


# *Leslie*

ORGAN SPEAKER

"PIPE VOICE OF THE  
ELECTRIC ORGAN"

owner's  
manual  
model  
145 & 147

Installation Instructions  
Service Information  
Parts List

electro  music

Pasadena, California

2MU14

## CONTENTS

Amplifier servicing information .....	7
Bass rotor bearings replacement .....	11
Bass rotor removal and replacement .....	11
Bass speaker removal and replacement .....	8
Belt replacement, upper and lower .....	10
Belt tension adjustment .....	9
Broadcasting with the Leslie Speaker .....	4
Chorale .....	1, 3
Connecting cables .....	3
Connecting multiple speakers .....	4
Console connector chassis .....	1
<b>Console load resistor</b> .....	3

### DIAGRAMS & SCHEMATICS

Amplifier .....	6
Cable connections .....	3
Console adapters	
27-5 (Gulbransen and Wurlitzer) .....	5
27-8 (Lowrey) .....	5
27-9 (Utility) .....	5
27-11 (Thomas) .....	5
26-4 (Extra tone cabinet) .....	5
Console connector chassis, No. 26-1 .....	5
Echo (speaker selector) control circuit .....	5
Parts identification chart .....	12
Power relay, No. 5B .....	7
Tremolo control circuit .....	5
Distortion .....	7
Echo (speaker selector) controls .....	1, 4
Electrolytic condensers .....	7
Fuses .....	7

<b>Gulbransen Organs, console adaptation</b> .....	2
Horn reflector replacements .....	9
Idler pulley .....	10
Line voltage .....	7
Load resistor setting .....	3
Load resistor setting in multiple installations .....	4
Loudspeaker system and dividing network .....	8
 <b>Lowrey Organs, console adaptation</b> .....	2

Maintenance, periodic .....	5
Mechanical maintenance .....	9

### MOTORS

Adjustment of small motors .....	9
Cleaning .....	10
Oiling .....	9
Multiple speaker installations .....	4
<b>Oiling</b> .....	5, 9

<b>OTHER ORGANS, installations</b> .....	3
Part list .....	13
Power requirements in multiple speaker installations .....	4
Preparing the Leslie Speaker for use .....	1
Recording with the Leslie Speaker .....	4
Rubber tire replacement .....	10
Screen voltage regulation .....	7
Shipping .....	4
Speaker problems .....	8
Speaker selector (echo) controls .....	1, 4
Specifications .....	1
Technical service information .....	7
<b>Thomas Organs, console adaptation</b> .....	2

Transformer replacement .....	8
Treble rotor removal and replacement .....	11
Treble speaker removal and replacement .....	8

### TREMOLO

Bass rotor removal and replacement .....	11
Brake accessory .....	3
Control operation .....	3
Speed adjustment, treble rotor .....	1
Treble rotor removal and replacement .....	11
Tubes .....	7
Voltage readings .....	8
<b>Volume control setting</b> .....	3
Volume control setting, multiple speakers .....	4
<b>Wurlitzer Organs, console adaptation</b> .....	2

## THE LESLIE ORGAN SPEAKER

### MODELS 145 & 147

These Leslie Speaker models are designed for use with Gulbrandsen, Lowrey, Thomas and Wurlitzer Organs. While the Model 145 was created essentially for use with spinet-type organs, the Model 147 is intended for use with larger organs; its size permits superior reproduction of the 16-foot pedal tones generated by these instruments. Procedures for connecting either of these Leslie models will vary according to the make and model organ which is involved. Detailed installation information is contained in this manual.

The Leslie Speaker is very efficient since it was designed exclusively for organ usage. Treble and bass ranges are handled separately, to achieve the desired frequency response. The unique tremulant in the Leslie results from the use of patented rotary elements. These same elements may also be rotated at a very slow speed, for a contrasting effect known as the "Chorale".

Two controls are normally furnished with the Models 145 and 147:

1. A Speaker Selector switch enables the organist to use either the Leslie Speaker (Echo) or the organ's speaker system (Main), or both together (Ensemble).
2. A Tremolo Control switch, by means of which the rotor may be made to operate at either the fast (Tremolo) speed, or at the slow (Chorale) speed.

### SPECIFICATIONS

**Cabinet:** Selected hardwood veneers with quality lacquer finish in woods and colors to harmonize with organ consoles.

**Dimensions:** Model 145: 33" high, 29" wide, 20½" deep  
Model 147: 41" high, 29" wide, 20½" deep

**Loudspeakers:** Treble—Compression-type driver, permanent magnet, 16 ohms impedance  
Bass—15-inch heavy duty, permanent magnet, 16 ohms impedance

**Electrical:** Operates on 117 Volt, 60 Cycle AC

**Amplifier:** 40 watts output

**Power Consumption:** 190 Watts, 2.1 Amps

**Weight:** 145: 128 pounds net, 144 pounds boxed for shipment  
147: 136 pounds net, 154 pounds boxed for shipment

**Guarantee:** One year from the date of purchase, covering both workmanship and materials. This guarantee does not include vacuum tubes which are guaranteed by their manufacturer, and does not cover belts or speaker cones which may wear out in less than one year due to severe usage.

### PREPARING THE SPEAKER FOR USE

**After unboxing the Leslie Speaker:**

1. Remove the upper and lower compartment back covers; take out the carton containing the connector kit if one is packed within the cabinet.
2. Remove the shipping blocks from the motor assembly, and the rubber bands which hold the upper rotor in position during shipment.

3. Remove the packing strip stapled to the middle compartment back cover.
4. Remove the shipping block from the amplifier in the lower compartment.
5. Make sure the upper belt is in place on the three pulleys—that is, the rotor, idler, and motor pulley.
6. Select the groove in the upper motor pulley which provides the desired tremolo speed. The center groove is the one used most often; faster or slower speeds may be obtained by use of the other pulley grooves.
7. Replace the upper and lower compartment back covers.
8. Remove shipping skid and place the cabinet so that it rests solidly on the floor. If the floor is uneven use snug-fitting wedges to keep the cabinet from rocking.
9. Plug the speaker connecting cable into the Leslie amplifier.

NOTE: Connections at both the speaker and the console should be completed with the organ power turned "Off".

### INSTALLATION PROCEDURES— AT THE CONSOLE

Installation of the Leslie Speaker is a relatively simple process. The first steps are the same for most of the organs with which the speaker is designed to be used. Certain organs, as noted later, are already fully prepared for the Leslie. Except for these particular instruments, however, the following procedure should be used:

#### The Tremolo and Echo Controls

1. Attach tremolo and echo controls to the wooden rail directly in front of the lower manual, choosing the two mounting holes on each control case which best center the wood screws in the rail. Use the screws which are provided. Controls may be grouped together at either end of the rail, or they may be separated, with one at each end.
2. Route the tremolo and echo control cables through openings into the interior of the console. Openings may be found in the bottom side of the lower manuals, on the left-hand side behind the lower manual, or in the corner of the knee panel. If only a "cable-size" hole is provided, cut cables near the plugs, strip ½ inch of insulation from each of the resulting wire ends, pass the wires through the opening, and re-connect using wire nuts. If no openings have been provided, drill a ⅝ inch hole in the shelf under the manual, at a point near the knee panel.

#### The Console Connector

The No. 26-1 Console Connector Chassis should be located inside the organ console at a convenient point, and within reach of the control cables and other connections. Wood screws are provided for fastening the chassis in place. The 6-conductor cable from the Leslie Speaker is also to be connected to this chassis.

Signal and AC power are drawn from the organ through the use of a console adapter. The type adapter to be used, as well as the procedure for installing it, will vary according to the make and model organ involved.



## ADAPTING THE ORGAN FOR THE LESLIE SPEAKER

Procedures for adapting the organ to receive the Leslie Speaker connection will vary according to the make and model of the organ, as described in the following sections.

