

FIGURE 3. BLOCK DIAGRAM

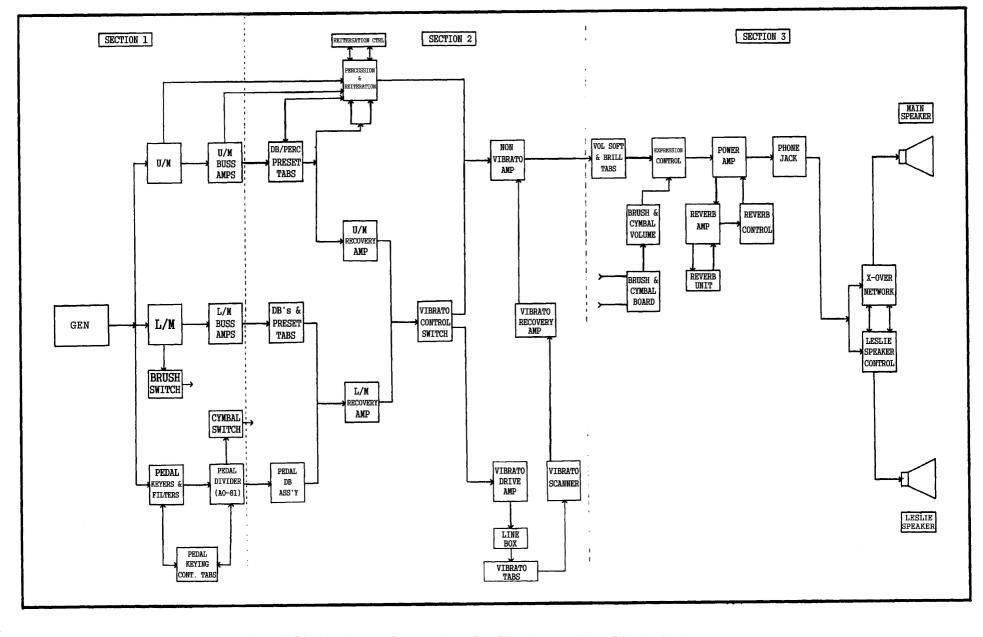


FIGURE 3. BLOCK DIAGRAM

THE HAMMOND ORGAN
SERVICE INFORMATION
T-100 T-200 SERIES



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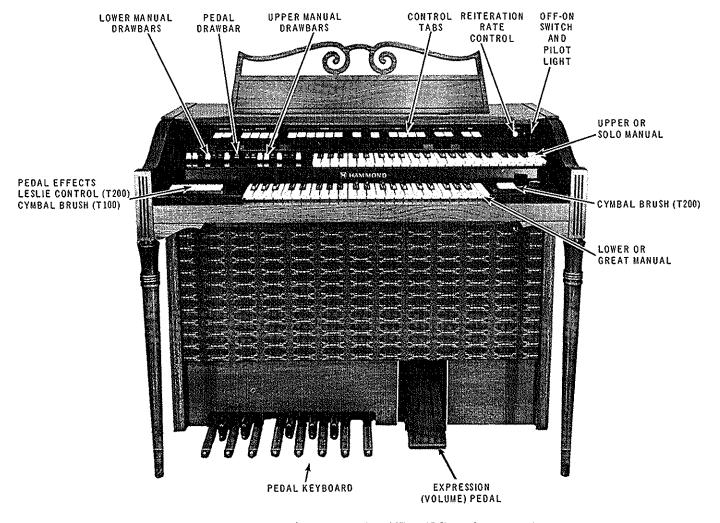


FIGURE 1. TYPICAL T-200 SERIES INSTRUMENT

#### **SPECIFICATIONS**

Cabinet Size 45" Wide, 25" Deep, 44-1/2" High with Music Rack

Weight with Bench T100 - 215 lbs. Weight with Bench T200 - 235 lbs. Power Input T100 - 0.7 amps. Power Input T200 - 1.2 amps. Music Power Output - 34 watts (Per EIA Standards - RS-234)

#### GENERAL DESCRIPTION

T-100 - T-200 Series

NOTE: The T-100 and T-200 series are electrically identical, however, the Leslie unit is omitted in the T-100 series and the brush & cymbal controls are located on the left-hand end block.

The Hammond "T" series organ is a completely self-contained console, requiring no external tone cabinet. It has two manuals-or keyboards-of 44 keys each, a 13-note pedal keyboard, and an expression (or swell) pedal for controlling the volume. All tones are produced by electro-magnetic tone generators and electrically amplified, as in other models of the Hammond organ. Selection of tone colors is made by adjusting 17 drawbars and 6 preset tabs. Other variations of the music are controlled by other tablets and knobs. A switch on the right turns on the instrument, the self-starting motor and amplifiers. A pilot light shows when the instrument is in operation.

Figure 1 shows the front view of a typical console, and Figure 2 shows a rear view, with rear panel removed.

#### INSTALLATION AND MAINTENANCE

The generator is permanently mounted and requires no loosening of shipping bolts.

The organ should be oiled yearly, using only oil supplied with it, as directed on the oiling plate on the rear cover.

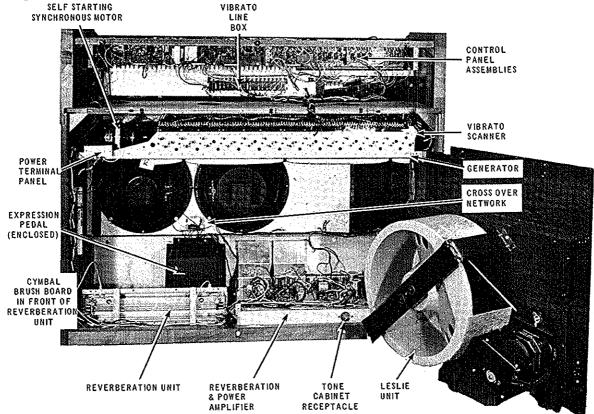


FIGURE 2. BACK VIEW OF CONSOLE REAR COVER REMOVED

#### MUSICAL TERMS

Service personnel and others who have had no musical training will find the following information helpful in studying the operation of the organ.

#### NOTES AND OCTAVES

Keyboard instruments are divided into "octaves" of 12 keys or notes, each with 7 "naturals" (white keys) and 5 "sharps" or "flats" (black keys) in a definite sequence. Black keys occur in groups of two and three in each octave and offer a convenient way to identify the notes of the octave. Technically, there is no difference between a black key and a white one, since each key has a frequency 1.059 times the frequency of the next one below it.

Each note has a frequency exactly one-half that of the corresponding note in the next higher octave. Each white key is called by a letter A to G and these letters are known as "notes of the musical scale." A black key may be called a "sharp" of the note below it or a "flat" of the note above it; for instance, the black key between C and D may properly be called C# (C sharp) or Db (D flat).

#### HARMONICS OR OVERTONES

Any musical note has a definite fundamental pitch or frequency and also a certain "tone quality" or "timbre", depending upon its wave shape. A complex note is one which includes not only a fundamental frequency but also one or more "harmonics" or "overtones", each of which is an integral multiple of the fundamental frequency. Such a combination is more pleasing musically than a note having only a single frequency. The ear does not distinguish the harmonics independently, but instead identifies the note as a complex tone having the pitch of the lowest component, or fundamental.

