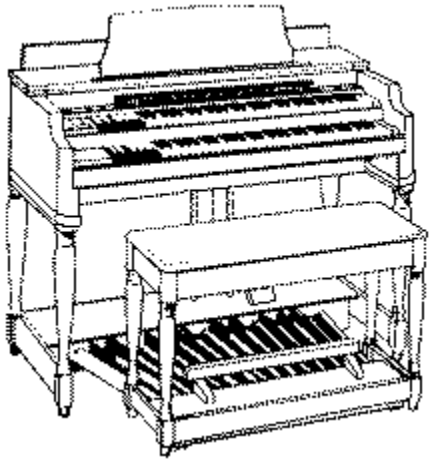
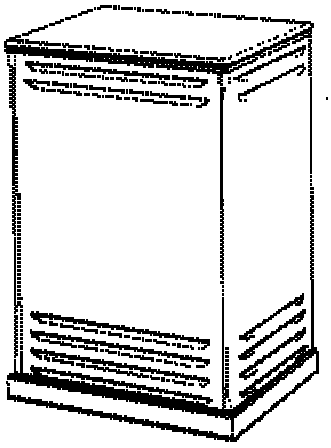
THE HAMMOND-LESLIE FAQ

EDITION 1.4.2 MAY 2000





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PREFACE

Welcome to the Hammond organ and Leslie speaker Frequently Answered Questions - a source of information, myth and lore regarding all things Hammond and Leslie for seasoned elders, new converts, skeptics, and visitors alike. It is hoped that among the fanatical ravings herein will be found real, actual, useful information. The information in this FAQ was collected from various sources, but most of the good stuff came from postings to the Hammond Technical Mailing List. [(1)]

INTRODUCTION

The sound of the Hammond organ has been somewhat absent in popular recordings of the previous decade or so. There was a time though when its presence on stage was de rigueur for any self-respecting band - you simply weren't a real band without one. The sound of the Hammond organ is being heard once again in contemporary recordings. It has been carried to the surface recently by a "retro" movement in popular music. The Hammond/Leslie combination can be seen on stage at concert venues around the country and on late-night talk shows, usually being played by someone in a contemporary pop group. But occasionally a veteran can be seen holding court at the console, grabbing a handful of drawbars while the Leslie spools up. The Hammond - starting to rumble - a full-hand slowly ascending glissando - the expression pedal floored - feet pumping furiously - now the Hammond is a full-throated roar - the Leslie a screaming dervish - eyes closed - arms extended - clinching a two-handed altered dominant chord on both manuals...

...but I digress.

What is it about the Hammond/Leslie combination that evokes zealous devotion in its advocates? Why do many of us consider the Hammond to be an instrument and other boxes with keys affixed to be merely poseurs?

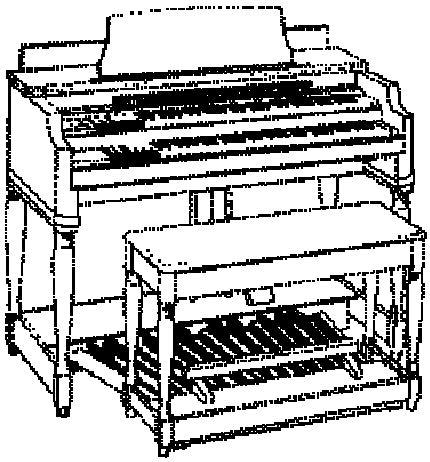
Well, of course, there's the sound ...

Some say the Hammond organ is an acquired taste. Perhaps this is true and no attempt will be made here to describe its bare-murmur-to- primal-wail-absolutely-righteous sound. But a serious listen to the best of the listed recordings in the accompanying discography should be sufficient to addict most of the uninitiated to that sound. These selections demonstrate the Hammond organ's ability as an instrument to evoke in the listener the emotion projected by the organist. That ability is the essence of the fanaticism some have toward the instrument. The Hammond/Leslie combination is an acoustic instrument, while more modern keyboards, controllers, and workstations lack this (ahem) organic quality.

And then, there's the technology ...

The first thing you notice when you remove the back of a tone wheel Hammond and poke your curious head into its innards is... the smell of oil and wood. Behind the pre-amp lies the tone generator, the heart of the Hammond's sound. Comprising cogs, shafts, bearings, and wire, the tone generator is a classic example of American over-engineering circa 1940. The rest of the instrument is hand constructed of the same high quality. And you can still get parts. Try getting parts for your Rolakorgamaha BS-1 in the year 2030. But then, why would you want to? Working on Hammond organs can be a pleasure.

1.0 THE HAMMOND TONE WHEEL ORGAN



The Hammond tone wheel organ, first introduced by Laurens Hammond in April 1935, is the one against which all contenders are measured. For this reason its technology is outlined below, and not the technology used in more recently manufactured Hammond organs.

A Hammond console organ includes two 61-key manuals; the lower, or Great, and upper, or Swell, and a pedal board consisting of 25 keys. The concert models have a 32-key pedalboard.

The secret of the Hammond tone wheel organ lies in its method of tone production. The tone generator assembly consists of an AC synchronous motor connected to a geartrain which drives a series of tone wheels, each of which rotates adjacent to a magnet and coil assembly. The number of bumps on each wheel in combination with the rotational speed determines the pitch produced by a particular tone wheel assembly. The pitches approximate even-tempered tuning, (it's done with integer math after all).

A note on the organ consists of the fundamental and a number of harmonics, or multiples of that frequency. In the Hammond organ, the fundamental and up to eight harmonics are available and are controlled by means of drawbars and preset keys or buttons. The setting at any particular time is applicable to one manual, either Great or Swell. (Harmonic content adjustment is provided for each manual independently.) The Hammond organ creates its tone colors through additive synthesis.

1.1 Hammond Percussion

Hammond Percussion is the name that Hammond gave to a patented circuit that changed the attack characteristic of a note. It does this by adding an additional tone, the Percussion signal, to the note that is depressed. The envelope of the Percussion signal is controlled to have a specific decay characteristic. The frequency of the Percussion signal is selectable to be either the 2nd or 3rd harmonic of the depressed note. The audible effect of this is that there is a chirp or ping at the attack of the note.

In modern keyboard parlance the Hammond Percussion would be called "single triggered". The Percussion envelope amplifier is triggered only when a note is depressed from an all-keys-up state. After it has been triggered and as long as any upper manual keys remain depressed, no Percussion effect will be heard when additional notes are depressed. Thus to hear the percussion effect for every note of a run requires a technique that fully releases the currently pressed key prior to depressing the next one in the run.

When Percussion is enabled, one of the harmonic busbar contacts from each key is used to trigger the Percussion amplifier. This removes one drawbar harmonic from the palette available to shape the sound. The stock setup removes the harmonic available at the 9th drawbar. The percussion circuit can be modified to trigger using any of the available harmonic contacts. See section 1.10.7 How to Change the Percussion Keying Source

On the console organs equipped with percussion, it is enabled only on the upper manual, and only while using "B" preset.

1.2 Key Click

The sound produced by early Hammond organs differed from pipe organs in one characteristic way. There was an attack transient that sounded like a click or pop when a key was pressed. This was considered a defect. Considerable design efforts were made to reduce it but it could never be eliminated. Later rock and blues players found the key click characteristic to be desirable and some jazz organists consider it to be essential. Many Hammond organ simulators include a key click control to reproduce this characteristic.

1.3 Hammond Vibrato

Provided on the organs so equipped are vibrato and chorus settings V1,V2,V3 and C1,C2,C3.

Vibrato is the periodic raising and lowering of the pitch, and is thus fundamentally different from tremolo, which is a variation in only the loudness of the pitch. The Hammond vibrato is implemented using a tapped delay line, really a low-pass filter. The signal is applied to the delay line and a rotating scanner, attached to one end of the tone generator assembly, picks the signal off of the delay line at the tap points. The scanner, a single-pole 16-throw air-dielectric capacitor switch, is wired so that the tap point will traverse the entire delay line twice, once up the delay line and once back down, for each scanner rotation. As the delay line is traversed phase is added-to and then subtracted-from the signal.

The chorus signal is produced by adding non-pitch-shifted signal to the pitch-shifted signal.