### **Gulbransen Organs, Models G3-A, H-1, and T-100**

1. Plug the 5-contact socket of the No. 27-6 Console Adapter into the No. 26-1 Chassis.
2. Disconnect the 12-pole plug from the amplifier and connect it to the 12-contact socket of the adapter.
3. Connect the adapter's 12-pole plug to the previously vacated socket on the amplifier.
4. Connect the adapter's AC power cord to the AC outlet on the console amplifier. NOTE: In T-100 installations, AC power is obtained by means of the female socket (furnished with the No. 27-6 adapter) which is to be attached to the console light power supply cord.

### **Gulbransen Organs, other models**

NOTE: This excludes Gulbransen Models J, K, N-1, and N-2, all of which use the Model 101 Speaker, rather than the 145 or 147.

1. Plug the 5-contact socket of the No. 27-5 Console Adapter into the No. 26-1 Chassis.
2. Disconnect the 6-pole console speaker plug from the amplifier and connect it to the 6-contact adapter socket.
3. Connect the adapter's 6-pole plug to the previously vacated console speaker socket on the amplifier.
4. Connect the adapter's AC power cord to the power outlet on the console amplifier.

### **Lowrey Heritage (DSL), Heritage DeLuxe (DSO),**

### **Lincolnwood DeLuxe (SSO-25), Festival (FL), Festival DeLuxe (FLO), Church (CH), Church DeLuxe (CHO), and Coronation (CN)**

These Lowrey models are regularly equipped for the Leslie, and no adapter or connector need be used in making the installation. Controls for the Leslie are already built into the consoles, and a socket is provided for the Leslie cable connections.

### **Lowrey Holiday, Chapel, Brentwood, Heritage and Lincolnwood**

1. Plug the 5-contact socket of the No. 27-8 Console Adapter into the No. 26-1 Chassis.
2. Disconnect the 8-pole console speaker plug from the organ amplifier and plug it into the 8-contact adapter socket.
3. Connect the adapter's 8-pole plug to the previously vacated console speaker socket on the amplifier.
4. Connect the 6-conductor cable to the No. 26-1 Chassis. (Final installation steps are described on page 3.)

### **Lowrey Starlet**

For this model only, use the No. 27-9 Adapter. This adapter has five open leads, each of which is labelled according to its function. Before connecting these be sure to refer to the organ wiring diagram for correct identification of signal and AC power sources.

### **Thomas**

NOTE: The Models 145 and 147 are not usable with all Thomas Organs. Some of the larger instruments require a different type Leslie, as is explained in the organ owner's manual. However, for those Thomas models which do utilize the Leslie 145 or 147, the following instructions apply:

1. Plug the 5-contact socket of the No. 27-11 Console Adapter into the No. 26-1 Chassis.
2. Cut one of the voice coil wires near the speaker terminal. Strip  $\frac{1}{2}$  inch of insulation from each of the two resulting wire ends.
3. Using the wire nuts which are furnished, connect the red adapter wire to the wire (see previous step) leading to the amplifier, and the green adapter wire to the wire leading to the speaker voice coil.
4. Connect the adapter's 5-pole plug to the 5-contact socket on the organ amplifier.
5. Attach the clip-on black wire to the other terminal of the speaker voice coil.
6. Connect the 6-conductor cable to the No. 26-1 Chassis. (Final installation steps described on page 3.)

### **Wurlitzer Models 4100, 4102, and 4460**

1. Plug the 5-contact socket of the No. 27-5 Console Adapter into the No. 26-1 Chassis.
2. Remove the dummy 6-pole plug from the console amplifier and in its place insert the 6-pole adapter plug.
3. Connect the dummy 6-pole plug, removed in the previous step, to the 6-contact adapter socket.
4. Connect the adapter's AC power cord to the power outlet on the console amplifier.
5. Connect the 6-conductor cable to the No. 26-1 Chassis. (Final installation steps are described on page 3.)

### **Wurlitzer Models 44, 4000, 4040, 4200, 4250, 4410, 4420, 4430, and 4602**

1. Plug the 5-contact socket of the No. 27-5 Console Adapter into the No. 26-1 Chassis. NOTE: In the case of the 4430, the No. 26-1 chassis must be mounted on the upper back rail inside of the console — otherwise the control cables will not reach.
2. Disconnect the 6-pole console speaker plug from the amplifier and connect it to the 6-contact adapter socket.
3. Connect the adapter's 6-pole plug to the previously vacated console speaker socket on the amplifier.
4. Connect the adapter's AC power cord to the power outlet on the console amplifier (Do not use blower motor outlet).
5. Connect the 6-conductor cable to the No. 26-1 Chassis. (Final installation steps are described on page 3.)

### **Wurlitzer Models 4600 and 4800**

Special adapters must be used with these models to permit the connection to be made at the console amplifier. These special adapters (to be used with the No. 27-5 Adapter) are not regularly included in the Console Connector kit, but must be obtained separately, as follows:

For 4600, order Leslie Parts Nos. 628-2 and 628-3

For 4800, order Leslie Part No. 628-4

Once the correct adapters have been attached, the remaining steps of the installation are as described previously for the Models 44, 4000, etc.

### Other Organs

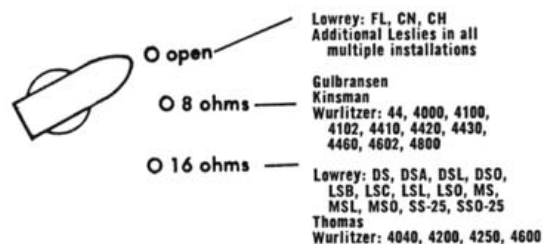
It should not be assumed that the Models 145 and 147 Leslie Speakers can be used with every make or model organ. However, the 145 and 147 are usable with certain organs other than those mentioned above. In most cases it is recommended that the No. 27-9 Adapter be used. This adapter has five open leads, each of which is labelled according to its function. Before connecting these be sure to refer to the organ wiring diagram for correct identification of signal and AC power sources.

## FINAL INSTALLATION STEPS FOR ALL ORGANS

Installation of the Model 145 or 147 Leslie Speaker should be completed by following the procedures described below. These procedures will be identical for all organ makes and models.

### Console Load Resistor Setting

When the Leslie Speaker selector switch is in "Echo" position, the console speaker will be inoperative and the Leslie Speaker alone will be heard. In this situation the organ amplifier is without its normal speaker load. To maintain proper operating conditions a substitute resistor load is provided in the Leslie amplifier. This must be adjusted according to the make and model organ involved, as illustrated in the diagram below. Note that only the first Leslie is to be so adjusted. Additional Leslie Speakers should have the load resistor switch set at OPEN.



### Volume Control Setting

The Leslie amplifier is designed purposely to have more gain than is normally required. Thus, a broad volume range is available. Volume is adjusted on the basis of the console signal output as well as for the particular acoustic environment.

The volume level should be set on the basis of maximum demand, avoiding distortion or overload, as follows:

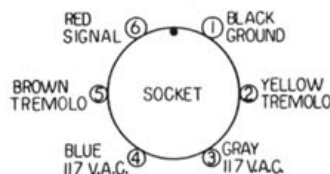
1. Using "full organ" registration, that is, with all stops in use, and with the swell pedal at maximum, play a full chord and a single pedal note.
2. Advance the volume control on the Leslie amplifier from a minimum position up to a point where some distortion can be heard.
3. Back off the volume control setting just far enough to eliminate all the distortion. This then is the correct setting for maximum undistorted loudness, and usually no further adjustment will have to be made. (Distortion, when continuous, can seriously damage speaker components.)

## CONNECTING CABLE

The 6-conductor connecting cable is supplied in a standard 30-foot length complete with plug and socket. This assembly is Leslie Part No. 727.

For longer console-to-speaker runs two or more of these standard 30-foot cable assemblies may be connected together in series.

In certain installations a specific length of cable other than 30 feet is required. In such cases bulk cable should be ordered, along with the necessary connectors, as specified in the parts list. In attaching the connectors to the cable the color coding should be followed exactly, with special care being given to the handling of all connections involving AC. The sketch below shows the color coding.