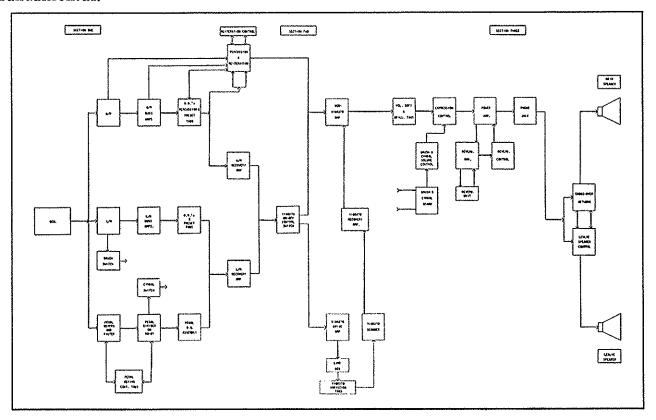


FIGURE 3. BLOCK DIAGRAM

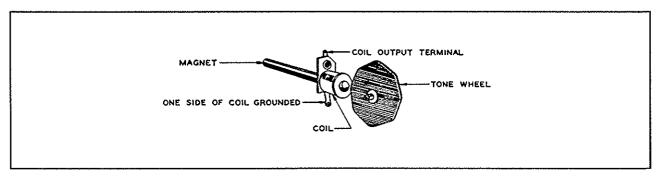


FIGURE 4. TYPICAL TONE GENERATOR

#### HOW THE ORGAN WORKS

Most tone sources, such as strings, reeds, or pipes, produce complex tones. The Hammond tone-producing mechanism, however, generates individual frequencies which can be combined by means of harmonic drawbars to produce any desired tone quality. The block diagram, figure 3, shows the chief components of the instrument.

Electrical impulses of various frequencies are produced in the "tone generator assembly" which contains a number of "tone wheels" driven at predetermined speeds by a motor and gear arrangement. Each tone wheel is a steel disc similar to a gear, with high and low spots, or teeth, on its edge. (See Figure 4) As the wheel rotates, these teeth pass near a permanent magnet, and the resulting variations in the magnetic field induce a voltage in a coil wound on the magnet. This small voltage, when suitably filtered, produces one note of the musical scale, its pitch or frequency depending on the number of teeth passing the magnet each second.

A note played on either manual of the organ consists of a fundamental pitch and a number of harmonics, or multiples of the fundamental frequency. The fundamental and harmonics available on each playing key are controlled by means of drawbars. By suitable adjustment of these controls the player may vary the tone colors at will. Several pre-selected tones are also available by use of the preset tabs.

Mixed tones from either the upper manual or the lower manual may go through either the "vibrato" channel or the "non vibrato" channel, depending on the position of the corresponding "Vibrato Cancel" tabs. The tones are then combined and pass through the expression control and additional stages of amplification before reaching the speakers.

Percussion tones are available by depressing independently, or in multiple, any of the 6 Percussion tablets, with upper manual Percussion tab depressed. Reiteration can be added to any of the percussion voices. Twin Mallet or alternating reiteration will be observed on the Xylophone and Marimba voices. Percussion rate can be controlled by the knobs so indicated.

Cymbal and Brush are also available, the Brush on the lower manual and Cymbal on the pedal; a separate knob controls the loudness of these trap effects. Both the percussion and traps are legato keyed. On the T-200 series instrument separate tablets control the Leslie effects.

Pedal tones are available in either 16' or 8' pitches when the pedal drawbar is pulled out. Separate tablets make pitch selection available, as well as pedal sustain and legato.

#### CONSTRUCTION AND OPERATION OF COMPONENTS

In studying this section, refer to schematic circuit of the entire organ, Figure 21. Connections between components are shown in the wiring diagram, Figures 22, 23, and 24.

#### MOTOR AND POWER SWITCH

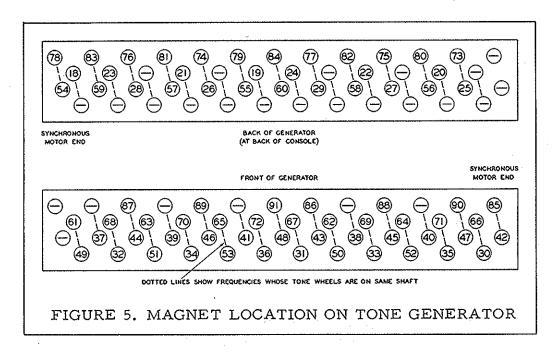
The tone generator assembly, in which all tones of the organ originate, is driven at constant speed by a synchronous motor, located at the left side as you look in at the back of the console (Figure 2). The entire instrument, generator and amplifier are turned on by raising the "Off-On" switch to "On".

#### TONE GENERATOR

All tones of the organ originate as electrical signals in the tone generator assembly. It contains 74 tone wheels having various numbers of teeth, with suitable gears for driving them at various speeds from a main shaft extending along the center. Each pair of tone wheels is mounted on a shaft and between them is a bakelite gear held by a coil spring, forming a mechanical vibration filter. As the gear is not rigidly attached to the shaft, any pair of wheels which may be stopped accidentally will not interfere with the operation of the others.

Adjacent to each tone wheel is a magnetized rod with a pick-up coil wound on it. These magnets extend through the front and back of the generator, and are held by set screws which can be loosened in case adjustment is ever necessary. Figure 5 shows where to find the magnet for any frequency number. In this drawing the dotted lines indicate frequencies whose tone wheels are on the same shaft.

On top of the tone generator assembly are small transformers and condensers, forming tuned filters for the higher frequencies. They are not likely to need replacing. In case one filter becomes inoperative, both the transformer and condenser must be replaced with a matched set from the factory. Figure 6 shows the location of these filters.



The output frequencies of the tone generator are numbered, for convenience, in order of increasing frequency. The lowest, number 18, is about 87 cycles per second, and the highest, number 91, is about 6000 cycles per second. Figure 21 shows typical tuned tone generators.

The output terminals of the generator consist of solder lugs mounted on the back edge of the generator. Figure 6 shows the terminations by frequency number.

#### MANUALS

Musical frequencies from the tone generator go through the manual cable to terminal strips on the two manuals and from them to the key contact springs.

Each of the two manuals has 44 playing keys, or approximately 3-1/2 octaves. The two manuals do not cover exactly the same pitch range, but they are arranged so that keys of like pitch are in line. Middle "C" is the first C on the upper manual and the key in line with it on the lower manual.

Under each key are a number of contact springs (for the fundamental and harmonics of that key) which touch an equal number of bus bars when the key is pressed. (Some keys at the right end of each manual have fewer springs, as noted below). All contact springs and bus bars have precious metal contact surfaces to avoid corrosion, and the manuals are sealed to exclude dust so far as possible. In case a contact becomes dirty in spite of these precautions, a bus bar shifter is provided in each manual to slide the bus bars endwise and thus provide a fresh contact surface.

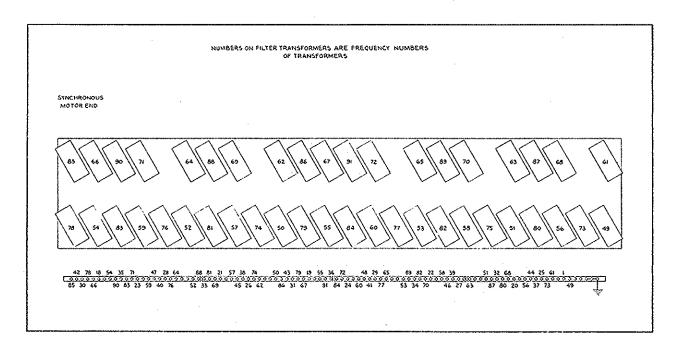


FIGURE 6. GENERATOR COVER, SHOWING FILTER LOCATION AND TERMINATIONS OF FREQUENCIES.

The busbar shifting mechanism for the lower manual will be found by looking on the underside left-hand end of the manual. A black wood end block will be observed. One-half inch from the front of this block is a drilled hole. Within this drilling is a small metal tongue with a punched hole. Using either long nose pliers, or a hook, this tongue can be moved in and out and it in turn moves the busbars. The upper manual shifter is in a similar place but requires removal of the back to gain access to it.

The key contacts are connected through resistance wires to the manual terminal strips. The manual wiring chart, Figure 7, shows how the contacts of each key are connected to the proper frequencies to supply the fundamental and harmonics of that particular key. The blank spaces indicate that no key contact is used, inasmuch as the highest harmonics of the highest keys are above the range of the tone generator and are not required.