The three settings each of vibrato and chorus correspond to different amounts of total delay thus different amounts of total pitch shift.

In addition to the pitch shifting function, the vibrato, as implemented in the Hammond organ, also acts as a sweeping low-pass filter. There is some frequency response and amplitude variation as the tap point of the filter is swept.

1.4 The Scanner

The scanner is used in the organ as a single-pole 16-throw rotary switch. It is constructed as a multi-plate air-dielectric capacitor with 16 stator poles and one rotor. It is used, in conjunction with the vibrato delay line, to create the chorus/vibrato.

1.5 Drawbar Registrations

There has been a lot of discussion on the Hammond Technical Mailing List about drawbar registrations. There has been general agreement that everything that has been published about the registrations used by famous Hammond players or in famous recordings is not to be taken too seriously (up to now of course). Want a quote? Here's part of Sal Azz's posting to the list on the subject...

> " I get the biggest charge out of the Hammond notated sheet music that was available back then. I actually have 'Sounds of Jimmy Smith at the Hammond Organ' published by

> Edmy Music in 1965. I bought it mail order in 1966 from a review in the 'Hammond Times'. Even as a 14 year old, I knew I'd been had the second I opened the book. Of course, it is not transcribed 'as played' by Jimmy Smith. It's notated on 3 staffs. Dig the registrations for 'The Sermon':
>
> Upper: 468364876
> Lower: 006545456
> Pedal: 82
> Vibrato: OFF
>
> SURE, play it like that and even your dog will die laughing while he dodges the broken stemware and pictures rattling off the walls from that pedal setting. Where the hell did they get this from?? Hey, at least they got the key signature right. "

Of course, Sal and others have had a few more things to say about some more current publications, but for those quotes you'll have to check the list archives. As it turns out, most players use the same few drawbar settings. Here then, presented for (what ought to be) the first time in print anywhere, are the preset setup and drawbar registrations that most players use. These will make your organ sound like 90% of the recorded jazz material extant. [(2)]

B preset upper

Registration: 888000000
Percussion: Soft/Fast Attack
Vibrato: V-3/C-3 on or off to taste.
- or -
Registration: 88800000x ...adjust 1' to taste for a whistle
Percussion: Off
Vibrato: On/Off

A# preset upper

Registration: 888888888
Vibrato: C-3 vibrato on or off to taste.
Leslie fast or off.

B preset lower

Registration: 838000000
Vibrato: C-3 vibrato on or off to taste.
Comment: Left hand bass, right hand comp.

A# preset lower

Registration: 008600000 8' and 4' to taste.
Pedals: x0 Adjust 16' to taste.
Comment: Use to play left hand chords when playing bass on pedals.

There's another specialty registration that may be used to get, what has been referred to on the mailing list as, the "Errol Garner style". This style can be heard on several recordings. Among them...

J. Smith: "Mack the Knife" and "Makin' Whoppee" on *Crazy Baby*, "Satin Doll" on *Organ Grinder Swing*.

J. McGriff: "I Cover the Waterfront" on *A Bagful of Soul*, "Frame for the Blues" on *Live at the Apollo*.

Joey DeFrancesco: "Work Song" and "All of Me" on *Live at the Five Spot*, "On the Street of Dreams" on *Street of Dreams*.

The registration most often used for this style is 800008888. Try it with a C-3 chorus, and a fast Leslie. The upper drawbars may need to be adjusted to compensate for the brightness of your organ and Leslie setup.

Hammond Presets

Listed here are tables of the presets' registrations and their names as they appear in an A-102 owner's manual (contributed by Steve Blau <blaumills@healey.com.au>).

Standard Voices

Upper Manual		
Key	**Registration**	**Name**
C	-- ---- ---	Cancel
C#	00 5320 000	Stopped Flute
D	00 4432 000	Dulciana
D#	00 8740 000	French Horn
E	00 4544 222	Salicional
F	00 5403 000	Flutes 8' & 4'
F#	00 4675 300	Oboe Horn
G	00 5644 320	Swell Diapason
G#	00 6876 540	Trumpet
A	32 7645 222	Full Swell
A#	1st Group Drawbars Upper	
B	2nd Group Drawbars Upper	

Lower Manual		
Key	**Registration**	**Name**
C	-- ---- ---	Cancel
C#	00 4545 440	Cello
D	00 4432 220	Flute & String
D#	00 7373 430	Clarinet
E	00 4544 222	Salicional
F	00 6644 322	Great, no reeds
F#	00 5642 200	Open Diaposon
G	00 6845 433	Full Great
G#	00 8030 000	Tibia Clausa
A	42 7866 244	Full Great with 16'
A#	1st Group Drawbars Lower	
B	2nd Group Drawbars Lower	

Theatrical Voices

Upper Manual		
Key	**Registration**	**Name**
C	-- ---- ---	Cancel
C#	00 8740 000	French Horn 8'
D	00 8408 004	Tibias 8' & 2'
D#	00 8080 840	Clarinet 8'
E	08 8800 880	Novel Solo 8'
F	60 8088 000	Theatre Solo 16'
F#	00 4685 300	Oboe Horn 8'
G	60 8807 006	Full Tibias 16'
G#	00 6888 654	Trumpet 8'
A	76 8878 667	Full Theatre Brass 16'
A#	1st Group Drawbars Upper	
B	2nd Group Drawbars Upper	

Lower Manual		
Key	**Registration**	**Name**
C	-- ---- ---	Cancel
C#	00 4545 440	Cello 8'
D	00 4432 000	Dulciana 8'
D#	00 4800 000	Vibraharp 8'
E	00 3800 460	Vox 8' & Tibia 4'
F	00 6554 322	String Accomp. 8'
F#	00 5642 200	Open Diaposon 8'
G	43 5434 334	Full Accomp. 16'
G#	00 8030 000	Tibia 8'
A	84 7767 666	Bombarde 16'
A#	1st Group Drawbars Lower	
B	2nd Group Drawbars Lower	

1.6 Harmonic Foldback

A Hammond console model manual has 61 keys. The number of tonewheels necessary to produce all 9 harmonics for all 61 keys is 109. Since all console models have either 82 or 91 frequency generators, certain outputs are reused for the upper harmonics of the keys at the upper end of the manual. This characteristic of repeating, for the harmonics of an upper octave, the harmonics used for a lower octave, is called foldback. Most of the console organs also have foldback of drawbar 1 of the lowest octave of the manuals; it repeats the harmonic used for drawbar 1 of the next octave above.

The earliest console organs with 91 frequency generators have no foldback of the lower octave; the bottom twelve tone generator outputs are available on the first drawbar of the manuals' bottom octave. On other console organs, the lowest twelve outputs of the tone generator are available only on the pedals.

Since no legitimate (Hammond authorized) explanation has yet been found as to why foldback of the lower octave was introduced, the likely explanation seems to be given in the service manual's description of the various models of tone generators.

The first tone generators were 91 frequency generators. In these generators, the lowest twelve frequencies were produced using twelve wheels with two teeth each. When, subsequently, the 82 frequency generators were introduced, the lower octave foldback was implemented. The Service Manual states that the lower nine frequencies were omitted and manual and pedal rewiring made them unnecessary.(!) When the wide version of the 91 frequency generator was introduced, (from the Service Manual) "...the original twelve two-toothed wheels were replaced with twelve two-toothed complex tone wheels, which supply a fundamental tone that is enriched with the odd-number harmonics." Thus these lower twelve frequencies have a different harmonic content from the, allegedly sinusoidal, remaining seventy-nine.

A narrow version of the 91 frequency generator with complex tone wheels is the one that is used in the B-3, C-3, RT-3, A-100, D-100, and some of the earlier models. The breakdown of the models that have different tone generators (thus different foldback) follows: [3]

Models that have no foldback in the bottom octave (and have a 91-frequency TG) are:

- Model A: serial 1 - 2676
- Model B: serial 4000 - 10549
- Model C: serial 1 - 1247
- Model D: serial 1 - 3143
- Model E: serial 8000 - 8663
- Player consoles: serial 9000 - 9209

Models that fold back the lowest 9 notes of the bottom octave (and have an 82-frequency TG) are:

- Model A: serial 2677 - 2711
- Model B: serial 10550 - 17074
- Model C: serial 1248 - 17074
- Model D: serial 3144 - 17074
- Model E: serial 8664 - 8739
- Model G: serial 4101 - 7349
- Player consoles: serial 9210 only

Models that fold back all 12 notes of the bottom octave (and have a 91-frequency TG, with 12 complex tone wheels for frequencies 1-12) are:

- Model BV: serial 17075 and above
- Model CV: serial 17075 and above

Incidentally, there is an audible difference between the complex tone wheels and the regular tone wheels.