## THE LESLIE TREMOLO

One of the unique aspects of the Leslie Speaker design is the method for producing tremolo, or tremulant. Two rotating elements within the Leslie cabinet project the sound a full 360 degrees in a manner which results in a realistic acoustic tremolo. This patented system adds important musical values to the tone of any organ, greatly enhancing its performance. As was mentioned earlier, the rotors may be operated at either the regular speed, to produce the Tremolo effect; or, they may be operated at slow speed, for an entirely different type effect, known as the "Chorale".

### Tremolo Control

A switch at the console controls the supply of power to the motors which drive the tremolo rotors. Each motor assembly is a combination of two individual motors. The large motors, actuated whenever the switch is at the "Tremolo" position, drive the rotors at regular tremolo speed. The small motors, actuated whenever the switch is at the "Chorale" position, drive the rotors at slow speed.

The tremolo switch circuitry has no provision for completely stopping the rotors at any time. In switching from fast to slow rotor speed, the small motors function initially as a brake, bringing the rotors down to the slow (CHORALE) speed in just a few seconds. At slow speed, the movement of the rotors is apparent only with very slow sustained playing, where each chord is held for well over a second. In such cases the slow rotor movement provides a very pleasing musical effect. However, in more rapid playing, the movement of the rotor at slow speed is almost imperceptible, thus making it usually unnecessary that the rotor be completely stopped.

### Brake Accessory

Where unusual requirements make it necessary or desirable to stop the rotor, an accessory brake may be added. In most cases the Type 5 Brake should be used. However, with organ consoles having built-in controls for the Leslie, the Type 4 brake should be used. Complete installation instructions are furnished with these brakes.

## MULTIPLE SPEAKER INSTALLATIONS

When a particular installation requires greater volume than can be obtained without distortion from a single Leslie Speaker, additional units may be added. Moreover, even where no additional sound volume is needed, the use of a second Leslie cabinet normally enhances any installation, adding fullness, and still more of a pipe-like quality to the sound. Adding speakers is like adding chests of pipes in a pipe organ: the sound is distributed over a broad area. The effect of "bigness" is most pronounced when the speakers in a multiple installation are separated from each other by fifteen to twenty feet. Also, the selection of a different pulley groove (upper motor) for each speaker provides contrasting tremolo effects, further enhancing the pipe organ effect.

### Connecting Multiple Speakers — the AC Requirement

The several Leslie Speakers that may be used in an installation are connected together in a "chain". The first Leslie is connected to the console, the second Leslie is connected to the first, the third connected to the second, etc., for as many Leslies as may be used in the installation. As a means for connecting the several Leslies together, the 5B Power Relay must be used — one for each Leslie except the first.

Use of the 5B Power Relay is necessitated by the limited amount of external AC power that is available from the organ console. A single Leslie may readily be powered by the console, but for each additional Leslie a separate AC power source must be provided. The 5B Power Relay accomplishes this for the Leslie which it serves, and at the same time keeps this speaker under full on/off control from the organ power switch. Moreover, the 5B Power Relay also provides the connecting socket for the additional speaker. No such socket is provided on the Leslie amplifier because of the previously mentioned console power limitations.

The 5B Power Relay is attached to the amplifier of the Leslie Speaker to which another Leslie is being added. In other words, the relay is connected *ahead* of the speaker which it serves. The relay is connected to the input plug of the Leslie, and the cable from the organ console, or from the previous Leslie, is then connected to the relay. The remaining socket on the relay accommodates the cable which leads to the speaker being added. Finally, the AC cord from the relay is to be connected to a convenient electrical outlet.

Since the several Leslies that may be used in an installation are connected together, they will be controlled together by the speaker selector switch. All the Leslies will be heard whenever the switch is at the "Echo" position, and the console's built-in speaker system will be heard whenever the switch is at the "Main" position. The Leslies, as well as the built-in speaker system will be heard together when the speaker selector switch is at the "Ensemble" position.

### Volume Control Settings on Multiple Speakers

In a multiple installation of Leslie Speakers, the volume control of each one of the speakers should be set according to the instructions given previously. (See page 3.) If the maximum levels thus obtained result in too much overall loudness, further adjustments should be made.

It is most important that a balance be maintained between the several speakers that may be used in an installation. Each speaker should make approximately the same contribution to the total sound; no speaker should be allowed to overpower the others. Time spent in achieving the "right" adjustment for each speaker will greatly improve the final musical results.

### Load Resistor Setting in Multiple Installations

The first Leslie Speaker — the one which is connected directly to the console — should have its load resistor switch set according to instructions previously given (see page 3.) All additional Leslies in a multiple speaker installation should have the load resistor switch set at OPEN.

## SPECIAL USES OF THE LESLIE SPEAKER

### Broadcasting and Recording

To obtain full rich pipe-organ effects, the organ should be played at a fairly high volume, using a live studio. The microphone should be placed ten to fifteen feet away from the Leslie. For a smooth tremulant, adjust the microphone height so that it is either above or below the upper speaker louvers in the cabinet.

### Non-Organ Use of the Leslie Speaker

The Leslie Speaker is a product of superb quality, designed solely and expressly for use with electric organs. It does not function satisfactorily in other applications. The unique musical characteristic of the speaker is the result of electrical and acoustical properties totally different from those found in "high-fidelity" sound equipment. This specialized concept upon which the Leslie Speaker is based restricts its recommended usage to the electric organ.

## SHIPPING

The Leslie Speaker may be moved or carried in any position without special preparation. However, if it is to be shipped, the cabinet should be in an upright position, with shipping blocks in place to protect the motors, rotors, and the power amplifier.



## RECOMMENDED PERIODIC MAINTENANCE

The Leslie Speaker is carefully engineered for durability and minimum service. Lubrication is required only at infrequent intervals, depending on usage and environmental factors, as explained later. Otherwise, except for the periodic checking of several mechanical functions, the Leslie requires very little attention.

### Oiling

The need for motor lubrication will vary considerably since it is related to the amount of usage given the motors, also the environmental conditions under which the Leslie Speaker is used. The usage factor is an obvious one, but the effects of dust and other contaminants should likewise not be overlooked. In "normal" service, motor lubrication once a year is usually sufficient. On the other hand, where the speaker is in use several hours each day, it may be necessary to lubricate motors every three or four months. The exact schedule can only be determined through experience, although the need for lubrication is usually much less than might at first be expected. When the motor bearings have dried out, or the motors are clogged with dust and lint, they may fail to start when power is first applied. This usually

indicates that lubrication is needed; at least the motor assemblies should be carefully checked for this possibility.