The busbars of each manual, each one carrying a certain harmonic, are fed to bus amplifiers, then to the harmonic drawbars for that manual.

#### HARMONIC DRAWBARS

The left group of 7 harmonic drawbars (Figure 8) is associated with the lower manual, and the right group of 9 drawbars controls the upper manual. By sliding these drawbars in and out, the organist is able to mix the fundamental and harmonics (or overtones) in various proportions. The distance a bar is pulled out determines the strength of the corresponding harmonic; and if a drawbar is set all the way in, the harmonic it represents is not present in the mixture. Neither manual will play unless at least one of its drawbars is pulled out part of the way, with the "Drawbars" tab pressed, or a preset tab is pressed.

The drawbars slide over 9 busbars, representing intensity levels, and each drawbar has two contacts connected together by a 5600 ohm resistor. As the drawbar moves, at least one of the contacts is touching some busbar at all times, and therefore there is no "dead spot" in the drawbar motion. The 5600 (ohm resistor) avoids an actual short circuit between adjacent busbars.

These busbars extend the length of the drawbar assembly but are split in the middle to form two groups of 9 (see Figure 21). Those in the left group, under the lower manual drawbars are connected to the base of the transistor Q-851. Those on the right group, under the upper manual drawbars, are connected to the base of transistor Q-854 through the upper manual Drawbar Percussion tablet.

#### PEDAL DRAWBAR

The center drawbar adjusts the volume of the pedals by sliding over 9 busbars mechanically segregated from the upper and lower manual busbars. The output from this busbar is fed in parallel with the signal from the lower manual to the base of transistor Q-851.

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Each manual has an additional set of key contacts grounded by an individual 220 ohm resistor. The bus bar termination for these contacts is the white/orange wire. This wire terminates in the brush circuit for the lower manual and in the percussion circuit for the upper manual.

# FIGURE 7. MANUAL WIRING CHART

#### PEDAL KEYBOARD

The 13 playing pedals are operated by the left foot. Like the manuals, they have light and dark keys arranged in the standard octave pattern. Figure 9 identifies the pedals and shows the generator frequency number associated with each. A pedal contact on each pedal closes when a pedal is pressed, allowing the correct generator frequency to reach the pedal drawbar amplifier. As the pedal switches are in a series arrangement, only one pedal plays at a time. If two pedals are pressed, only the lower pedal will speak. When the pedal is released, the last played pedal note continues to sound for a length of time, determined by the position of the "PEDAL SUSTAIN" and "Pedal Legato" tabs. The electrical operation of these circuits is described under "amplifier".

#### EXPRESSION PEDAL

The "expression" pedal, sometimes called "swell" pedal (Figure 1), is operated by the player's right foot and varies the volume of both manuals and pedals together.

When the pedal is tilted back (closed) by pushing on the player's heel, the music is softest, and when pushed forward (opened) by the player's toe, the music is loudest.

#### CONTROL TABS

There are 30 tabs on the T-200 series (28 on the T-100) instrument, each providing some change in the instrument's operation.

To have the instrument sound after turning it on, tabs such as "Theater Brass" and "Ensemble" will place the upper and lower manuals in operation. A tab is in use when in the down position. Functions of the various tabs from left to right, as they appear on the instrument, are given in the following paragraphs.

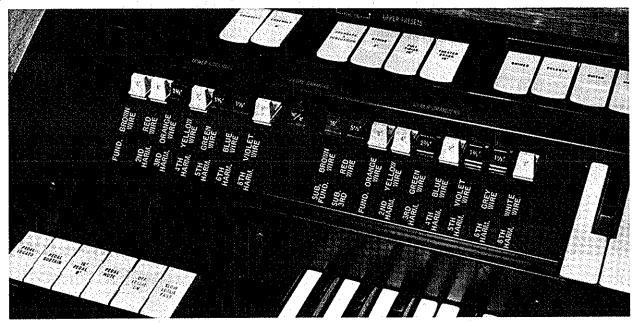


FIGURE 8. DRAWBARS AND CONTROLS (PARTIAL)

#### PRESET TABS

Two tabs are provided for the lower manual, and four tabs for the upper manual. As indicated, they provide a choice of using the drawbars or playing the preset tones indicated on them.

#### PERCUSSION CONTROL TABS

There are seven (7) tabs which operate only when the upper manual "Drawbar Percussion" tab is up. The drawbars can be used without percussion when this tab is depressed.

#### VIBRATO TABS

The "T" series instruments are equipped with four "Vibrato" tabs to vary the vibrato effect. An additional tab (Vibrato On) to the left of the vibrato group permits the vibrato effect to be introduced immediately. Various vibrato effects are available by use of the tabs. "Vibrato Celeste III" is achieved by depressing both Vibrato Celeste tabs I and II.

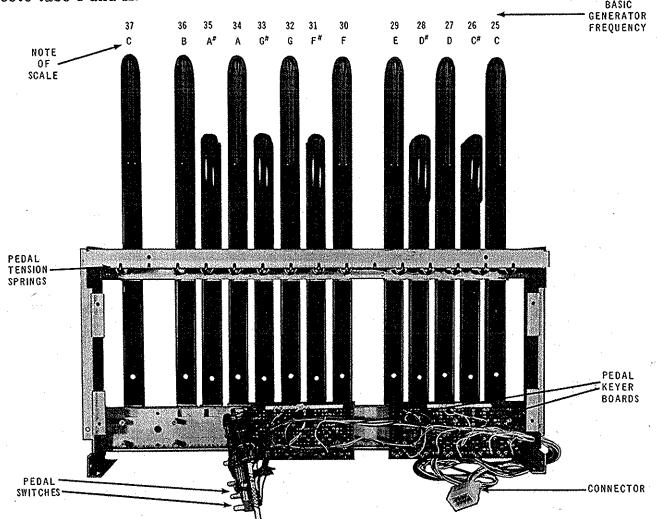


FIGURE 9. PEDAL KEYBOARD

The Hammond Organ vibrato equipment (see Fundamental Diagram of Vibrato System, Figure 10) varies the frequency of all tones (excepting the pedal and percussive tones) by continuously shifting their phase. It includes a phase shift network or electrical time delay line, composed of a number of low pass filter sections, and a capacity type pickup or scanner, which is motor driven so that it scans back and forth along the line.

Electrical waves fed into the line are shifted in phase by each line section (the amount per section being proportional to frequency), so that at any tap of the line, the phase is retarded relative to the previous tap.

The scanning pickup traveling along the line will thus encounter waves increasingly retarded in phase at each successive tap. As a shift in phase is equivalent to an instantaneous change in frequency, the continuous change in phase becomes a continuous frequency variation. Since the scanner sweeps from start to end of the line and then back, it alternately raises and lowers the output frequency, the average remaining equal to the input frequency.

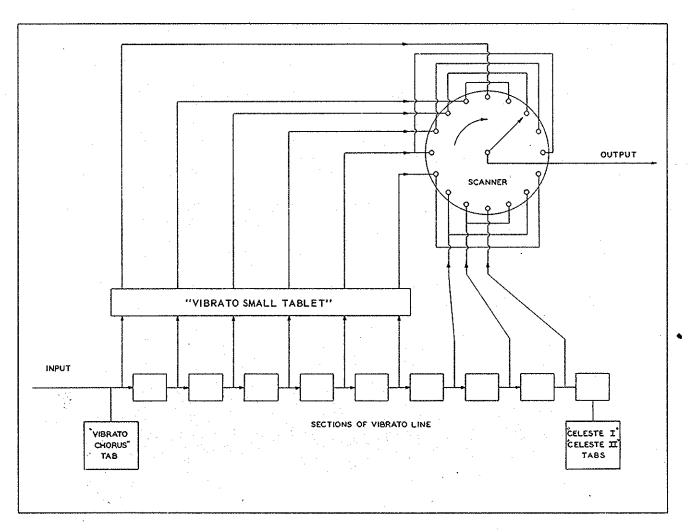


FIGURE 10. FUNDAMENTAL DIAGRAM OF VIBRATO SYSTEM

The exact amount of frequency shift depends not only on the amount of phase shift in the line but also on the scanning rate. This rate, however, is constant because the scanner is driven by the synchronous running motor of the organ.