1.7 Obtaining Service or Owners Manuals

You can still get an owner's manual or service manual for your Hammond. Organ Service Co. Inc. has manuals available for just about every Hammond made. Other vendors have manuals for a more restricted range of Hammonds, mainly the A's, B's, C's, RT's. Check the theatreorgans.com site for the Hammond Shop listing.

1.8 Oiling the Hammond

People often ask how often they should oil their Hammond, and whether it is possible to over oil it. The service manual states oiling should be performed once a year using Hammond oil, which is available from many organ parts suppliers. [4] Oiling your Hammond this often will certainly insure that is thoroughly oiled. It will be so well oiled that anything beneath the organ will be thoroughly oiled as well ... the carpet, your feet, the dog. This convenient built-in over oiling indicator, not mentioned in the Service Manual, by the way, shows that you can't really over oil the generator; it just drips out the bottom of the generator onto what ever is beneath. There have been problems reported about over oiled scanners though, and a scanner cleaning and rebuild can be quite expensive. See section 1.10.5 How to Rebuild the Vibrato Scanner According to Jerry Welch at Organ Service Company Inc., people over oil the scanner by filling its oil cup all the way up when actually only the wick in the cup should be saturated. The scanner oil cup is located between the run motor and the scanner at the far left end of the tone generator. The main generator is best oiled by putting a couple of teaspoons of oil directly into the two funnels located on top of the generator.

1.9 Caveat Emptor - Buying a Hammond

Some considerations for a typical B-3 purchase: [5]:

- If you happen to find a B-3, remember that it is at least 20 years old, with a last-model-year (1974) organ, among the hundreds of thousands sold throughout their 30 years of production. The average B-3 found in the used-organ market is around 30 years old. The average B-2, C-2 and other older model Hammond approaches 40-50 years old, regardless of the cabinet condition.
- Be sure of what you are buying. Often a naive seller will not really be aware of what is he or she is selling. What's advertised as a "B-3 with Leslie" may end up being a BV with a Hammond tone cabinet. Check the data on the manufacturer's plates. Compare the features of the organ you are looking at with those features you know to be present (or absent) in that model.
- Examine the overall cabinet as a good indication of the organ's treatment in life up until now. If it's in poor shape, with missing wooden parts, broken keys, etc., consider this in your assessment of the use/abuse to which the organ has been subjected.
- Start the organ (see below). Test each drawbar on each manual. For B-3 or other console organs use the A# and B preset (reverse color) keys, and their corresponding sets of nine drawbars. The far left set is for the Upper Manual "A#" preset, the second set is for the Upper Manual "B"

preset, the two drawbars in the middle are for the pedals, the third set is for the Lower Manual "A#" preset, and the fourth set is for the Lower Manual "B" preset. Hold a key down on the manual and try each drawbar to be sure they sound, making sure it's corresponding preset is pressed.

Then, pick a preset and drawbar group and pull out the first drawbar from the left in that group (brown) and play from the first "C" note to the last "C", a total of 61 notes. It is normal for the first octave of tones to repeat on B-3 and similar organs due to the manual wiring. (This is not the case in some very early models) Then, push in the first brown drawbar and pull out the last white drawbar and starting from the second "C" (notice it's the same tone as key #61, last "C" was with the first brown drawbar out) on the same manual, play all remaining notes up to F# an octave from the end where the notes will again begin to repeat. This repeating is called foldback and is very important to the classic B-3 sound.

- Repeat this procedure with all drawbar groups and both manuals. You can also try every note on every drawbar to be sure they all sound. If you have missing tones, this may be simply a broken wire on the tonewheel generator, or in the harness between the manuals, or it may be a broken resistance wire within the manuals or other problem. Some are an easy fix, some are very difficult.
- Check the percussion on the B-3 and similarly equipped organs keeping in mind it only functions on the upper manual with the "B" preset. It does not work on the lower manual, or with any other preset down. Push all drawbars in, press the "B" preset for the upper manual, turn the percussion "ON" and play a note, listening for decay. Check the decay and "SECOND/THIRD" harmonic rocker switches. The "NORMAL/FAST DECAY" should function in this manner - the FAST decay should decay in about one second, the NORMAL decay should decay in about four seconds. There is an adjustment on the preamp for setting the decay. If you have no percussion, be sure you are checking it correctly. It may be simply a dead 12AU7 tube, or it may be a bad percussion transformer or other problem in the organ.
- LISTEN to the START and RUN motors when you start the organ. Be sure both are functioning normally when their respective switches are set to ON.

Hammond organ starting procedure

Hold the START switch ON for eight seconds, then while still holding the START switch ON, turn the RUN switch ON and hold both switches ON for four more seconds. Let go of both. The START switch will spring to the OFF position, and the RUN switch should remain ON.

- Try the pedals. Pull out one of the pedal drawbars (two in the center of the organ between the sets of nine manual drawbars) and play each pedal. Then push the first in, pull out the other and repeat the test.
- Check the vibrato for each manual. The SWELL vibrato switch is for the UPPER manual, the GREAT is for the LOWER. Check all positions of the Black Vibrato knob - V1,V2,V3,C1,C2,C3. If the chorus or vibrato sounds choppy, or is dead, problems exist which require repair. A very common problem in older organs is choppy or "motorboating" vibrato and chorus, which requires vibrato scanner rebuilding. Other possibilities include preamp component problems, bad tubes, bad vibrato line box components, etc. None of these are particularly easy to fix for most owners.

- If a Leslie is included be sure of the model and the Leslie's operation. Do not rely on the cabinet condition. Plug-in the cable to the Leslie, be sure the Leslie changes speeds, sounds good from both the upper horn and woofer. If the Leslie is being offered with an A-100 or other organ with an internally powered speaker, listen to the organ driving just the Leslie. The presence of sound from the organ's internal speakers can mask certain defects in the Leslie's sound. A complete Leslie comes with wood back pieces (three on 122/142/147/145 models).
- Many organ deals go sour due to bad Leslie's, so don't be surprised if something is amiss. Not all organs are B-3's, and not all Leslie's are 122's or 147's. If it turns out that one or the other is not as advertised, is incomplete or is otherwise deficient, reduce the offered price, and hold your breath. Walk away if the negotiation gets nasty, or if something doesn't seem right to you.

And to help you when you ask on the Mailing List about some organ you want to buy, here's Bob Schleicher's Used Organ Rating Scale...

Used Organ Rating Scale

OUTSTANDING
Looks and works like new or better. Original finish with no blemishes or sun fade. No apparent wear anywhere. This is the one the maid polished every day and the owner made you take your shoes off to play after you serviced it yearly.
EXCELLENT
Slight cabinet imperfections, but original finish. Minor touch-up O.K.. Works perfectly and well maintained.
VERY GOOD
Same appearance as excellent, but may need busslube, scanner & other minor repairs. May have been professionally refinished.
GOOD
Moderate cabinet defects which are repairable. Normal wear for it's age. no major problems with keyboards or generator.
FAIR
This one has seen commercial service. Keyboards need key combs, upstop felts & busslube. Cabinet too far gone for restoration to good appearance. Organ is complete and has pedals and bench.
POOR
Major cabinet and mechanical defects. Not a practical restoration project. May or may not work, but is complete. This one was on the road for years, or killed in a church.
PARTS
At least some useable parts. Good for training project. Probably has shot keyboards, frozen generator, bad scanner and missing parts.

With the increasing popularity of Hammonds, owners think they are all 24k gold. Fact is, it's easy to put more $$$ & time into a poor specimen than you will ever recover.

Buyer beware !!