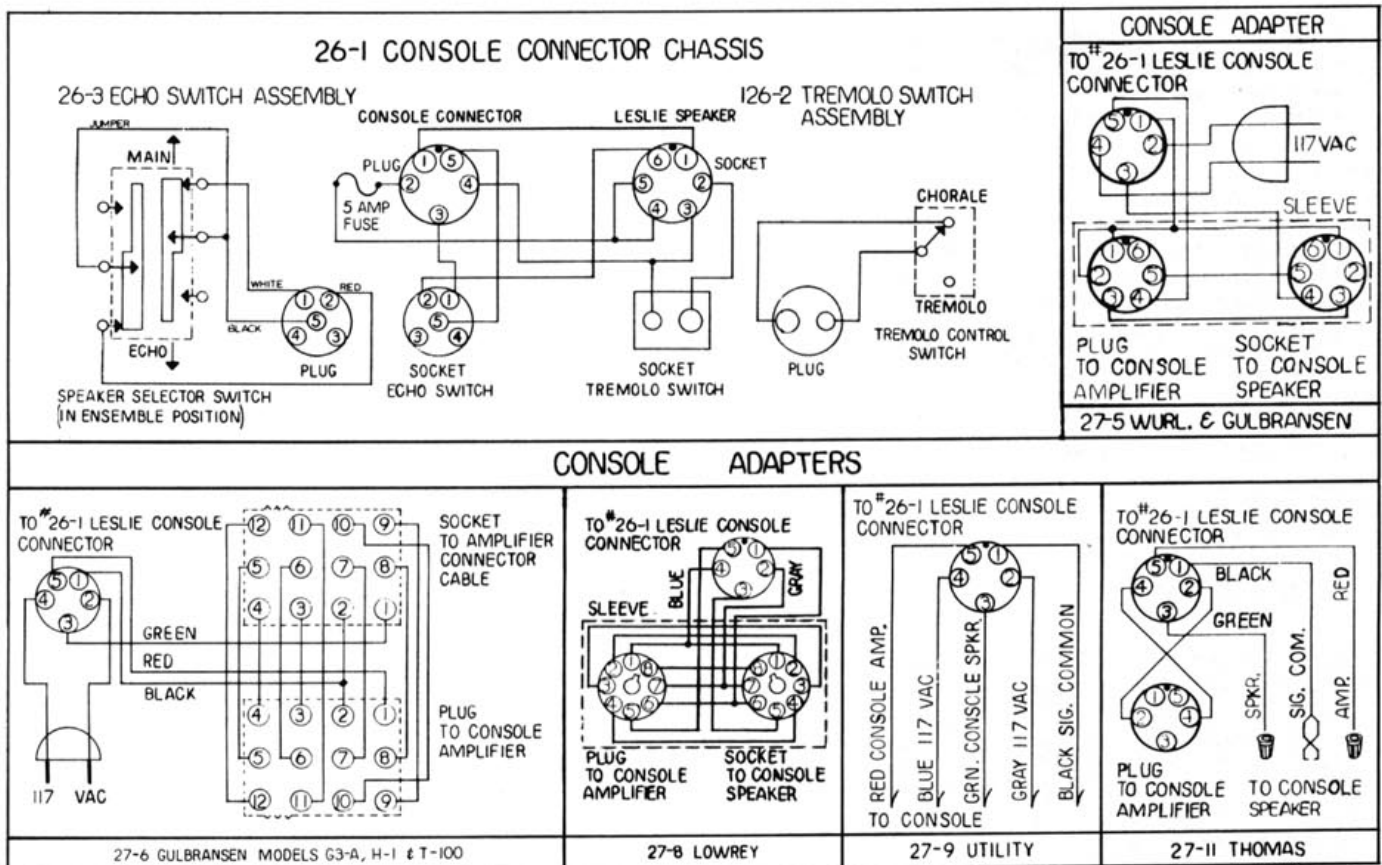
Proper lubrication of the two-speed motor assemblies can only be accomplished by completely removing these assemblies from the Leslie cabinet. Complete lubrication instructions are given elsewhere in this manual. (See "Oiling", page 9.)

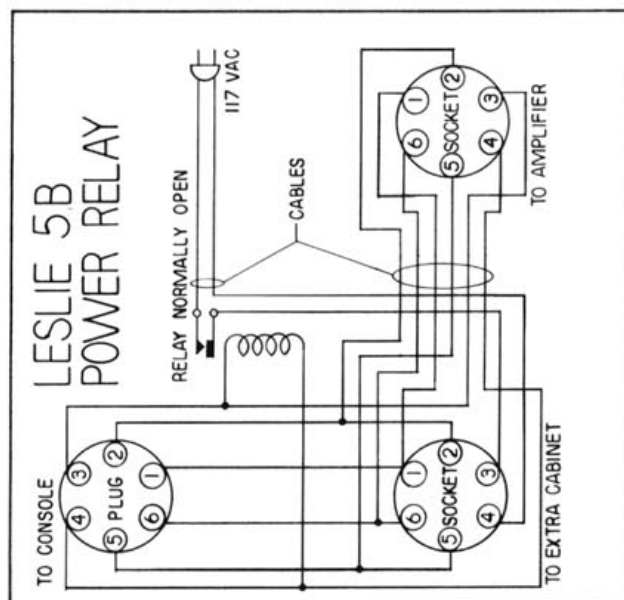
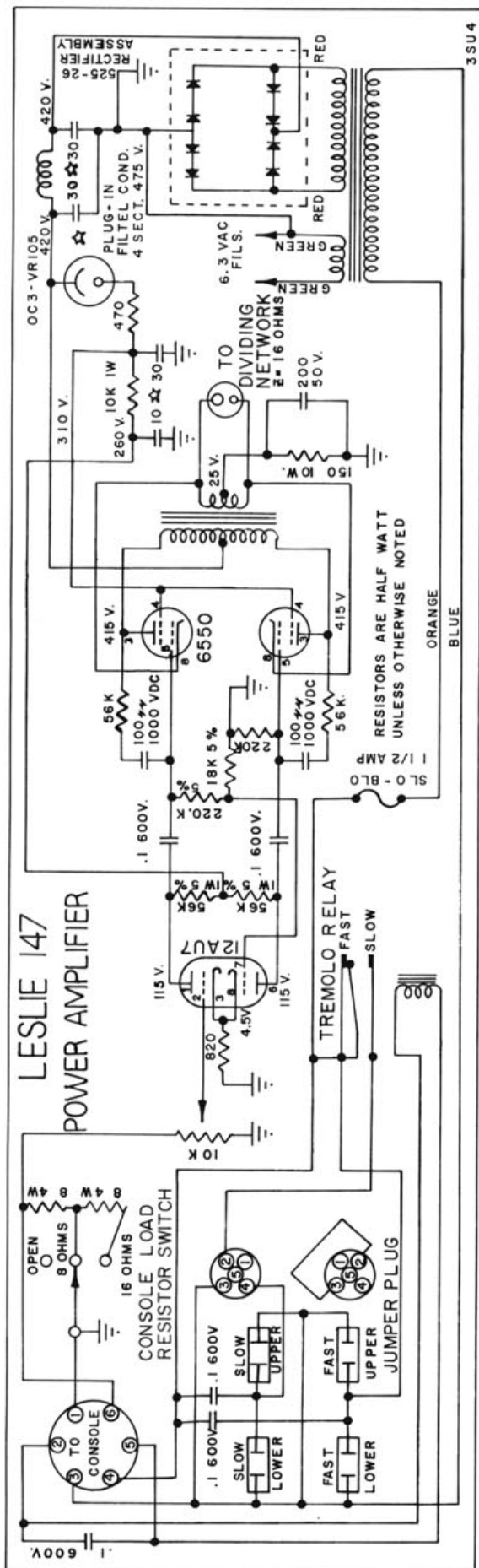
### Belt Life

Although belts normally will last for several years, periodic inspections should be made to determine whether there has been any significant deterioration. A frayed or badly worn belt can cause noise and should be replaced. Instructions are given on page 10 of this manual.

### Tubes

Periodic checks should be made to see that all the tubes are illuminated, and are functioning properly. The weakening of tubes with long use is such a gradual process that the resulting sub-standard performance may not at first be noticed. New tubes will restore the speaker to its original operating efficiency. For best results it is recommended that the tubes be replaced before appreciable deterioration has occurred.







## TECHNICAL SERVICE INFORMATION

Some service procedures involve the making of inspections or certain adjustments in the cabinet's lower compartment, in the area of the spinning rotor. There is an obvious danger of physical injury, as well as the possibility of damaging some of the Leslie components. Care should be exercised accordingly. Also, the connection between the Leslie Speaker and the organ should be made or broken only with the organ's power turned "off".

### Replacement Parts Procurement

Transformers, filter chokes, and tremolo relays should be obtained from the Electro Music factory. Standard type parts such as fuses, sockets, resistors, and condensers can be obtained from radio parts supply stores. The detailed parts list with this manual gives further information.

## THE AMPLIFIER

### Amplifier Removal and Replacement

The amplifier is removed from the cabinet by taking out the one screw which holds the front end of the amplifier to the bottom of the cabinet. After the four motor plugs and the speaker plugs are removed, the amplifier may be withdrawn. When pushing the amplifier back into place, align the back end of the chassis in approximate position so that it will engage the clamp at the back of the cabinet.

### Fuses

The amplifier uses a replaceable "Slo-Blo" 1½ amp. fuse for protection against short circuits. The No. 26-1 Console Connector Chassis uses a replaceable 5 amp. fuse.

When a fuse fails, the cause of failure should be determined and eliminated *before* the fuse is replaced. Replacement fuses of higher than specified rating should never be used.