The "Vibrato Small" tab varies the amount of frequency shift by causing one half of the line to be scanned, in contrast to the entire line when in the up position.

A vibrato chorus effect, similar to the effect of two or three slightly out-of-tune frequencies mixed together, is obtained when the vibrato output signal is mixed with a portion of signal without vibrato. This is accomplished by the "Vibrato Chorus" tab, which causes only part of the incoming signal to appear across the vibrato line and the rest across a resistor in series with the line. As the vibrato effect is applied to the part of the signal appearing across the line but not to the part appearing across the resistor, the combination produces a chorus effect.

A celeste effect is obtainable by the use "Vibrato Celeste I", and "Vibrato Celeste II" tabs. These can be used independently or together. Use of these tabs introduces a resistor network at the far end of the vibrato line, changing the termination impedance. This causes a reflective signal to appear in the line, which is picked up by the scanner.

Figure 10 shows only the "vibrato" channel of the amplifier. All tones sent through this channel have the vibrato effect. When vibrato is not desired, the "Vibrato On" tabs in the up position feeds the signal through the "non vibrato" channel.

Figure 11 shows the vibrato line box. It is mounted on the rear of the upper manual.

The scanner is mounted on the right end of the generator and driven at 412 revolutions per minute. It is a multi-pole variable condenser with 16 sets of stationary plates and a rotor whose plates mesh with the stationary ones. Figure 12 shows the construction of the scanner, with two sets of plates removed to show the rotor.

Signals coming from the vibrato line appear on the stationary plates and are picked up, one at a time, by the rotor. Connection to the rotor is made by carbon brushes as shown in Figure 12. Two brushes touch the sides of the contact pin and a third presses on the end, in order to eliminate the possibility of contact failure.

The complete electrical circuit of the vibrato system is shown on the schematic diagram, Figure 21.

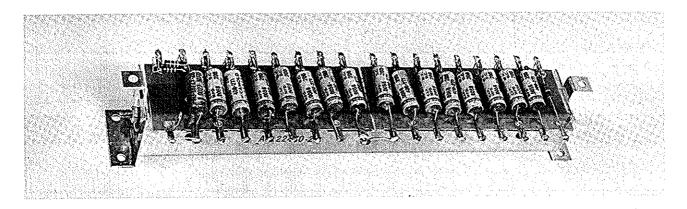
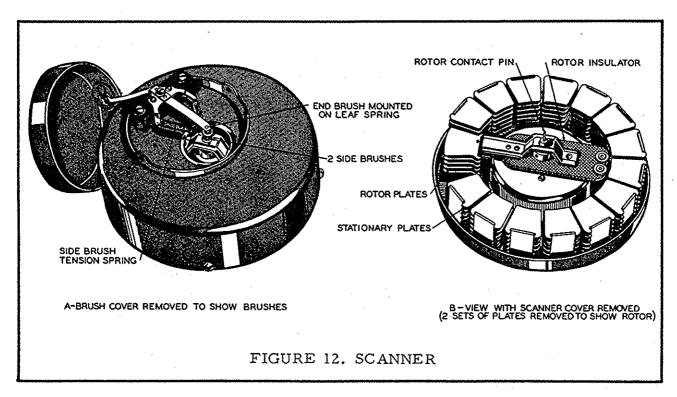


FIGURE 11. VIBRATO LINE BOX



# REVERBERATION

Three degrees of reverberation are obtained by the use of either or both tabs labeled "Reverberation I" and "Reverberation II". These tabs, in addition to turning this feature on, govern the loudness or amount of reverberation by a resistive network.

#### VOLUME SOFT, BRILLIANCE TAB, AND REITERATION RATE CONTROL

The "Volume Soft" tab controls the overall volume of the organ and is useful when playing might disturb others.

The "Brilliance" tab in the up position bypasses a portion of the higher frequencies to ground, making the organ sound deeper.

The "Reiteration Rate Control", as the name implies, adjusts the rate or speed of this effect when used in conjunction with the percussion tabs and reiteration tabs.

#### PEDAL TABLETS, LOWER LEFT END BLOCK

Upon playing the bass pedals, a normal decay and attack are heard when the pedal drawbar is pulled out. Either 16' or 8' pitch is available, as that tablet indicates.

Use of the "Pedal Legato" tablet provides a very slow pedal decay which many beginners find useful, as the pedal last played sounds until the next one is played. "Fast Sustain" causes the pedal tone to cut off very sharply. "Bass Mute" gives added deep tone to the pedals when desired. Further information as to electrical function is given under "Pedal Keyboard, Pedal Divider".

# LESLIE TABLETS, LOWER LEFT END BLOCK (T-200 ONLY)

To the left of the pedal tablets will be found controls for this unit. One tablet turns the signal on, while the second permits either a slow or fast speed. The motor runs (at either fast or slow speed, depending on the tab setting) all the time the organ is on.

# CYMBAL-BRUSH TABLETS (T-100 and T-200)

These tablets permit the addition of the cymbal effect to the pedal and brush effect to the lower manual. Their location on the T-100 is adjacent to the Pedal tablets, while on the T-200 they will be found on the right side. Both models also have a single control adjacent to the tablets to control brush and cymbal volume.

#### AMPLIFICATION

The tone generator system in the "T" series instruments is conventional, as related to earlier models of the Hammond organ. All amplification, pedal divisions, reverberation, vibrato, special effects, and power supply are solid state. Most of the circuits used in this instrument will be found in some part in the larger models of Hammond organs and have been proven in actual use. Printed wiring boards are used in all the circuitry and the following paragraph will explain their operation. When reading these descriptions, refer to the complete Schematic, Figure 21, located to the rear of this book.

NOTE: The following paragraphs covering various printed wiring board functions are suffixed with a number which is the stock number of that board or boards. Pin numbers mentioned are a part of that board. Schematic Figure 21 also shows these numbers and pins. Individual pictures of most of these boards follows this section.

# MANUAL BUS BAR AMPLIFIERS (124-000015 124-000016)

The busbar amplifiers for both manuals are located to the rear of the control panel. The lower manual board contains one preset voicing mesh and one amplifier for each of the seven harmonic bus bars. The upper manual board contains three preset voicing meshes and one amplifier for each of the nine harmonics. All the amplifiers have a response curve to decrease the amount of key transient. A typical bus amplifier receives its input signal from the busbar. The signal is amplified and sent to the proper drawbar and/or voice mesh.

The voice mesh mentioned selects the proper content and amplitude of each harmonic necessary for a particular voice.

PEDAL KAYBOARD AND SWITCH, PEDAL KEYER BOARDS (124-000025, 124-000026, 124-000027)

The pedal keyboard and switch assembly is located under the power and reverberation amplifier. Three pedal keyer boards, No. 1, 2, and 3, are also mounted on the switch assembly. Board 1 contains the keyers for the five lowest pedal notes (25 through 29). Board 2 contains the keyers for the pedal frequencies #30 through #33 and Board 3 the keyer for frequencies #34 through #37. This provides one keyer for each pedal note.

All pedal keyers operate in the same manner. Following is a typical function, involving the lowest pedal (C). Switch S-751 is closed, placing +15V on C-751. This voltage forward biases Q-753 through resistors R-756 and R-757. This allows the generator signal, present at pin 6 to pass to the emitter. All emitters are common on the boards and provide the input signal to the high pass active filter network located on the pedal keyer board #3. Board #1 also contains an erase circuit and buffer stage, working in conjunction with all pedals. When any pedal is pressed, a negative pulse is coupled across C-750 to the base of Q-750. This negative pulse reverse biases Q-750, causing a positive pulse to appear at the collector. The positive pulse passes through D-750 and forward biases Q-751, resulting in a negative going pulse to ground at the base of Q-752 and the cathode of D-751 through 755. This is the erase pulse and turns off any pedal keyer which does not have its associated pedal pressed. The buffer stage Q-752 transfers the positive DC signal from the keyer and the erase pulse to other organ functions at pin 8.