1.10 HOW-TOs: Repairs, Modifications, and Tech Tips

The following methods and procedures are for those individuals that want do technical repairs on their organ. They vary in complexity from the relatively benign drawbar cleaning procedure, to the potentially damaging busbar lubing procedure, a procedure probably best left to those with previous experience.

1.10.1 How to Clean Key Contacts

Three steps are mentioned in the Service Manual for progressively bad cases.

1. First, try striking the offending key 15 to 20 times in a rapid staccato manner to dislodge the dust particles and to clear the contacts.
2. If this procedure does not dislodge the dust particles, adjust the busbar shifters. The busbar shifter for the upper manual is a slotted shaft about 1/2" in diameter, protruding about 1/4" from the rear surface of the upper manual assembly. It is located behind the mixing transformer. The lower manual adjuster is located in the corresponding location on the lower manual. The shifter for the pedal assembly is located at the low end of the pedals. Turn the proper busbar shifter about two turns in either direction. This operation permits the key contacts to strike a new position on the busbar and should free all contacts of accumulated dust particles.
3. If, in extremely stubborn cases, the procedure above does not dislodge the dust particles, use a board to depress one octave of notes (or the offending key) and then adjust the busbar shifters holding the key(s) down.

A warning about procedure (3) was issued in a Keyboard article, Nov. 1991:

> "... 'This is extremely dangerous,'... 'and should never be done by anyone except a technician who knows that the busbars are in absolutely perfect condition. If the keys are worn enough to have notches in their contacts, running the busbar back and forth against depressed keys can saw those little contact wires in half.'..."

Also, the preset keys are implemented similarly to regular keys, with the same type of key contacts and so forth. So if you choose to adjust the busbar shifter, as (2) and (3), be sure that no preset keys are latched down, else the same damage could occur as in number (3) above.

1.10.2 How to Clean Drawbar Contacts

One suggestion ...

> "First, pull out all the drawbars to their full 'on' position. From the rear of the organ, spray Cramolin R-5 [(6)], Contact Clean, or another spray contact cleaner into the back of each drawbar, using the spray nozzle extension tube that's supplied with each product. Then work each drawbar fully in and out several times to dissolve the oxidation and dust. The second method is to insert tape head cleaner swabs coated in Vasoline into the rear of each drawbar similar to the first method, and carefully coat the top surface of the drawbar base. This also works well to quiet the noisy 'ratchet drawbars' on early Hammonds." [(7)]

And then there's ...

> "We remove the drawbar contact and burnish it with a contact burnishing tool. Be sure the nichrome resistance wire (1 ohm) is not broken. If it (they) are, do not try to solder them. Go forth and buy 1/8 watt 1 ohm resistors and solder them where the wire was. They fit just duckey and work great." [8]

1.10.3 How to Adjust the Preamp Drive Level (B-3/C-3/RT-3/A-100)

In organs using the AO-28 preamp (also M3) driving a Leslie the drive level can be adjusted to give you both the classic Hammond growl or a clean organ sound on demand. The preamp drive level is set by adjusting a trimmer capacitor that is accessible behind a removable plug located on the cover of the box containing the swell capacitor.

Here's a recommended method: [9]

The setup:

- Select the A# preset key, upper manual with drawbar setting 80 8808 008 (first brown drawbar and all four white drawbars pulled out to position 8). Expression pedal should be fully depressed (maximum volume), vibrato and percussion OFF.
- If you regularly use pedals, pull the first (16') pedal drawbar out to position 8. The preamp trimmer on the organ should be adjusted fully clockwise.
- For a tube amplifier Leslie adjust the volume control fully clockwise. For a solid-state Leslie (760, 722, 860, 900, etc), all amp controls should be almost or fully clockwise.

The procedure (requires two people):

- One person should play a full 5-finger "C" chord on the upper manual; use all 10 fingers if you don't normally play bass. Don't chord in the lower octave, but play a realistic full chord. If you play bass with the left hand, play bass on the first octave of the lower manual with the first four drawbars out to position 8. Play the low C-pedal if you are using pedals.
- While the first person plays the above, the second person should begin turning the trimmer slowly in a counter-clockwise direction, no more than 1 turn. The organ / Leslie should be getting louder as you turn the trimmer, but should not yet be distorting.
- If you like a clean organ sound then the final setting should be slightly less than the point where the Leslie starts to distort.

If you like a dirtier sound then the final setting should be slightly more (1/8 of a turn) than the point where it just begins to distort.

The caveats:

Increasing the drive level by turning the trimmer more will only cause problems, as distortion can excessively heat the upper driver and woofer and may lead to their premature failure. The classic Hammond growl is a direct result of correct preamplifier drive adjustment, as well as a well maintained organ and Leslie. Most organs should require a trimmer adjustment no more than 1 to 1 1/2 turns open.

The test:

To test your freshly adjusted organ and Leslie - If you have it adjusted for a slight distortion at maximum volume, the distortion should disappear or be greatly reduced by simply pushing in the first two drawbars 2 clicks to position 6. It should still be very loud and very clean, but should have no distortion. The desired result is to have some Hammond growl on demand, and a clean organ sound at other times.

Organs with solid-state Trek-II preamp should be set almost the same way, but the max drive level on the preamp is adjusted with the volume pot attached to the swell pedal control arm. Loosen the set screw and use a small screwdriver to turn the pot within the arm - do not remove the arm - all other adjustments are the same.

1.10.4 How to Unstick a Stuck Vibrato Scanner

Not all Vibrato Scanner problems are because of dendrite build-up (discussed below). Because of this, don't be so quick to yank the vibrato scanner! (10)

If you turn on the vibrator tab and the treble is boosted, but there is no oscillation, there's a chance your scanner simply isn't turning. The scanner can get stuck in place from simple deposit build up and non-use. You may only need to take off the rear scanner cover, reach in and give it a spin as follows.

With the organ off, remove the two screws from the rear scanner cover (this is on the extreme left end of the TG assembly as view from the rear of the organ). Carefully slide the rear cover off, and look inside. You'll see the tip of the vibrato rotor just sticking out. You can just get 1 finger in to give it a nudge. Spin it a few times, the opposite direction from the generator shaft. With the cover still off, hit the start switch and make sure the vibrato rotor is turning. Finish starting the organ and try the vibrato. The toughest part is replacing the rear screw of the scanner cover. You need a small hand and short screwdriver. To replace it, use a mirror and plastic-extension-tube-screw-holder to get the screw started.

If this doesn't help your problems, read on, it may be time to perform a necropsy.

1.10.5 How to Rebuild the Vibrato Scanner

The presence of a motorboating or chopping sound in the Vibrato can be an indication that one or more pole pieces of the scanner have been shorted out. The likely culprit is a crystalline growth that can occur on the plated and metal composing the scanner housing (dendrite formation). This shows up as conductive whiskers or dust between the scanner body and the poles of the scanner. High humidity and temperature is said to aggravate dendrite formation. An over-oiled scanner can also cause vibrato motorboating, though it is probably an aggravating condition to the dendrite formation. The oil coats the insulators and picks up and retains conductive dust and debris, shorting out the stators.

A Hammond technical bulletin was issued detailing corrective procedures to cure this condition. What follows is a shortened version of it: (11)

Before you condemn the scanner, be sure the rightmost 6AU6 is healthy. Swap with the other one to verify. If you still have the problem, measure the plate and screen voltage on V2. They should measure about 130VDC and 60VDC respectively. Plus or minus 15% is O.K. If the problem persists proceed as follows:

- Remove the two springs from the coupling to the generator.
- Remove the four 5/16" nuts and lockwashers at the corners of the run motor.
- Unsolder the seven black wires which go to the vibrato switch and the red and blue wires at the vibrato line box. Be sure to note or mark their position.
- Carefully move the motor/scanner assembly to the left and twist to move it toward back of the console.
- Remove the spring clip from the rectangular oil trough. Lift the wick and unwind the oil threads.
- Remove the three screws which attach the scanner to the motor and separate the scanner from the motor.
- Remove the rear cover from the scanner and unsolder the wire. Be careful not to bend the pin that the two brushes contact. Raise the end brush and slide the others off.
- Make an indexing mark on the scanner by the red wire for easier reassembly.
- Remove the screws from the perimeter of the scanner and remove the cover. You will now see the stators. WATCH THAT PIN ON THE BACK !!!
- Remove all 16 screws, lockwashers, flatwashers and round insulators from the outside, the stators, and the square insulators from the inside.
- Soak everything you just removed in denatured alcohol overnight. (The original bulletin said to soak the parts in gasoline. Yikes!).
- Clean the scanner body with alcohol and a ScotchBrite pad.
- Spray the clean body and dry insulators with Krylon clear. Allow to dry thoroughly. WATCH THAT PIN !!
- Make sure the rotor spins freely. If any oiling threads are missing or broken, this is the time to replace or splice them.
- Reassemble the scanner and reinstall it. Just reverse the above procedure. Aren't you glad you made those marks now and didn't bend the pin?
- When you replace the brushes, be sure to look at the bend in the brass doodads to which the springs are soldered. The lowest one goes on first.
- By the way, the problem of dendrite formation on the metal parts of the organ have been known to cause problems in other locations in which it can occur, the vibrato and percussion switch assemblies, etc..