### Distortion

Distortion frequently is the result of setting the Leslie volume control too high. Extra gain has been designed into the Leslie amplifier in anticipation of possible low output from some consoles. This extra gain must be used with care, as the maximum setting of the Leslie amplifier will usually cause distortion whenever the organ's expression pedal is fully open. Instructions for properly setting the volume control are given in an earlier section of this manual.

### Line Voltage

Line voltage that is lower than 100 volts, or higher than 130 volts, will adversely affect the operation of the amplifier. While the low voltage condition will merely result in poor performance, the high voltage condition will cause overheating and possible component damage. Some sort of voltage-regulating device should be used in those instances where the condition cannot otherwise be eliminated.

Line voltage at the electrical outlet may be in the proper range, and yet read lower at the amplifier. A drop may be due to faulty contacts on the cable, or to a long (extension) power cord, with small gauge wires.

### Screen Voltage Regulation on Power Tubes

The patented screen stabilization circuit used in the Leslie amplifier results in a high level of operating efficiency. This circuit holds the power tube screens at the ideal voltage despite variations in the signal level. Heart of this circuit is the gas regulator tube, which operates in conjunction with the power supply to maintain a constant voltage regardless of current variations. Parts used in this circuit, and their functions, are as follows:

0C3-VR105 Regulator tube provides constant voltage to the power tubes' screens.

470 ohm, ½ watt resistor acts to suppress possible gas tube oscillations caused by variations in screen current. This resistor, whose value is not critical, also acts as a fuse in case of a short circuit in the screen supply.

### Tubes

Tubes are a common source of amplifier difficulties, although it must be recognized that certain malfunctions which might at first appear to be caused by tubes, are actually the result of other conditions.

The tube tester will reveal certain tubes to be defective. However, replacement is also recommended for tubes which have been in service for a considerable period of time, as their performance will have deteriorated and the amplifier will not operate efficiently.

Tubes for replacement purposes may be obtained from local sources. However, for best operating results it is recommended that the 6550 power tubes be replaced as a pair, with units obtained from Electro Music. These tube pairs have been carefully tested and matched for use in the Leslie Speaker.

### Electrolytic Condensers

Practically all modern amplifiers contain electrolytic condensers. These have a definite life expectancy, and must eventually be replaced. The Leslie amplifier uses the finest electrolytic condensers obtainable, these units may be expected to perform satisfactorily for a period of several years.

Most of the electrolytic condensers in the amplifier are contained in a single plug-in unit that can be replaced as easily as a tube. The condenser is a four-section 30-30-30-10 mfd., 475 volt unit.

### Transformer Replacement

If the output transformer should require replacement, the color coding of the lead wires must be carefully followed, so that the replacement transformer will be wired in properly. If leads are in-

correctly connected the phasing will be disturbed, and the amplifier may "oscillate". It is also possible for oscillation to occur even when the color coding is followed exactly in connecting the transformer leads. In such cases the indicated procedure is to reverse the leads from the secondary of the transformer at the point where they are attached to the speaker socket. However, do not disturb the ground or feedback loop connections. Those leads from the transformers which furnish the plate current for the tubes should be as short as possible and should be dressed close to the chassis. Replacement transformers and filter chokes should be obtained from the Electro Music factory.

### Voltage Readings

If the amplifier malfunctions, or fails completely, the tubes and the electrolytic condensers should be checked first. If it appears that the difficulty lies elsewhere, the faulty components may be found by checking the voltages at various points in the amplifier circuitry. Readings should be similar to those shown on the circuit diagram, although reasonable allowances should be made for meter resistance, line voltage variations, and normal tolerances. The voltages in the diagram were obtained by using a 20,000 ohms-per-volt voltmeter. An unusually high or low reading (with respect to voltages shown in the circuit diagram) usually indicates a defective component in that particular part of the circuit.

## LOUDSPEAKER SYSTEM AND DIVIDING NETWORK

The Leslie Speaker uses a full two-way system with two separate loudspeakers. Pedal and midrange tones are generated by a heavy-duty 15-inch speaker with permanent magnet. Its impedance is 16 ohms. Upper middle and highest tones are generated by a compression-type driver unit, also with a permanent magnet. Its impedance is 16 ohms.

The 15-inch speaker is mounted in a matched bass reflex enclosure. It is therefore important that the cabinet back be in place and securely fastened. The high frequency driver is loaded by means of a rotary horn. Only one of the horns in the upper rotor actually radiates sound. The other horn provides dynamic balance which serves to prevent vibration. A small cotton acoustic filter is placed in the throat of the horn. This filter also prevents dust from entering the driver unit, and should not be removed.

The two loudspeakers are connected to the amplifier by means of a two half-section M-derived frequency dividing (crossover) network. This network separates the amplifier output into treble and bass ranges, permitting the correct type signal to be channelled to each of the two loudspeakers. The crossover occurs at 800 cps. The dividing network is built up of durable, stable components, and rarely requires service attention.

### Speaker Problems

Because of the extremely strong permanent magnetic fields in the loudspeakers, it is inadvisable to attempt cone replacements or any other repairs involving disassembly of the speakers. Repairs or replacement of the loudspeakers should be arranged through Electro Music.

Should the treble speaker become inoperative for some reason, emergency operation of the cabinet can be arranged. Unplug the bass speaker from the dividing network and plug it directly into the amplifier output socket. There will, of course, be a loss of musical quality until the complete system is restored.

Suspected low output from the dividing network can also be checked with the above procedure, that is, temporarily bi-passing the dividing network, and plugging the speaker directly into the amplifier.

### Treble Speaker Removal and Replacement

1. Remove the upper back cover and the rotor belt.
2. Remove the center compartment back cover.
3. Remove the treble speaker unit plug from the dividing network.
4. Remove the three screws in the rim of the treble speaker unit, and drop the speaker unit straight down and out of the cabinet. The upper tremulant rotor may be removed, if desired, by turning it sideways.

**IMPORTANT:** When replacing these parts, be sure the rubber and metal thrust washers are on the spindle, so that the tremulant rotor will operate at the correct height, and bass tones will not produce thrust bearing noises. The rubber washer is first placed on the spindle and then the metal washer is placed on top of the rubber washer.

### Bass Speaker Removal and Replacement

Remove the eight mounting screws around the rim of the speaker. Unplug the speaker from the dividing network. Finally, remove the speaker, lifting it straight up, then out of the cabinet, to avoid damaging the cone. Similarly, in replacing the speaker, it should be lowered *straight* down over the large opening in the shelf. Place eight screws in the mounting holes, then tighten them securely. Finally, reconnect the speaker, inserting the plug into the proper socket in the dividing network.

### Horn Reflector Replacements

On a damaged reflector, cut the stand-off pins so they can be pulled out with a pair of slip joint or "gas" pliers.

In assembling the new reflector, make sure it is put on so the cut edge will be at the top of the horn when it is in operating position. To hold the reflector without rattling, use the special cement furnished by Electro Music.

## MECHANICAL MAINTENANCE

### Motors

In order to obtain the desired musical results from the Leslie Speaker, the motors in each of the two motor assemblies must function properly. Mechanical adjustments must be such that the rotors will operate quietly, and at the correct speeds. The motors must also be adequately lubricated, and free from excessive dirt.

#### Belt Tension Adjustment — Lower Rotor only

If the rotor turns too slowly at fast speed the belt is probably too loose; if the rotor is noisy in operation the belt is probably too tight. A properly adjusted belt will slip very slightly when starting, but will be sufficiently tight so as to bring the rotor from full speed to slow speed in about five seconds. Belt tension is related to the position of the motor assembly, and should be adjusted as follows:

1. Loosen the motor-mount wingnut nearest the back of the cabinet.
2. Pull the motor assembly to the left until the belt is taut, but do not force it beyond this point; tighten the wingnut.
3. Test the operation of the rotor, switching the speed control from "Tremolo" to "Chorale", and observing the time interval required for the rotor to reach the slow speed. If the time interval substantially exceeds five seconds, it means that the belt is too loose; if the interval is less than five seconds it means that the belt is probably too tight.
4. Correct the adjustment as necessary, then tighten the wingnut securely in order to maintain the adjustment.