#### PEDAL DIVIDER & FILTER BOARD ASSEMBLY (124-000013)

The Pedal Divider and Filter Board Assembly is located on the power and reverberation amplifier chassis. It provides amplification, shaping and division by four bi-stable frequency dividers.

The amplifier and shaping circuit receives its input signals from the pedal keyer circuitry. The signal is amplifier by Q-701, Q-702, and Q-703. Shaping is accomplished by Q-704 and Q-705, which furnishes a +15V square wave at the input frequency to the first divider bi-stable. Q-706 and Q-707 make up the first bi-stable or flip-flop configuration. The input signal is divided by 2 and appears at the collector of Q-707. This signal will become the 8' component of the pedal signal when called for by the positive DC signal from the emitter of Q-752 in the buffer stage. The DC signal forward biases D-702 which allows the signal to pass through R-723 to 709. The signal at the collector of Q-707 also becomes the input to the second bi-stable.

Q-708 and Q-709 make up the second divider. The signal is again divided by 2, and will appear at the collector of Q-709. This signal will become the 16' component when called for by the positive DC signal from the emitter of Q-752 in the buffer stage and the grounding of R-731. Notice that there will always be an 8' signal even in the 16' mode.

The signal is now coupled through C-709 and shaped by R-724, R-725, C-710 and C-711. After passing through Q-710 emitter follower, it is coupled to "pedal mute" filter circuit through C-712 and R-729 and appears in the pedal drawbar.

#### RECOVERY AND NON-VIBRATO BOARD (124-000014)

The recovery and non-vibrato board is located on the control panel and consists of two recovery amplifiers. One recovery amplifier handles the signals from the pedal drawbar, lower manual drawbars and presets. The other handles the signals from the upper manual drawbars and presets. The board also contains the non-vibrato amplifier and intermediate amplifier (with click filter) which drives the main amplifier.

The recovery amplifier receive its signal from input pins 6 or 8. The signal is amplified by Q-851 or Q-852, and the outputs appear at pins 5 and 7. These outputs are tied together and sent to the "Vibrato ON" tablet, located on the control panel, where the "Vibrato" or "Non-Vibrato" mode will be determined.

With the "Vibrato On" switch in the Off position, the pedal and both manual signals appear at pin 4. The signal is amplified by Q-853 and sent to the intermediate amplifier and click filter.

The intermediate amplifier receives its signal from pin 9 in the vibrato mode or from R-860 in the non-vibrato mode. It is amplified by Q-854. The remainder of the circuitry acts as a click filter with the output appearing at pin 3.

The output of the entire board is controlled by potentiometer R-870 that also serves as "system" volume adjustment.

#### VIBRATO BOARD ASSEMBLY (124-000018)

The vibrato board assembly is also located on the control panel. It controls the vibrato drive and vibrato recovery amplifiers.

The vibrato drive amplifier receives its signal at pin 1 from the "Vibrato On" switch. This signal is amplified by a low noise transistor Q-801, followed by further amplification by Q-802, and Q-803 (the latter an emitter follower). Final amplification is by Q-804 and transformer T-801. Output to the phase shift line is from pin 4.

The vibrato recovery circuit receives its input signal at pin 3 from the vibrato scanner. The "Darlington" type emitter follows Q-805 and Q-806 and Q-807, present a high reactive impedance to the scanner with the output appearing on pin 7.

# PERCUSSION BOARD ASSEMBLY (124-000021)

As with the vibrato board assembly, the percussion board assembly is attached to the control panel. It contains a number of inter-related circuits.

1-1/4' HARMONIC GENERATOR (used in Chime Voice only) (Part of 124-000021)

The 1-1/4' harmonic generator receives its input at pin 18 from the upper manual 5th harmonic bus amplifier. This harmonic is amplified and shaped by Q-501 and Q-502 to form a proper trigger signal for the first stage of the "Divide by four" network.

This network is composed of two bi-stable or flip-flop dividers connected so the output of the first stage, Q-504, becomes the input of the second. The output at the collector of Q-506 is now exactly 1/4 the frequency of the input signal. This signal is reduced and shaped for voicing requirements by the filter network C-505, R-513, C-506. The resulting signal is at pin 19.

#### TOUCH RESPONSE KEYING CIRCUIT (124-000021)

When a key is depressed, a negative going DC change is produced at pins 2 and 3. This causes a small change at the base of Q-507. The change is amplified and inverted by Q-507 and Q-508, giving +15V at pin 6. R-517 controls the bias on the base of Q-507 and must be adjusted so that with no keys pressed, pin 6 is at ground through R-518, and with one key pressed pin 6 is at +15V.

#### LEGATO KEYING CIRCUIT (124-000021)

Again depressing a key, a negative going DC change is produced at pins 2 and 3. A differential pulse is developed at the base of Q-509 causing a positive pulse at the base of Q-510. This pulse is inverted by Q-510 and results in a pulse to ground at the collector of Q-510. This pulse is used to discharge C-509 each time a key is depressed.

#### PERCUSSION ENVELOPE GENERATOR. (124-000021)

The discharge of C-509 mentioned in the prior paragraph is the start of the percussion envelope generator. In the percussion mode CR-504 and R-527, are out of the circuit. R-528 and R-529 in conjunction with C-509, determine the shape of the pulse at the base of Q-517. Q-517 amplifies the pulse and it becomes the input to Q-518. In the reiteration mode CR-504, pin 8 is grounded and oscillation occurs between R-528, R-529 and C-509, developing a continuous train of pulses to the percussion and alternate gates.

#### PERCUSSION SIGNAL GATES AND AMPLIFIER (124-000021)

With the percussion signal present at pin 12, the pulse at the base of Q-518 causes it to turn off developing a percussive signal at the source of Q-518. Amplified by the "Darlington" Q-519 and Q-520, the signal appears at pin 14.

#### ALTERNATE SIGNAL GATE AMPLIFIER (124-000021)

The pulse or pulse train is fed to the base of Q-511. The amplitude and timing of the alternate gate pulse is determined by R-530. The signal is then amplified by Q-512 and Q-513. C-510 shapes the pulse and CR-505 grounds the negative going portion. The amplitude of the signal at the gate of Q-514 is determined by R-539. An alternate signal will appear at pin 21, only when the Marimba tab (4th harmonic), the Xylophone tab (6th harmonic), and the Reiteration tabs are pressed. The alternate harmonic is then gated by the pulse to Q-514. The signal is amplified by the Darlington Q-515, and Q-516 and appears on pin 14.

#### POWER SUPPLIES (124-000021)

The Percussion Board Assembly also contains two power supplies (Filtering and Regulation) having discreet filtering circuits with Zener Diodes for regulation. Inputs for one are pins 16 and 17 with pin 1 the associated ground. Input to the second is pin 23 with pin 22 the associated ground.

#### CYMBAL AND BRUSH GENERATOR ASSEMBLY (124-000020)

This assembly is basically a "White Noise" generator feeding two gating transistors, the outputs of which are shaped and fed to a common transistor amplifier. It is mounted on the lower shelf in front of the reverberation unit.

### CYMBAL/PEDAL (124-000020)

With the "Cymbal/Pedal" tablet depressed, and a pedal depressed, a keying voltage is applied through R-911 to one plate of C-909. A like charge now appears on the opposite plate through Diode D-904. This voltage now passes through D-905 charging C-910 and applying the keying voltage to the base of Q-906. This voltage causes Q-906 to conduct, amplifying the "white noise" from D-903. This noise is coupled to the base of Q-906 through C-904.

The collector circuit of Q-906 is a broadly tuned resonant circuit of approximately 8 kc. The output of this circuit is fed to the cymbal-brush amplifying transistor Q-903 and on to the expression control.