1.10.6 How to Lube the Manual Busbars

Your manuals may need a busbar lube if the notes are scratchy, intermittent, and don't respond to the busbar shifting procedure. This procedure is probably best left to a professional technician because you can easily damage something by forcing things. [(12)]

First, the cautions. - You can do **VERY** serious damage to your keyboards if this procedure is done incorrectly, so take your time and follow instructions.

The manual chassis (keyboards) is very heavy. If you're not strong, use two people to remove and install them. Have all the materials on hand as well as the service manual for your instrument.

You will need the following materials:

1. A can of NEVR-DUL - A treated wadding available at most hardware or antique stores.
2. A box of alcohol prep pads - any drug store.
3. Hammond Busbar lubricant - Organ service Co.
4. A book of matches.
5. Time and patience.

Refer to the service manual for your model and remove the manual chassis. Be sure to protect the finish on the organ with posterboard or several layers of newspaper positioned at the ends of the cheek blocks.

- Stand the manuals on end with the presets facing up.
- Remove the small rectangular plate from both keyboards, and remove the large screw that goes through the drawbar base. You will now see a gadget that retains the busbars. Loosen the two screws and move the restraint back to allow removal of the rods.
- Take your matchbook and jamb it between the cheek block and the Cancel key. This will prevent you from hitting a contact, or getting the rod back in on the wrong side of the busbar.
- Start at either the top or bottom and remove only one rod. With a gob of NEVR-DUL, wipe the rod several times. You'll be amazed at the dirt and crap you get. If the wadding sticks or tears while cleaning, inspect the palladium wire for broken or missing sections between the spot welds. If the rod is damaged, replace it. (Again, Organ Service Co.) If your organ has the round gold plated rods, this will not be a factor. Just make sure they are very clean and bright.
- Now, with an alcohol prep pad, wipe the rod several times. Use one pad for each rod, dry and apply a thin coat of bus lube to the rod. It's time for the fun now. Make sure the rod is not bent and re-install in the same place from which it came. CAUTION!! If you encounter any resistance, STOP. Remove the rod and again inspect for bends. Keep trying until the rod goes back in easily. I've found that on later units with the square rods, it sometimes helps to arch the rod slightly as you re-insert it. Make sure the Cancel key is down! I'd bet that a great deal of swearing is in order at this time, but DON'T FORCE THE RODS. On later consoles, there are holes for additional rods. Be sure to replace the rods in the same holes originally used.
- Repeat the procedure for all 18 rods, move the retainer to the original position, replace the cover plates and re-install the keyboards. The pedal switch may need a lube too. The procedure is similar.
- Apologies in advance to tech who don't want this information out there.
- DON'T FORCE THE RODS and best of luck. I'm sure you'll like having all the notes play again.

1.10.7 How to Change the Percussion Keying Source

When Percussion is enabled, one of the harmonic busbar contacts from each key is used to trigger the Percussion amplifier. This removes one drawbar harmonic from the palette available to shape the sound. The stock setup removes the harmonic available at the 9th drawbar. Some players prefer to have the top-most drawbar available at all times, even when Percussion is enabled. This modification to the percussion circuit changes the percussion amplifier's trigger source from the 9th harmonic busbar to some other source, usually the 8th.

The following procedure has worked on a B-3, C-3, and A-100. You will probably want a copy of your organ's schematic and wiring diagram for reference.

Note: All references to soldering on drawbars are in reference to the Upper Manual "B" Preset group, which is the 2nd group of nine from the left, when viewed from the console seat.

Identify the following:

RESISTOR PANEL

A phenolic board measuring about 1" X 5" is mounted to the rear of the upper manual just below the upper manual "B" preset drawbars. This board is called the RESISTOR PANEL. On the left side of this panel are three dual-mounting lugs. Each of the dual lugs has two wires attached of similar color. One dual-lug has two WH wires, one has two GN wires, and one has two YL wires.

PRESET BUNDLE

A bundle of nine multi-colored wires comes from the upper manual "B" preset key. They exit the upper manual behind the PRESET PANEL (metal bars with lots of screws). This bundle will be called the PRESET bundle. Six of the wires in this bundle are routed up and immediately below the drawbars, where they breakout of the bundle and are soldered to the drawbar ends. The remaining three of the bundle are routed below the drawbars behind the upper manual and attach to three of the dual-lugs on the RESISTOR PANEL:

Color	Destination
BN	1st drawbar
RD	2nd drawbar
OR	3rd drawbar
YL	RESISTOR PANEL (2nd harm)
GN	RESISTOR PANEL (3rd harm)
BL	6th drawbar
VI	7th drawbar
GY	8th drawbar
WH	RESISTOR PANEL (the percussion trigger wire)

The other wires of similar colors (to those from the PRESET BUNDLE) on the RESISTOR PANEL come from the Percussion Switch assembly.

The Procedure:

1. Unsolder the GY wire from the 8th drawbar.
2. Unsolder the WH wire from the 9th drawbar and solder it to the 8th drawbar. This WH wire goes to the percussion switch and this now configures the percussion to trigger from the 8th drawbar key contacts.
3. There are two WH wires soldered to one of the dual-lugs on the RESISTOR PANEL. This is the left-most lug on my A-100's Resistor Panel. One of the WH wires comes from the Percussion switch and one comes from the PRESET BUNDLE. Identify and unsolder the WH wire that comes from the PRESET BUNDLE (routed from behind the PRESET PANEL) that is attached to a dual-lug on the RESISTOR PANEL.
4. Solder the GY wire, removed in step 1, to the RESISTOR PANEL at the point where the WH wire was removed in step 3.
5. Solder the WH wire, removed from the RESISTOR PANEL in step 3, to the 9th drawbar. Splice a short length of wire to it if it's not long enough.

1.10.8 How to Trouble-Shoot a Percussion that Doesn't Decay

The percussion gate is triggered by grounding the "K" terminal on the preamp. The ground comes to this terminal from the 1' busbar (white wire) through the percussion switch. Our old friend metal migration is almost always the cause of percussion problems. This can be easily verified by measuring the voltage on the K terminal of your preamp (blue wire) with the percussion on and the B preset selected. With no keys depressed you should see a positive voltage of 25 to 30 volts. This should go to 0 when any key is pressed. If the voltage is very low or missing, the switch is the problem. Cleaning is the proper cure.

- Select the B preset, turn the percussion to ON, NORMAL, SLOW, SECOND.
- Measure the K terminal with no keys pressed. It should read 25 to 30 volts.
- Now press any upper key and the reading should go to 0. If little or no voltage appears at K with no keys pressed, unsolder the blue wire and measure the voltage again. If you now have 25 - 30 volts or so, then you need to clean the percussion switch.
- Remove the music rack, the two large screws and two wood screws which secure the drawbar base, place heavy paper at either end to avoid scratches and raise the drawbar base 4 to 5 inches.
- Remove the two screws from the percussion switch cover and remove it.
- Spray the interior of the percussion switch housing and contacts with a good non-residual cleaner and retest to see if it works.

As only about 1/2 of the contacts are reachable from the back of the switch, it may be necessary to dismantle the entire switch to get results. This is not a job for the faint of heart. Many foul words have been uttered during re-assembly. Some will advise applying copious amounts of D.C. to burn the offending bits into oblivion. I don't recommend this procedure as severe damage to many components may occur.