The upper rotor belt has no adjustment provision, since the spring-loaded idler pulley automatically maintains the proper tension. Note, however, that the upper rotor speed may be changed merely by shifting the belt to one of the other grooves of the motor pulley. The middle groove usually provides the ideal speed, but the additional grooves in the motor pulley make two other speeds optionally available.

### Oiling

The motors require little lubrication, and usually only at yearly intervals. The requirement is related to the amount of usage, but other factors can be involved; dust and dirt, for example, can absorb the lubricant, leaving the bearings too dry to operate properly. An oiling schedule can only be worked out through experience with each individual situation. Generally, there is a tendency to over-oil. Thus, all factors should be considered in determining just when lubrication is to be done.

Correct lubrication of either of the two motor assemblies necessitates that it be completely removed from the Leslie cabinet. This may be done quite easily merely by unplugging the motor power plugs and removing the mounting wingnuts. The upper motor assembly can only be removed through the top compartment of the cabinet, and this must be done

with care to avoid damage to the cabinet or to the motor assembly.

Bearings are located inside the two end covers on each of the motors. These are sleeve-type (Oilite) bearings, and each is surrounded by a felt pad which functions as an oil reservoir. Both the bearings in the small motor, and the bearing nearest the drive pulley in the large motor may be oiled without disassembly. The bearing in the large motor nearest the rubber-tired drive wheel, however, is not so readily accessible. Fortunately, this bearing requires less lubrication than any of the other bearings, and thus needs to be oiled only when the motors are completely disassembled for cleaning. See "Motor Cleaning", page 10.

In applying oil, care should be taken to avoid excessive amounts. Each felt pad can absorb an ample, but limited, amount of oil. Once the saturation point has been reached, additional oil will not be held, but will flow out onto the motor shaft, possibly to the pulley and belt, and will impair operation of the motor. Oil holes will be found in the ends of the small motors. Oil should be applied by holding the motor assembly so that the oil will flow *down* through these holes, and onto the felt. Apply one drop at a time. The felt at the end of the large motor nearest the drive pulley is readily visible through the several holes in the motor's cover. A maximum of 10 drops of oil should be applied here. In the event that the regular Leslie oil is not available, any light oil, such as sewing machine oil, may be satisfactorily used.

#### Adjustment of the Small Motors

The small motors drive the rotors at slow speed (Chorale) by means of the rubber-tired drive wheels which actually cause the large motors to turn at a slow speed. The small motor armatures are spring-loaded or gravity-loaded, as necessary, so that they will withdraw from contact with the rubber-tired drive wheel whenever the small motors are off. When the small motors are turned on, magnetic pull moves the armatures into operating position, which automatically brings the ends of the motors' shafts into contact with the rubber-tired drive wheel.

If the end of one of the small motors' shafts does not properly engage the rubber-tired drive wheel, an adjustment should be made. A positioning bolt will be found running through the motor's laminations and the base plate, with holding nuts on both sides of the laminations. First, turn the inside nut (nearest the large motor) so that it moves away from the laminations. Then, with the small motor ON, turn the outside holding nut clockwise until the motor shaft end no longer touches the rubber-tired drive wheel. Next, while holding the rotor so that it cannot move, turn the outside nut just enough to cause the motor pulley to turn under the belt. Avoid excessive pressure on the rubber tire. When the optimum adjustment has been obtained it should be secured by tightening the lower nut firmly against the laminations. Make sure also that the end of the motor shaft is free of oil and dirt.



### Rubber Tire Replacement

A badly worn rubber tire on the slow motor drive wheel will impair operation of the rotor at slow speed, and thus should be replaced. To accomplish this, the entire motor assembly should first be removed from the Leslie cabinet. Then, detach the small motor and its mounting plate (held in place by four screws) so that the drive wheel will be fully accessible. Replace the tire on the wheel, taking care that it is not twisted, but is properly seated in the wheel's outside groove. The molding seam on the tire should be the point of contact with the small motor drive shaft. After making sure that the tire and wheel are free of oil and dirt, replace the motor assembly, and readjust the drive unit according to previous instructions.

### Upper Belt Replacement

Remove the old belt by slipping it off the drive pulley and the idler pulley. Then, lift it up over first one of the horns, then over the other. Prestretch the replacement belt before installation, by pulling it out to full length. Pass the belt over one of the horns, then over the other, and fit it into the groove around the base of the horns. Fit the belt onto the idler pulley, and finally onto the drive pulley.

As was noted previously, the center pulley groove provides the standard tremolo speed, the upper groove provides a slower speed, and the lower groove a faster speed.

### Idler Pulley

The spring mounted idler pulley provides proper belt tension, and in the event the spring mounting becomes bent, it should be readjusted by bending so that it is aligned with the belt.

### Lower Belt Replacement

Unplug the bass speaker at the dividing network. Remove the eight screws around the rim of the speaker, then lift it up from the shelf, and out of the Leslie cabinet.

Pull the exposed rotor support from the shaft. Remove the old belt. Place the new belt on the large pulley and pass the rest of the belt between the rotor and shelf towards the driving motor. Fit the belt onto the motor pulley.

Replace the bearing support on the rotor shaft and position the ends of the support in the shallow locating channels in the shelf adjacent to the speaker opening. Align the holes in the support with the speaker-mount holes in the shelf.

Replace the bass speaker, and partially insert the two mounting screws which also fasten the rotor support in place. Then partially insert the other six mounting screws around the rim of the loudspeaker. Finally, tighten down all eight mounting screws.

Readjust the belt tension according to the instructions given previously. (See "Belt Tension Adjustment", page 9.)

### Motor Cleaning

The motor assemblies should be examined periodically for a possible build-up of lint and dust. Such an accumulation interferes with proper lubrication and ventilation. The condition may occur at frequent intervals, or more rarely, depending upon environmental conditions and usage. A thorough cleaning of the

motors is recommended whenever it appears that their operation is being thus impaired.

The motor assembly should first be removed from the Leslie cabinet. This may be done by disconnecting the motor power plugs from the amplifier, then removing the two mounting wingnuts.

After the motor assembly has been removed from the cabinet it should be disassembled, cleaned, oiled, and reassembled as follows:

1. Detach the small motor from the rest of the assembly by taking out the four screws in the mounting plate.
2. Disassemble the small motor by removing the screws which hold it together. Be sure to note the assembly sequence of the various springs and washers on the motor shaft, so that the motor will be reassembled correctly.
3. Remove the large pulley (with rubber tire) from one end of the large motor's shaft, then the pulley and the pulley support ring.
4. Note or mark the position of the large motor's end covers in relation to its laminations; this is important for correct reassembly of the motor. Remove the four screws holding the end covers, and disassemble the motor.
5. Clean the moving parts of both motors with solvent, and allow them to dry.
6. Oil the felt pads inside the end covers of each motor, avoiding excess oil which cannot be absorbed by the pads.
7. Reassemble both motors, and the entire motor assembly.
8. Check the operation of the large motor; undue noise could indicate that one or both of the bearings is not properly seated. In such cases, tap the side of the motor with a fairly heavy tool and the bearings will assume the correct alignment.
9. Adjust the positioning of the small motor according to instructions given previously (See "Adjustment of the Small Motor").
10. Check the position of the rubber-tired drive wheel in relation to the end of the small motor shaft. With both motors off, push the small motor's armature in until the round end of the shaft just touches the rubber tire. This point should be about midway in the armature's total travel. Adjust the rubber-tired drive wheel on the large motor shaft as may be necessary in order to achieve this condition.
11. Replace the motor assembly in the cabinet, fasten it in place with the two mounting wing nuts, and position the drive belt in the motor pulley groove.
12. Connect the motor power plugs to the amplifier, using the designated sockets.
13. Check all functions of the motor assembly, observing as operation is switched between fast and slow speeds.