The decay time of the cymbal effect is governed by C-910 and R-914, while the shaping and keying are controlled by R-911, R-912, and C-909. The cymbal effect will occur each time a pedal is depressed.

#### BRUSH/LOWER (124-000020)

With the "Brush/Lower," tablet depressed, and a lower manual key depressed, a small variation in D. C. voltage occurs at the base of Q-901. This small variation is amplified by Q-901 and appears as a larger varying potential on one plate of C-901. A like variation now appears on the opposite plate through Diode D-901. This voltage now passes through Diode D-902, charging C-902 and applying the voltage to the base of Q-902. This voltage causes Q-902 to conduct, amplifying the white noise from D-903. This noise is coupled to the base of Q-902. The collector circuit of Q-902 is a broadly tuned resonant circuit of approximately 11 k.c. The output of this circuit is fed to the Cymbal-Brush amplifying transistor Q-903 and on to the expression control. R-909, a variable resistor on the collector of Q-901 controls the "Brush" output level.

The decay time of the brush effect is governed by C-902 and R-903.

#### SWELL PEDAL CIRCUITRY (123-000004)

The main organ signal appears at pin 8. Pin 10 is connected to the LDR located on the swell pedal assembly and provides a variable resistance to ground to vary the amplitude of the input signal.

# POWER AND REVERBERATION AMPLIFIER ASSEMBLY

The power and reverberation amplifier assembly is mounted on the pedal keyboard and switch assembly. It contains the power supplies, the swell pedal circuitry, the main amplifier, the reverberation drive and recovery, and the previously-mentioned pedal divider and filter board assembly.

#### MAIN AMPLIFIER (124-000017)

The resulting signal at C-601 is amplified by Q-601 passed to the base of Q-602. The signal is then amplified by Q-602 and transferred to the primary of T-601 through the Darlington configuration emitter follower Q-603 and Q-604. Q-605 and Q-606 is an "AB" type amplifier and the output to the speakers appear on pin 19.

#### REVERBERATION DRIVE (124-000017)

The reverberation drive gets its signal from the emitter of Q-601. The signal is amplified by Q-607 and Q-608 and transferred to the primary of T-602. Q-609 and Q-610 is an "AB" type amplifier and the output appears at pin 28.

# REVERBERATION RECOVERY (124-000017)

The output from the reverberation unit appears on pin 4. The signal is amplified by Q-611 and Q-612 and appears at pin 6. The reverberation signal then goes through the reverberation tab circuitry and appears as an input at pin 12.

#### EAR PHONES

These organs are equipped with an ear phone jack which will give pleasing results. Use Headsets such as Clark 200, Koss SP-3XC, or Sharp HA-10.

#### SPECIAL POWER SOURCES

This instrument is made to operate on the voltage and frequency specified on the name plate. It is available for 117V/60 cycle - 117V/50 cycle - 234V/50 cycle, and 234V/60 cycle. If the unit is moved to an area having voltages or frequencies different than those specified on the name plate, consult your local dealer as to changes required for conversation.

#### REMOVAL OF PARTS

The following procedure requires prior removal of top, back, or both.

- 1. To remove a key from upper manual:
  - (a) Remove four screws which secure metal cover on control panel assembly.
  - (b) Unsolder Violet and Black wires, as well as Yellow and Black wires, terminating directly behind lower drawbar tab, which are connected to drawbar assembly.
  - (c) Remove two large studs located on ends of control panel which secure it to upper manual.
  - (d) Fold control assembly so that it rests on shelf.
  - (e) To remove a Black key, loosen its key mounting screw and lift from rear.

To remove a White key, loosen its key mounting screw and those of adjacent Black keys as required.

- 2. To remove a key from lower manual:
  - (a) Remove two mounting bolts from rear of upper manual end blocks.
  - (b) Remove two screws which pass through angle brackets into upper manual. These brackets are located on the inside surface of cheek blocks. These screws are accessible from front of organ.
  - (c) Tilt upper manual up and back.
  - (d) To remove a Black key, loosen its key mounting screw and lift from rear. To remove a White key, loosen its key mounting screw and those of adjacent black keys as required.
- 3. To remove a Drawbar Contact Spring, Drawbar Knob, or Drawbar Assembly:

  Perform steps "a" through "d" of Paragraph "1".
  - (e) Unsolder wire from drawbar contact spring to be replaced. Remove fiber stop retaining screw. NOTE: Be certain that thin insulator is between contact spring and drawbar. Replace contact, stop, and screw and resolder wire.
  - (f) To replace drawbar or drawbar knob, proceed as above, but do not unsolder wire. This will permit slider to be removed from front for its replacement, or knob replacement.
  - (g) To remove complete drawbar assembly, unsolder all wires from 17 drawbars and 6 wires terminating on control panel. Remove three hex head screws toward either end of drawbar assembly.
  - NOTE: The upper and lower drawbars can be removed individually, as well as the pedal drawbar.
- 4. The Pedal Drawbar Assembly can be replaced independently by removal of two screws securing the assembly to the phenolic plate. Remove assembly by sliding to the rear.
- 5. To remove Lower Manual Control Panels (End Blocks):
  - (a) For left end block, remove two round head screws one inch inside manual end block.
  - (b) Remove screw that passes through angle bracket into control panel.
  - (c) For right-hand block. Remove two round head screws that pass through right-hand end block.
  - (d) Remove screw that passes through angle bracket into control panel.

#### 6. To remove Upper Manual:

- (a) Remove four screws that retain metal cover on control panel assembly.
- (b) Remove two mounting rear bolts from upper manual end blocks.
- (c) Remove two screws that pass through angle brackets into upper manual. These brackets are located on the inside surface of cheek blocks. These screws are accessible from front of organ.
- (d) Tilt upper manual up and block in this position. Remove upper manual front strip.
- (e) Snap off harness clamp from left side of manual by pulling forward.
- (f) Unsolder all wires from terminal strip.
- (g) Return manual to normal position.
- (h) Unplug bus bar wires from upper manual at bus amplifier.
- (i) Remove all grounding terminations on rear of upper manual. Release 3 plastic cable clamps and remove line box.

Remove drawbar assembly and base, as a unit, by removing six screws securing it to upper manual.

(i) Remove manual from casework.

#### 7. To remove Lower Manual:

- (a) Perform operations "a through d" in Paragraph 6.
- (b) Remove two lower control panels as described under Paragraph 5. Unplug bus bar wires from lower manual at bus amplifier.
- (c) Remove two mounting bolts through lower manual end blocks and loosen four screws attaching manual to front rail.
- (d) Remove lower cover panel and unsolder all wires from terminal strip.
- (e) Raise upper manual and remove lower manual. Reverse procedure for reinstalling.

#### 8. To remove Tone Generator:

(a) Unsolder all harness connections from the generator terminal strip.

- (b) Remove heavy ground wire in center of generator.
- (c) Remove the AC cover panel and unsolder the five wires from harness.
- (d) Remove the four bolts which secure tone generator to support brackets.
- (e) Remove control panel cover by removing 4 screws.
  - 1. Remove the brown, red, orange, and Yellow wires from the terminals behind the "Vibrato Small" switch.
  - 2. Remove the green, blue, violet, grey, and white wires from the right-hand end of the line box.
  - 3. Unplug shielded cable from pins 2 & 3 of the vibrato board.
- (f) Release all cable ties securing scanner leads.
- (g) Slide tone generator out rear of organ.
- 9. To remove Power Amplifier:
  - (a) Release all cable ties and plastic cable clamps from chassis.
  - (b) Unplug 12-pole plug on top of chassis.
  - (c) On large printed circuit board, unplug wires from terminals 3-4, 5-6, 7-8, 9-10, 11-12, 19, 20, 27-28, 29-30, 31.
  - (d) On small printed circuit board, unplug wires from terminals 1, 2, 3, 4, 5, 6 (two wires), 7, 9, 10.
  - (e) Unplug Red wire from six-lug terminal strip near small printed circuit board.
  - (f) Remove four screws securing amplifier two at each end.
- 10. To remove Pedal Sustain Keyer:

Pedal Sustain Keyers are located beneath Power Amplifier Chassis.