1.10.9 How to Eliminate Organ Volume Drop When Percussion VOLUME is Set to NORMAL

The most popular setting for the four percussion switches in the B-3 family of Hammonds is the where all four switches are rocked toward the rear of the console. With this setup the percussion VOLUME switch is in the SOFT position. When this switch is rocked toward the front of the console, the NORMAL position, the volume of the percussion signal increases while the volume of the drawbars signal decreases. A simple modification can be performed that will eliminate the decrease in the drawbar volume, while still allowing the volume of the percussion signal to be increased when the NORMAL/SOFT switch is set to the NORMAL position.

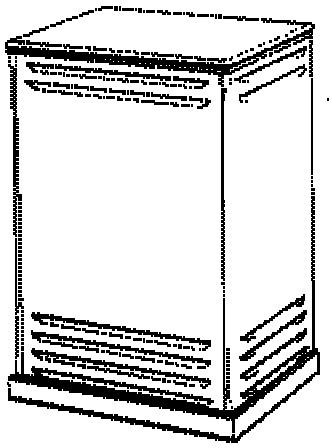
GENERAL TECH TIP [13] -- The percussion drawbar-volume drop, that has been mentioned on the Hammond Technical Mailing list, is inherent in many organs, including ALL B-3, C-3, A-100, and RT-3 organs. To solve this on those models, you can jumper out a resistor on the matching transformer assembly, which is the round metal-enclosed thing mounted on the upper right side of the organ.

- Remove the two screws securing the cover, and notice a group of resistors mounted on a strip on the left side of the matching transformers. The resistor to jumper out is the lowest one on the left. Use a clip jumper first as a test.
- Be sure you understand what this will do before you make any changes! Normally, the percussion volume is increased when the percussion tab is rocked from soft to normal. But... the drawbar (organ) volume is also reduced substantially!
- To test what the jumper change will do before you solder it permanently, turn the percussion ON with the first 4 drawbars out to position 8. Hold a chord, listen for the percussion to decay, then while still holding the chord, rock the Percussion volume (not organ volume) tab from SOFT to NORMAL. Notice that the drawbar volume drops! This is normal in all organs of this type and is considered a serious drawback to professional players. Most play the organ with the percussion tabs "four up" or all four tabs rocked up toward the rear of the organ for this very reason. This mod to eliminate the organ volume drop completely changes the way the organist can use the percussion!
- Once you understand the original percussion situation, try this - add the jumper on the lowest resistor on the left, then hold a chord with the percussion on SOFT, let the percussion decay and

while still holding the chord, rock the Percussion tab to NORMAL. You should now not have a drop in drawbar volume when you switch the percussion volume tab from SOFT to NORMAL.

- There are several ways to modify the percussion even further, but this is the easiest way to get a fatter organ sound with increased percussion volume, and still keep the original SOFT position of the rocker switch volume capability.

2.0 THE LESLIE TONE CABINET "PIPE VOICE OF THE ELECTRIC ORGAN"



The Leslie Rotating Speaker, named after its inventor, Don Leslie, is designed as a sound modification device, not a hi-fi speaker. The pairing of the Leslie Speaker with another device, usually a Hammond organ, constitutes a musical instrument. It operates on a simple principle; a directional sound source rotates at constant (or variable) speed around a fixed pivot point. The effect at the listening location, some distance removed, is quite pronounced. The characterization of a Leslie Speaker in an acoustically reflective listening area is a complicated proposition at best but at least four effects are in operation: amplitude modulation, frequency modulation, timbre shift, and apparent motion of the sound.

Since the sound source is directional, the intensity of the sound to the listener (or microphone) is dependent upon, at least, the angular position of the rotating sound source. The intensity varies as the sound source rotates and the listener perceives a periodic modulation of the sound as a function of the rotational speed. This is the amplitude modulation (AM) component of the sound and when the listening position or microphone is placed closer to the sound source it will, in general, increase the AM component of the sound.

The sound source when rotating is periodically accelerating toward and decelerating away from the position of the listener. This imparts a Doppler shift on the source material and thus a frequency modulation (FM) to the sound. As in other Doppler induced pitch shifts the pitch is perceived to rise as the source moves toward the listener and fall when the source moves away from the listener.

The directional pattern of the rotating component is frequency dependent. High frequencies exhibit more beaming than do lower frequencies, which are emanated in a more omni-directional pattern. A shift in timbre is perceived as the angular position of the sound source changes. The treble component is generally strongest when the rotating component is pointed at the listener and weakest when it is pointed away.

Finally, due to the multiple reflections of the listening area and the rotating sound source, the sound appears to emanate from multiple locations imparting a sense of motion to the sound.

2.1 The Basic Configuration

The Leslie Loudspeakers company produced many configurations of this speaker. Models came with reverberation, two-piece cabinets, tube and solid-state amplifiers, and more. The most popular Leslie Speaker is probably the model 122. The models 122, 142, 145, and 147 all share a similar configuration. A 40-Watt monophonic amplifier drives two transducers, a 15" woofer and a 3/4" throat diameter Jensen compression driver, through a 16 ohm, 800 Hz passive crossover. The stationary compression driver fires

upward into a rotating horn assembly and the stationary woofer fires downward into a rotating drum-like reflector. The rotating assemblies are mechanically belt driven by AC induction motors. In general, two speeds are available, fast and slow.

The usual cabinet has three compartments. The upper compartment houses the rotating treble horn assembly. The middle compartment behaves as a vented enclosure for the woofer, contains the crossover, both drivers, and motors for both rotating assemblies. The lower compartment houses the amplifier and the rotating drum. Louvers are located on the three finished sides for upper and lower compartments.

Two basic sizes of this configuration can be found. The 122 and 147 are 41"H, 20.5"D, 29"W, while the 142 and 145 are 8" shorter. The 122 and 142 have a balanced amplifier input while the 147 and 145 have an un-balanced input. The taller cabinet is said to have a better bass response.

2.1.1 The Treble Rotor

The treble rotor is primarily responsible for the Leslie's sound characteristic. Some organists think that the slower acceleration of the lower drum detracts from the sound and disconnect power to the motors driving the drum.

The compression driver fires into a vertical tube that acts as a thrust bearing for the horn, a twin-bell, conical device molded of black Bakelite. The horn starts vertically and flares horizontally. It is belt-driven by a two-speed, AC induction motor, (actually two motors; one for slow, one for fast). Three drive pulley diameters are provided to vary the rotational speed and an idler pulley is used to maintain belt tension. The treble horn, while appearing to be bi-conical, actually has only one operating side. The other side is plugged and exists to provide dynamic balancing to reduce bearing loads and prevent wobble during operation.

A conical diffuser is located at the mouth of the horn. The diffuser plays a large role in defining the sound of the treble horn assembly; the dispersion pattern of the horn is changed from a single, highly directive lobe, to a more omni-directional, multi-lobed pattern. This complicates the Doppler pattern and with internal reflections of the cabinet considered, provides a more characteristic sound.

In addition to changing the dispersal pattern, the diffuser performs another function. With the diffuser absent, the distance of the apparent sound source from the rotation center varies inversely with frequency. That is, as the frequency goes up, the emanation point of the sound appears to travel back down the horn toward the throat. The effect of this is that the Doppler shift becomes less as the frequency rises and thus there is less FM effect. With the diffuser in, the emanation point for all frequencies is much closer to the same rotational radius. A trade-off can be made between a higher FM component with the diffuser in, and a higher AM component (especially at high frequencies due to the single-lobed beaming), with the diffuser removed. Removing the diffuser is a common modification. Replacement horns can be purchased both with and without the diffuser.

2.1.2 The Bass Rotor

The lower compartment contains a rotating wooden drum beneath the downward-firing woofer. The drum has an open top, straight sides, and a scoop that starts vertically at the top and rear of the drum and ends up horizontal at the bottom and front of the drum. A shaft runs vertically through the drum's rotational axis. The shaft is supported by a lower bearing beneath the drum that is mounted in the bottom of the

cabinet. The upper bearing is mounted in a cross member that is held in place by the secured 15" woofer. The pulley is mounted at the upper end of the shaft between the drum and the woofer.