14. Check starting time in the case of the lower rotor, also the length of time required to change from fast to slow speed. Adjust the belt tension as needed to achieve the desired performance. (See "Belt Tension Adjustment", page 9.)

#### **Treble Rotor Removal and Replacement**

1. Remove the upper back cover and the rotor belt.
2. Remove the center compartment back cover.
3. Remove the treble speaker unit plug from the dividing network.
4. Remove the three screws in the rim of the treble speaker unit, and drop the speaker unit straight down and out of the cabinet. The tremulant rotor may now be removed by turning it sideways.

**IMPORTANT:** When replacing these parts, be sure the rubber and metal thrust washers are on the spindle, so that the tremulant rotor will operate at the correct height, and bass tones will not produce thrust bearing noises. The rubber washer is first placed on the spindle then the metal washer is placed on top of the rubber washer.

#### **Bass Rotor, Upper Bearing Replacement**

1. Remove bass speaker.
2. Remove top half of bearing clamp. The ball bearing can now be lifted out and replaced.

After the bearing clamp nuts are tightened, if the new bearing is found to be slightly loose, remove the bearing support assembly from the cabinet. Disassemble, and bend the lower half of the bearing clamp so it will apply more pressure to the ball bearing.

#### **Bass Rotor, Lower Bearing Replacement**

1. Lay cabinet on floor so that bottom is accessible.
2. Remove the two screws that fasten the bearing mounting plate to the cabinet, and entire bearing assembly can be pulled from the shaft. Be sure to

save the flat metal washer between the rotor and lower bearing grommets. It is important that this washer be in place when bearing is reassembled.

3. Remove the top half of bearing clamp to replace the ball bearing assembly.
4. Upon reassembly of bearing holder to rotor shaft make certain the flat washer is included between the rotor and bearing grommets.

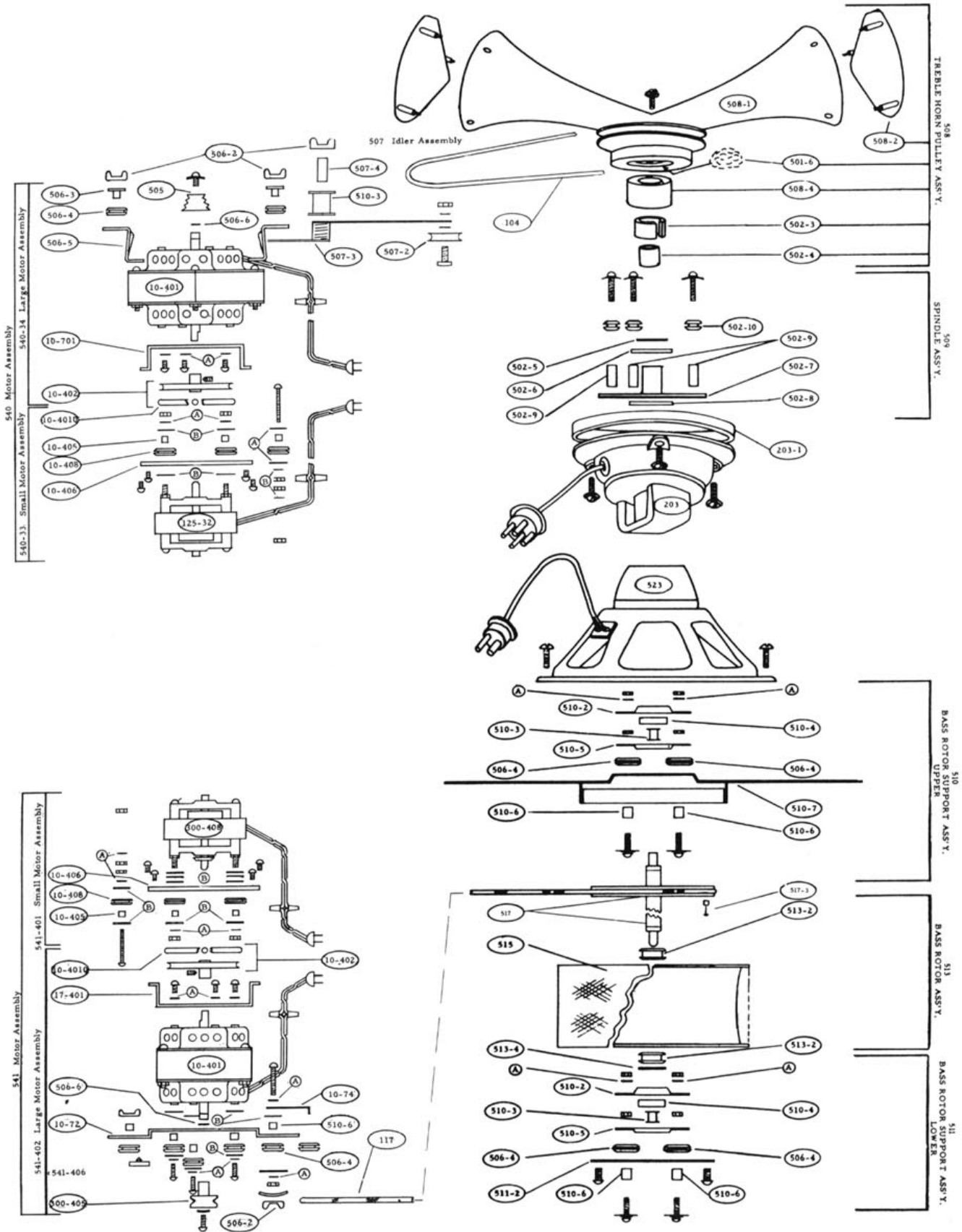
#### **Bass Tremulant Rotor Removal and Replacement**

1. Remove bass speaker.
2. Remove upper bearing support and belt.
3. Using the large pulley as a handle, remove the tremulant rotor shaft by twisting and pulling up at the same time. The tremulant rotor then will be freed to be removed towards the back of the cabinet. Be sure to save the metal flat washer found between the bearing and rotor grommets.
4. Replace the tremulant rotor with the concave surface of the deflector facing upwards. (The brace for the deflector will be underneath). Make certain the flat metal washer is in place between the bearing and bottom rotor grommets. When replacing the rotor shaft on the rotor, a little oil or Vaseline may be used as a lubricant. Grommets are made of Neoprene and will not be damaged by such lubricants.

When inserting the shaft and pulley assembly be sure that the two drive pins, located on the pulley, straddle the rotor spoke which is supported by the curved sound deflector. When inserting the shaft, hold the rotor in a position that will allow the lower shaft end to enter the bearing grommet without displacing the flat metal washer between the bearing and rotor grommets.

To simplify the alignment of the shaft with the lower bearing, it may be easier to place the cabinet on the floor and remove the lower bearing assembly as in replacing the lower bearing. Also, in this way, it can be determined that the washer (between the bearing and rotor grommets) is properly in place.

# LESLIE SPEAKER PARTS IDENTIFICATION CHART





## PARTS LIST

TO AVOID ERRORS, orders should include serial number of the Leslie Speaker on which parts will be used. ALSO, PARTS SHOULD BE ORDERED BY NUMBER. Be sure to state color when ordering switch cases or complete switch assemblies. Sockets, connectors, and standard value components (resistors, condensers) are available through local electronic supply houses. Most of the "hardware" items (bolts, nuts, screws) are also locally available. Parts listed below are mainly non-standard items, or components with close tolerances which should be obtained from Electro Music.