- (a) Release all cable ties in the speaker area to the right of the speaker.
- (b) Release cable tie at right-hand side of Reverb Unit (obtain as much slack in Expression pedal cable as possible.)

- (c) Remove the four screws securing power amplifier to pedal switch base and tilt back power amplifier chassis.
- (d) Pedal Sustain Keyers are now accessible and can be removed by removing appropriate cable harness and mounting bolts.

#### 11. To remove Pedal Switch Assembly.

- (a) Proceed with steps "a through d" of Paragraph #9.
- (b) Remove mounting bolts from pedal keyer boards (six from end board, four from center board).
- (c) Remove the two mounting bolts which go through the lower cabinet cross member and into the Pedal Switch Base.
- (d) Tilt Pedal Switch end of organ approximately 12 inches and block.
- (e) Remove the four mounting bolts which come up through the bottom of the cabinet into the Pedal Switch Base, (two on each end).

#### LESLIE SPEAKER MAINTENANCE

Hammond generator oil can be used to lubricate the rotor and motor bearings of the Leslie unit.

#### OILING INSTRUCTIONS

Motor and rotor shafts should be oiled once a year. To lubricate the following points it will be necessary to remove the Leslie unit from the console.

#### ROTOR (DRUM) SHAFT:

The outside bearing in the rotor support may be lubricated by applying a few drops of oil to the felt pad around the bearing.

The inside bearing may be lubricated the same way and is accessible through the throat of the drum. BE CAREFUL NOT TO DRIP OIL ON THE DRIVE PULLEY OR SPEAKER CONE.

#### MOTOR:

An oiling hole is provided in the front plate of the large motor to facilitate lubrication of the front bearing. This is accessible through a large hole in the rear of the Leslie speaker assembly.

Lubrication of the rear bearing of the large motor will require the removal of the small motor and the drive wheel.

Lubrication of the small motor bearings is accomplished by applying oil to the shafts and felt pads at each end of the motor. BE SURE THAT THE PORTION OF

THE MOTOR SHAFT THAT MAKES CONTACT WITH THE DRIVE WHEEL IS FREE OF OIL.

#### ROTOR SPEED

With Leslie switch in Fast position, rotor speed is approximately 390 R.P.M. In Slow position rotor speed is approximately 45 R.P.M.

#### SPEAKER REPLACEMENT

- 1. Remove the Leslie speaker assembly from console.
- 2. Remove back cover by removing nine flat head wood screws.
- 3. Remove acoustical material.
- 4. Remove four screws securing speaker to baffle.

Most routine service operations are outlined on a card located on the unit. They are also reproduced below.

The belt tension may be adjusted without removing unit from console. For belt replacement, however, or for motor lubrication and servicing, the unit should be taken out of the organ console. This may be done quite easily by removing the (4) mounting screws which secure the unit in the console. Removal of the unit from the console does not necessitate disconnecting the motor power and speaker leads. Thus, the operation of the unit may be fully observed as adjustments are being made.

#### BELT TENSION ADJUSTMENT

Correct tension for the rotor drive belt is extremely important: excessive slack will cause slow starting and slow operating speed, whereas excessive tension will cause noisy operation. A properly adjusted belt will slip very slightly when starting, but will be sufficiently tight so as to bring the rotor up to full speed in about 5 seconds.

To set belt tension, loosen the adjusting wing-nut which is readily accessible through the back of the unit. By means of this wing-nut the entire motor assembly may be moved as required; toward rotor reduces belt tension, away from rotor increases belt tension.

Once the motor is positioned so as to provide the correct belt tension, the wing-nut should be securely tightened.

#### BELT REPLACEMENT

After several years of normal usage a belt may become frayed or worn, and therefore noisy in its operation. Such a belt should be replaced, and to accomplish this the entire tremolo unit should be removed from the organ console and placed on the floor, back down.

Remove the two screws holding the front rotor support assembly. Grasp the rotor with both hands and pull it straight up from the body of the unit so as to free the

pulley and shaft from the back rotor support assembly. The belt can be slipped off of both pulleys and pulled from under the motor bracket.

Pass the replacement belt under the motor mounting bracket and hook it over the motor pulley. Holding the rotor by its front support with one hand place belt over the rotor pulley with the other hand. Reinsert the end of the rotor shaft into the bearing, taking care that the speaker cone is not damaged in the process. Position the front rotor support properly against the body of the unit, and replace the screws which hold it. Finally readjust the belt tension as described previously.

#### ADJUSTMENT OF SMALL MOTOR

Remove the entire tremolo unit from the console, but keep it in upright position with all plugs connected. Make sure the small motor's armature is withdrawn to its "off" position, so that the drive shaft does not touch the rubber-tired drive wheel. Check for correct belt tension, adjusting as necessary, according to instructions given previously. Locate the motor positioning bolt, which extends from the mounting plate through the motor laminations, with locknuts on both sides of the laminations.

Loosen the inside locknut. Then, with the small motor operating (slow speed tremolo ON) tighten the outside locknut until the motor shaft no longer touches the rubber-tired drive wheel. Next, while holding the rotor so that it cannot turn, loosen the outside locknut until motor shaft engages drive wheel just enough to turn the rotor-drive pulley under the belt. (Too much pressure on the drive wheel will cause excessive wear on the tire.) When this optimum adjustment has been attained, it should be secured by tightening the inside locknut. Make sure also that any oil and dirt have been removed from the motor shaft and from the rubber tire.

#### RUBBER (NEOPRENE) TIRE REPLACEMENT

Remove the complete unit from the console and place it on the floor with back down. Detach the small motor and its mounting plate (it is 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 all oil and dirt, the motor assembly should be replaced and the drive tension should be readjusted according to the previous instructions.

# ADJUSTMENTS (Requires Removal of Control Panel Cover)

#### ORGAN LEVEL

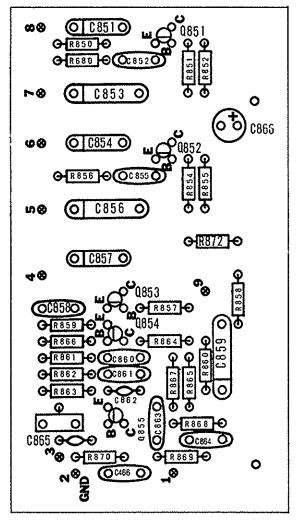
The recovery and non-vibrato board (124-000014) incorporates an overall volume level adjustment, set at the factory. If it becomes necessary, it can be readjusted by attaching a VTVM to the voice coil in either speaker, pulling 8' drawbar on either manual to #8, playing Middle C (Frequency 31), and adjusting the output to 1.4V. R. M. S.

MAIN CHANNEL BIAS, MAIN AMPLITUDE, MAIN NUMM (CUTOFF), ALTERNATE AMPLITUDE, ALTERNATE TIME

These adjustments with exception of the main channel bias, are located on the percussion board assembly. They are set at the factory and should not be touched. The main channel bias adjustment, located on the switch panel between the reverberation rate control and Brilliance tab, is likewise set at the factory and further adjustment is not necessary.