The primary effect of the bass rotor is to impart AM to the signal. There is very little phase shift of frequencies below 200 Hz due to their wavelength, though some phase shift may occur up around the crossover point of 800 Hz. The result is a low-frequency pulsation or throb that is very effective when used at the slow or chorale speed.

2.1.3 Amplification

The typical unit consists of a 40-Watt monophonic tube amplifier driving the above described components through a 12dB/octave, 800 Hz, 16 ohm crossover. The amplifier uses a pair of 6550s as final amplifiers. The motors that drive each rotor actually consist of a pair of motors, thus four motors exist, each with a pair of wires that plug into the amplifier chassis.

2.2 Leslie Accessories

Combo Pre-amp:

The Leslie Combo Preamp was a chrome wedge shaped box that was designed to be used with the Leslie speakers with the un-balanced input amplifier, i.e. 147, 145, etc.. It has two 1/4" inputs, a fader for each input, a foot-switch mounted top-middle, 115VAC power cord, 6-pin connector for the interconnect cable. These are available used. Aftermarket pre-amps are available that perform the same function as the Combo Preamp but are designed to work with a variety of Leslies: balanced, un-balanced, 6-pin, 9-pin, etc..

Accessory Kits:

Leslies usually need an accessory kit to adapt the balanced or un-balanced Leslie input with the organ, and to provide the switching voltages used to switch Leslie speeds. There are a large variety of kits available. Any competent organ technician should be able to provide you with the correct kit.

Poor-man's Leslie Switch:

With the old brown "half-moon" Leslie switches out of production and getting harder to find, here's a Poor (cheap) Man's Leslie switch for the B3/C3/A100. [(14)]

Remove the lower left black plastic endblock and make a duplicate of it out of wood. The wood should be at least 7/8" thick (and painted black) to match the old block. Save the original plastic endblock for posterity or restoration.

Go to any decent hardware or lighting store and buy a black Leviton "decora" model light switch. It's the nice wide toggle switch that you "push" instead of "flip". Also, buy the matching black plastic face plate. Total cost about $4.50. The face plate is the exact width of the endblock, which works out nicely.

Cut a hole in the wood block, just large enough to mount the switch. Note: while the switch and faceplate are centered on the block, the hole should be offset to the right to match the underside of the wire lugs AND *more importantly* to avoid the portion of the wood block where it attaches to the lower manual. Luckily, Hammond offset the mounting screws to the left. Route the wires through the most inconspicuous location of your choice, but you'll probably have to drill a hole somewhere.

The finished installation looks like part of the organ. You can easily "slap down" on the switch to toggle it, versus "swiping at" the old half-moon style.

You do have to unbolt and tip back the manuals to get at the back mounting screw for the endblock. Although it sounds like major surgery, here's info from an old post by Bob Schleicher. Note, in case you want to mount the switch on the upper left block there are instructions for both.

To remove the upper block:

Remove the music rack (four screws - 2 at each end). Remove the two bolts which secure the drawbar base. Remove the rearmost manual bolts from under the generator shelf. Raise the upper manual carefully and remove the two screws from the block.

To remove a lower block:

Remove music rack as above. Remove all four manual bolts from under the generator shelf. Remove the support bracket(s) between the front rail and the lower keyboard. Raise both manuals and remove bolts from lower cheek block.

2.3 Leslie Modifications

With a Leslie, as with anything else, improvements can be made - or so some people claim. On the other hand, some *other* people claim that they've never heard anything good out of a non-stock Leslie. Leslie modification (and Hammond too for that matter), is a subject that has the potential to generate lots of ire and bile among the devotees. Nonetheless, here are some of the things that can be done to modify or restore a Leslie's sound.

Removing the treble diffuser:

As was mentioned earlier, a common modification is to remove the conical diffuser from both active and dummy horns of the treble rotor. This will cause an increase in the AM component and a decrease in the FM component of the sound. As you can well imagine, there are opinions on both sides of the value of this modification and you might want to listen to one before you hack away. On second thought, a new horn assembly is not too expensive, so you could buy a second stock horn and hack away at the one you own now. That way you'll own one of both.

Stock driver replacements:

Some people feel that nothing but a fresh 40 Watt stock amplifier, a stock Jensen woofer, and a V-21 Jensen horn driver, will deliver *the sound*. Unfortunately, the stock drivers are no longer available new. Don't fret though, there are some good alternatives.

If you just gotta have a stock woofer, then you ought to have no trouble obtaining a reconed P15 or C15 Jensen. A stock V-21 treble driver is another matter however. These are notoriously fragile and since they haven't been manufactured in quite a while, finding a good one is going to be difficult. One thing that is said to approximate the stock driver pretty well is to use the driver currently being sold in new Leslies. This sixteen ohm driver, rated at sixty Watts, is made by Atlas and is slightly brighter than the stock V-21. Its use requires either a new spindle plate or a simple modification to the existing spindle plate. The addition of a 15 ohm non-inductive 10 Watt resistor, wired across the Atlas driver's leads, is said to make them sound quite similar to the Jensen V-21.

If you want to consider non-stock treble drivers, the Atlas model PD-60 and University Sound model EV1829, are said to be good sixteen-ohm replacements. The compression drivers that are normally used to replace the stock unit have a 1-inch throat diameter, with either a threaded or bolt-on mount. These will require an adaptor to allow their use with the treble horn assembly.

Regarding treble drivers, the highest frequency produced by the Hammond is around 6 kHz. Treble drivers used for PA use typically produce usable power to 15 kHz and beyond. Treble drivers with exceptional high-frequency response are probably not required to reproduce an adequate amount of key click and may be un-desirable in this regard. It's really a matter of personal taste.

Amplifier modification:

The stock amplifier produces 40 Watts. It's a great amp and has a terrific sound but it has a tough time competing on stage with a guitar amplifier at full honk. It's not surprising that a common modification consists of some method of achieving higher power. This usually involves replacing the amplifier or else powering the Leslie from an external amplifier. The increase in power will probably require a change in drivers as well. (You probably did that anyway when you blew up the treble driver).

2.4 Leslie Recording Techniques

How do you record a Leslie speaker? How many microphones are used and where are they placed? Everyone seems to have their favorite technique. Just to give you an idea of the range of methods that have been used, here's an excerpt from " Unearthing the Mysteries of the Leslie Cabinet, " by Clifford A. Henricksen.

As with just about anything, recording a Leslie is a matter of particular taste and purpose. You might want record the best possible recreation of a live Hammond B3/Leslie combination; you might also want to make it sound "better". You might also want to use it as send and receive device, like an echo unit, with a high level send to the Leslie Amp, and a mono or stereo microphone receive. You could put it in a studio, in a reverb room (or in the bathroom) during the mix, or you might use it live. The possibilities are only limited by your level of creativity and/or insanity. However, the following are some standard techniques and descriptions of behavior.

Mono Recordings. I have recorded Leslies with a single microphone mounted as close as 1 foot from the treble horn, with very pleasing results. If the mike is placed even closer (within several inches) the severe amplitude-modulation effect becomes very annoying, and wind noise from the rotor at high speeds sounds like you have a helicopter in the room. Which is a sound you might want. The same thing happens on the bass rotor, where up close there is also a lot of mechanical noise. A loose scrim will be real noisy; tighten it up. The sound from both rotors is mellower coming out of the louvers. By removing the back panels and miking the Leslie from the rear, the sound is more "direct" and defined.

Stereo And Multi-Mike Recording. Use of two mikes on the top and bottom of the cabinet is a very effective way of getting a good sound, bearing in mind the AM effects of close-miking. The *best* way I know of recording a Leslie, however, is in stereo. The left and right channels can be recorded with either a top and bottom pair of mixed mikes, or with just single mikes panned between left and right. The stereo image achieved with

two pairs panned full left and right is very exciting. Many combinations are possible though, the point being that a Leslie is capable of providing a great deal of spatial information.