### EQUIPMENT USED AT ORGAN CONSOLES

#### Part No.

- 126 **Console Connector Kit, complete**  
(Includes connector chassis, tremolo and echo controls, 727 cable assembly, and specified console adapter)
- 26-1 Console connector chassis, complete
- 126-2 Tremolo switch with plastic case and knob, with cable attached. Case colors: brown, ivory, ebony
- 429-1 Switch only
- 122-3 Case with cover, plastic, brown
- 122-4 Case with cover, plastic, ivory
- 122-5 Case with cover, plastic, ebony
- 428-6 Knob, push-on, for switch, brown
- 428-7 Knob, push-on, for switch, ebony
- 428-10 Retainer, for switch (2 used)
- 26-3 Echo switch with plastic case and knob, with cable attached. Case colors: brown, ivory, ebony
- 3H-5 Switch only
- 3H-2 Case with cover, plastic, brown
- 3H-3 Case with cover, plastic, ivory
- 3H-4 Case with cover, plastic, ebony
- 428-6 Knob, push-on, for switch, brown
- 428-11 Retainer, for switch (2 used)
- 727 Cable assembly, 6-conductor, 30-foot length, with connector plugs installed
- 27-5 Console adapter—for Gulbrandsen and Wurlitzer
- 27-6 Console adapter—for Gulbrandsen Models G3-A, H-1, and T-100
- 27-8 Console adapter—for Lowrey
- 27-9 Console adapter—utility (open leads)
- 27-11 Console adapter—for Thomas

#### INSTALLATION ACCESSORIES

- 727 Cable assembly, 6-conductor, 30-foot length, with connector plugs installed
- 727-1 Six-conductor bulk cable, less connectors, to specified lengths
- 727-2 Six-pole plug and cap, for 727-1 cable
- 727-3 Six-contact socket and cap, for 727-1 cable
- 5B Power relay, for multiple speaker installations
- 4600 Console adapter for Wurlitzer 4600
- 628-2 Adapter, 4 to 6
- 628-3 Adapter, 6 to 4
- 628-4 Adapter, 4 to 6 and 6 to 4, for Wurlitzer 4800
- 26-4 Extra tone cabinet adapter

### PARTS FOR THE LESLIE SPEAKER

#### 147

#### Power Amplifier, complete

- 525-7 Bushing, metal (4 used)
- 510-6 Bushing, relay mounting
- 525-6 Bushing, rubber, shoulder (4 used)
- 525-11 Choke, filter
- 525-20 Condenser, bias, 200 mfd., 50 volts
- 725-15 Condenser, filter, plug-in type, 30-30-30-10 mfd., 475 volt
- 625-18 Control, volume, 10,000 ohms
- 525-17 Fuse holder
- 502-10 Grommet, neoprene, relay mount
- 525-5 Mounting strip, chassis (2 used)
- 525-26 Rectifier assembly, complete
- 525-212 Diode, 800 volt, 1 amp (4 used)
- 625-12 Relay
- 525-19 Resistor, bias, 150 ohms, 10 watt
- 525-21 Socket, filter condenser
- 525-13 Socket, motor outlet (4 used)
- 730-3 Socket, speaker
- 625-13 Switch, console load resistor
- 525-10 Transformer, output
- 122-12 Transformer, power

#### 508

#### Treble Horn-Pulley Assembly

- 502-4 Bearing insert, oilite
- 501-6 Filter, cotton
- 508-1 Horn-pulley, moulding only
- 508-4 Housing, for bearing
- 502-3 Pad, felt, oil reservoir
- 508-2 Reflectors, for horn (2 used)

#### 509

#### Spindle Assembly

- 502-10 Grommet, neoprene (3 used)
- 502-9 Spacer, spindle mounting (3 used)
- 502-7 Spindle without mounting plate
- 502-8 Washer, rubber, spacing, 3/8" hole
- 502-5 Washer, metal, thrust
- 502-6 Washer, rubber, thrust, 1-1/16" hole

#### 203

#### Treble Speaker Unit

- 203-1 Ring, fibre, spacer

#### 104

#### Treble Rotor Belt

#### 507

#### Idler Pulley Assembly, Treble Rotor

- 507-4 Bushing, metal
- 510-3 Grommet, rubber
- 507-2 Pulley with bearing
- 507-3 Spring

- 540 **Motor Assembly, Two-speed, Upper**  
 540-34 Motor assembly, large, fast-speed drive  
 506-5 Bracket, motor mount (2 used)  
 10-701 Bracket, slow-speed motor mount  
 506-3 Bushing, shoulder, metal (2 used)  
 506-4 Grommet, neoprene (2 used)  
 10-401 Motor only  
 505 Pulley, three-step, rotor drive  
 10-402 Drive wheel, complete  
 10-4010 Tire, neoprene  
 506-6 Ring, pulley support  
 540-33 Motor assembly, small, slow-speed drive  
 10-405 Bushing, metal, for grommet (3 used)  
 10-408 Grommet, neoprene (3 used)  
 125-32 Motor only  
 10-406 Mounting plate, for motor

- 523 **PM Bass Speaker**  
 Note: Replacement cones are not available. Rebuilding service available at Electro Music

- 541 **Motor Assembly, Two-speed, Lower**  
 541-402 Motor assembly, large, fast-speed drive  
 10-72 Bracket, motor mount  
 17-401 Bracket, slow-speed motor mount  
 541-406 Bumper, rubber  
 510-6 Bushing, for grommet, metal (5 used)  
 506-4 Grommet, neoprene (6 used)  
 10-74 Locking lever  
 10-401 Motor only  
 300-405 Pulley, rotor drive  
 10-402 Drive wheel, complete  
 10-4010 Tire, neoprene  
 506-6 Ring, pulley support  
 541-401 Motor assembly, small, slow-speed drive  
 10-405 Bushing, for grommet, metal (3 used)  
 10-408 Grommet, neoprene (3 used)  
 300-408 Motor only, complete  
 10-406 Mounting plate, for motor

- 510 **Bass Rotor Support Assembly, Upper**  
 510-4 Bearing  
 510-6 Bushing, metal (2 used)  
 510-5 Clamp, for bearing, lower half  
 510-2 Clamp, for bearing, upper half  
 510-7 Crossbar support  
 510-3 Grommet, for bearing  
 506-4 Grommet, for bearing clamp assembly (2 used)  
 513 **Bass Rotor (complete, but less cover)**  
 513-2 Grommet, for ends, rubber (2 used)  
 513-3 Grommet, center, rubber  
 513-4 Washer, metal

- 517 **Bass Rotor Shaft and Pulley**  
 517-3 Drive pin with bushing  
 117 **Bass Rotor Belt**  
 515 **Bass Rotor Cloth Cover**  
 511 **Bass Rotor Support Assembly, Lower**  
 510-4 Bearing  
 510-6 Bushing, metal (2 used)  
 510-5 Clamp, for bearing, lower half  
 510-2 Clamp, for bearing, upper half  
 510-3 Grommet, for bearing  
 506-4 Grommet, for bearing clamp assembly (2 used)  
 511-2 Mounting plate, for bearing clamp assembly  
 528 **Dividing Network, Complete**

#### MISCELLANEOUS PARTS

- 525-8 Bracket, amplifier hold-down  
 526-21 Cover, for back of cabinet, lower compartment  
 526-19 Cover, for back of cabinet, upper compartment  
 530 Oil, lubricating, in container

#### MISCELLANEOUS SCREWS & HARDWARE

Thread and length	Quantity	Usage
6-32 x $\frac{3}{8}$ " self-tap	2	Bottom covers, control cases
8-32 x $\frac{3}{8}$ " w/washer	1	Motor pulley mount—upper motor
8-32 x $\frac{3}{8}$ " w/washer	3	Attaches large motor to mounting plate—lower motor assembly
10-24 x $1\frac{1}{2}$ "	3	Motor mount
10-24 x $1\frac{1}{2}$ " w/flat washer	13	Fasten backs to cabinet
10-24 x $2\frac{3}{4}$ "	2	Fasten dividing network to shelf
10-24 wingnut	4	Upper mount mount (2), lower motor mount (1), Idler pulley assembly
10-24 "T" nut		Used throughout cabinet
#6 x $\frac{1}{4}$ " sheet metal	8	Fastens small motor assembly to large motor assembly
#6x $2\frac{1}{4}$ " machine	2	Small motor adjustment
#8 x $\frac{3}{8}$ " sheet metal		Parts assembly
#8 lockwasher	1	Used under screw for holding motor pulley on lower motor assembly
$\frac{1}{4}$ " dome-toothed periphery lockwasher	1	Under motor adjustment wingnut, lower motor assembly



LITHO IN U.S.A.