I spoke with a few engineers I know about such recording techniques, and here are a few of their preferences:

Jay Mark *(Sigma sound, New York)* has been pleased with a "tight" or "direct" Leslie sound, when recording organ. His principle reason for this is because the organ is used as background and not a featured instrument; the tight sound is needed so that the organ sound is very clear and unmistakable, even when way down in a mix. Jay has used the following setup with good results: an RCA 77DX ribbon at back of the top rotor cabinet, about 8 inches from the treble horn, with the high-end rolled of to suit. He also uses, at the back of bottom rotor, a U87 with the lows rolled off, and mixed with the top mike to suit. He remembers experimenting with the top and bottom sound panned left and right, and not liking the effect.

Allen Sides *(Ocean Way Recording, Hollywood)* prefers a pair of tube U67s, located about 5 feet away from the Leslie, aimed midway between top and bottom rotors, and spaced 10 feet apart. The mikes are panned left and right, and recorded on two separate tracks. Allen prefers the U67's natural roll-off on the high-end for de-emphasizing the high-frequency distortion on top. He told me of recording Billy Preston, who played a Fender Rhodes electric piano with stereo vibrato, and sent each channel to two separate Leslies.

Joe McSorely *(Veritable Recording, Ardmore, Pennsylvania)* likes to use a pair of U87s mounted relatively close in top and bottom cabinets. For a "tight" organ sound, he rolls of the lows from the bottom rotor, but records the top flat. Joe echoes a repeating problem - wind noise up close - and he always uses windscreens on the mikes. He says that most organ Leslie recordings done at Veritable are on one track, but a great "fake stereo" mixdown effect can be achieved by panning the dry track to one side, and using a Harmonizer in the "doubling" mode on a second track panned full opposite. Joe describes the resultant sound as "monstrous".

2.5 Oiling the Leslie

Tom Tuson, of Hammond Suzuki says: "You only need a drop, a tiny drop at that, about once a year. Remember a little oil goes a long, long, long, long way. DO NOT USE 3 in 1... Call Hammond and order our Leslie oil.... I know of no light oil that you can buy in a hardware store or sewing machine shop that is light enough....."

2.6 One-speed to Two-speed Leslie Conversion

Early model Leslies were equipped with motors which provided only the fast speed. This gave you a choice of tremolo or off. One of the first things often asked by someone that acquires one of these is whether they can be converted to provide the chorale speed as well as tremolo. This modification can be done by either using an electronic speed control, or by modification or replacement of the motors.

The simplest, and probably least expensive way is to use an electronic speed control designed specifically for the purpose. This is an aftermarket kit that installs between the existing motors and the line supply. One such device gates the power to the horn and drum motors providing one or two full cycles of AC out of every eight cycles. These devices are available from at least two suppliers: Goff Professional, and Keyboard Engineering, Inc. (see Suppliers List).

The single speed motors can be modified with the addition of the chorale motor and associated hardware. CAE Sound (see Suppliers List) performs this conversion.

And finally, the motors can be replaced with the dual-motor style motor assembly but the cabinet may have to be modified to accept different motor mounting location. For the adventurous, here is a step-by-step method for doing this: [15]

The following is a step by step procedure to convert a 21H to two speed operation. Other models may vary slightly, but the idea is the same. It took a 2" hole saw, a drill, a router, and about 20 minutes. Don't try this if you are unskilled, or unsure about the proper use of power tools.

Laying the Leslie on it's face will help for part of the procedure, remove the amp first.

1.) Remove the upper motor assembly, including the wooden housing and bolts.

2.) Reinstall the bolts, or replace them with shorter units.

3.) Hang the new upper motor in the same position. If you're salvaging the moter from a Leslie internal module, swap the pulleys and brackets from the two motors.

4.) Optional- make a new box out of 1/4 in. plywood to accommodate the larger motor. This will need longer bolts, or threaded rod and nuts. I skipped this as I couldn't hear any degradation of the Leslie's performance with the box eliminated. YMMV.

Bob Schleicher disagrees with this step, stating:

I don't consider this optional, rather necessary. You are adding a rather large hole to the porting which will de-tune the enclosure and allow low frequencies to enter the upper compartment where they will be modulated somewhat by the horns.

5.) With the Leslie on it's face, remove the lower motor.

6.) Locate the groove for the belt and pulley. Drill a small hole in the center of the pulley area. This will be the starter hole for step 7.

7.) Using a 2 in. hole saw, drill from the top of the shelf into the groove. If you drilled the pilot hole in the right place you should only need to drill down about 3/8 in.

8.) If you are using the two-speed motor from a standard Leslie skip to step 10. If you are using a motor salvaged from an internal Leslie module, go to step 9.

9.)The shafts on the leslie modules were slightly shorter, meaning the belt will rub on the top of the groove. Get thee to a Hardware store for a 1/4 inch spacer, 1/4 inch in length. Also pick up a 1/4 inch

longer screw. Remove the pulley from the two-speed motor, and install the pulley from the single speed motor, with the spacer between the shaft and pulley.

Bob Schleicher adds:

The pulley is a different part number. It has a longer butt just for this reason. The motor shaft lengths are the same.

10.) Because of clearance problems, the lower two-speed motor needs to be turned 180 deg. from the normal 122/147 mounting position. In other words, it needs to have the tension adjustment towards the inside of the cabinet.

11.) Mount the motor from the top of the lower rotor shelf. Set it in place, install the belt, and spin the rotor by hand to check for interference. Reposition the motor as necessary. When you have found the correct position, mark the screw holes and remove the motor.

12.) For the outer screw, drill the hole, and mount the screw and t-nut.

13.) For the inner hole, rout a 1/4 in. groove through the board 1-1/2 in. long in an arc matching the movement of the motor. To mark the groove, temporarily mount the motor on the outer screw, without the belt, and put a pencil through the inner screw hole. move the motor to scribe the arc. Remove the motor.

14.) Using a 1/2 in. router bit, cut a groove along the one you just cut. This lets the mounting washer and nut to drop in, thus allowing the motor mounting plate to fit flush against the baffle.

15.) Mount the motor, and adjust the tension.

For modifications to the amp to allow two speed operation, consult a qualified technician.

To which Bob Schleicher once again adds:

This is much easier than the woodwork. On one speed Leslies the relay supplies 120V to the motors to run and either has an internal brake, or on some models (21-H, later 31-H, 44-W, 46-W) an optional plug-in brake. All that is necessary is to re-wire the relay and outlets to supply 120V to the leftmost socket when the relay is NOT energized and 120V to the rightmost socket when the relay IS energized. The motor leads may either be paralleled and plugged into the two sockets, or you can install a "cube tap" into the sockets and use separate plugs.

2.7 Leslie Rotation Speed

When developing the PRO-3, John Fisher measured his 147. He found that the top rotor had a rotation speed of 400 RPM on Tremolo and 48 RPM on Chorale. This was with the belt in the middle pulley position and with a normal belt tension. The lower drum rotated at about 342 RPM on Tremolo and 40 RPM on Chorale.

3.0 HAMMOND AND LESLIE MODELS

The listing of Hammond and Leslie models is maintained by Bevis Peters and can be found at http://www.phys.ucl.ac.uk/~bp/hammonds/models.html.

http://theatreorgans.com/hammond/faq/models.html

Hammond and Leslie Models - (requires Frames)

Hammond Models - (non Frames)

Leslie Models - (non Frames)

4.0 DETERMINING THE AGE OF A HAMMOND OR LESLIE

This is one of the most commonly asked questions, and unfortunately, due to the lack of available factory records on production dates, one of the most difficult to answer. There is some help available however. The *Hammond Age Determination List,* [16] currently maintained by Rick Prevallet, is an ad hoc effort started by list members expressly for the purpose of helping individuals date their Hammond Organs and Leslie speakers. In addition to dates and model serial numbers, it provides guidelines to determine generally the age of a Hammond, based on certain features and characteristics that changed throughout the model history. Since many of the dates were delivery dates, and organs often sat on dealers showroom floors for years, it is not a definitive reference. But with it you ought to be able to get within a few years of the actual production dates.

5.0 FAQ CONTRIBUTORS

This FAQ was compiled from correspondence that occurred on the Hammond Technical Mailing List and from sources listed in the Hammond-Leslie FAQ Site Bibliography. Many contributions were made. At least the following people made significant contributions. Anyone that feels they have been wrongly omitted from, (or wrongly accused in), the following list please speak up:

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