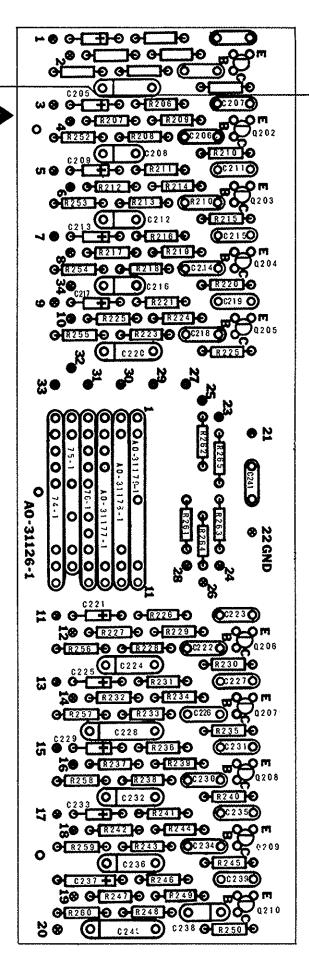
#### THIS PORTION UNUSED

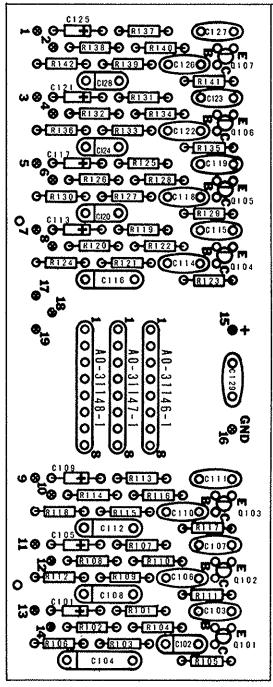
FIGURE 14. MANUAL BUS BAR AMPLIFIER 124-000015



124-000014

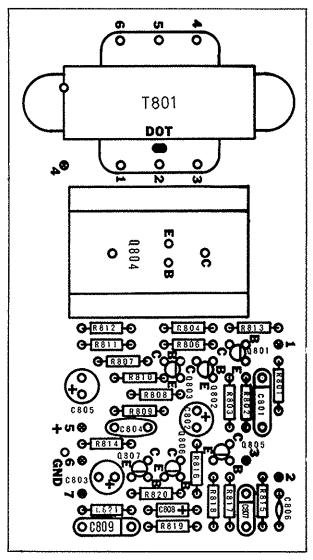
FIGURE 13 RECOVERY AND NON-VIBRATO BOARD





124-00016

FIGURE 15. MANUAL BUSBAR AMPLIFIER



124-000018

FIGURE 16. VIBRATO BOARD ASSEMBLY

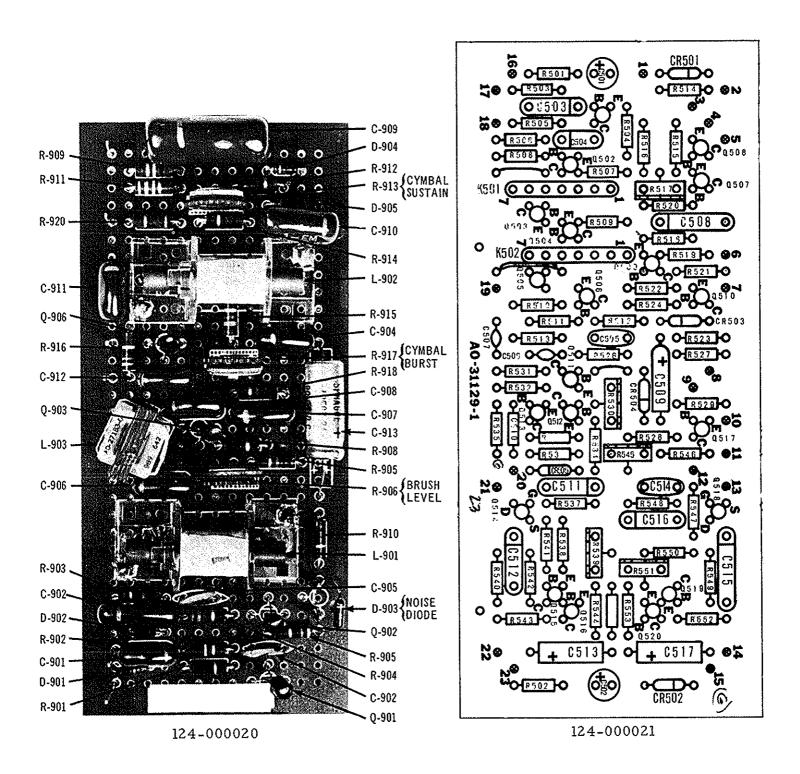
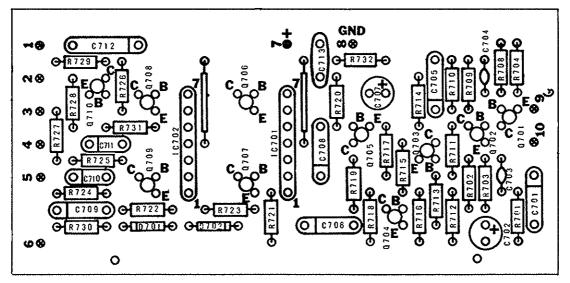
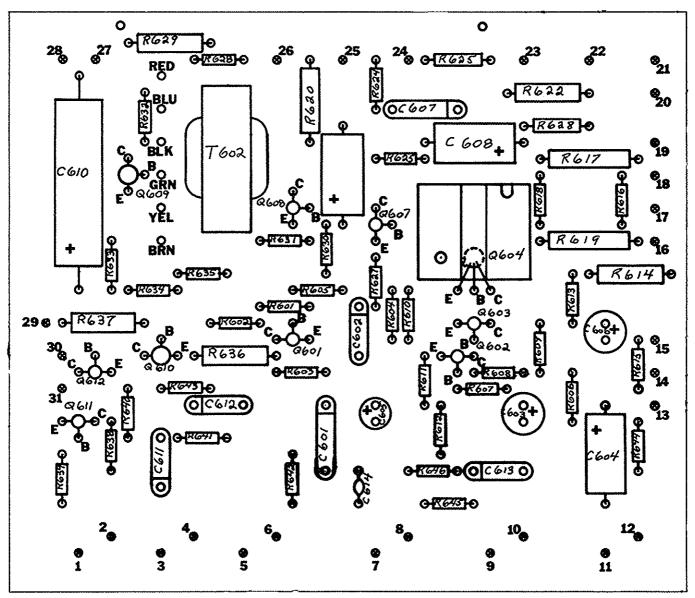


FIGURE 17. CYMBAL AND BRUSH GENERATOR ASSEMBLY

FIGURE 18. PERCUSSION BOARD ASSEMBLY

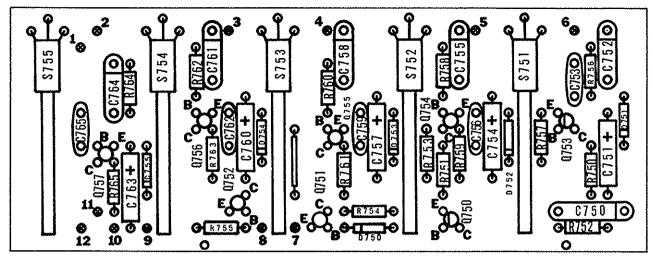


124-000013 PEDAL DIVIDER

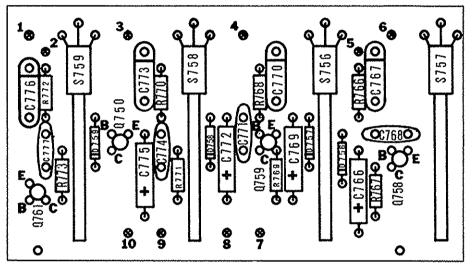


124-000017 POWER AND REVERBATION AMPLIFIER

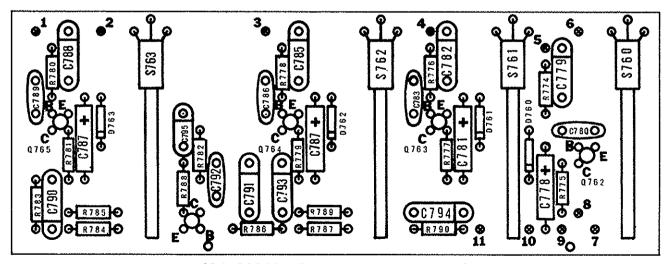
FIGURE 19. AMPLIFIER 126-00000-1



124-000025 PEDAL KEYER NO. 1

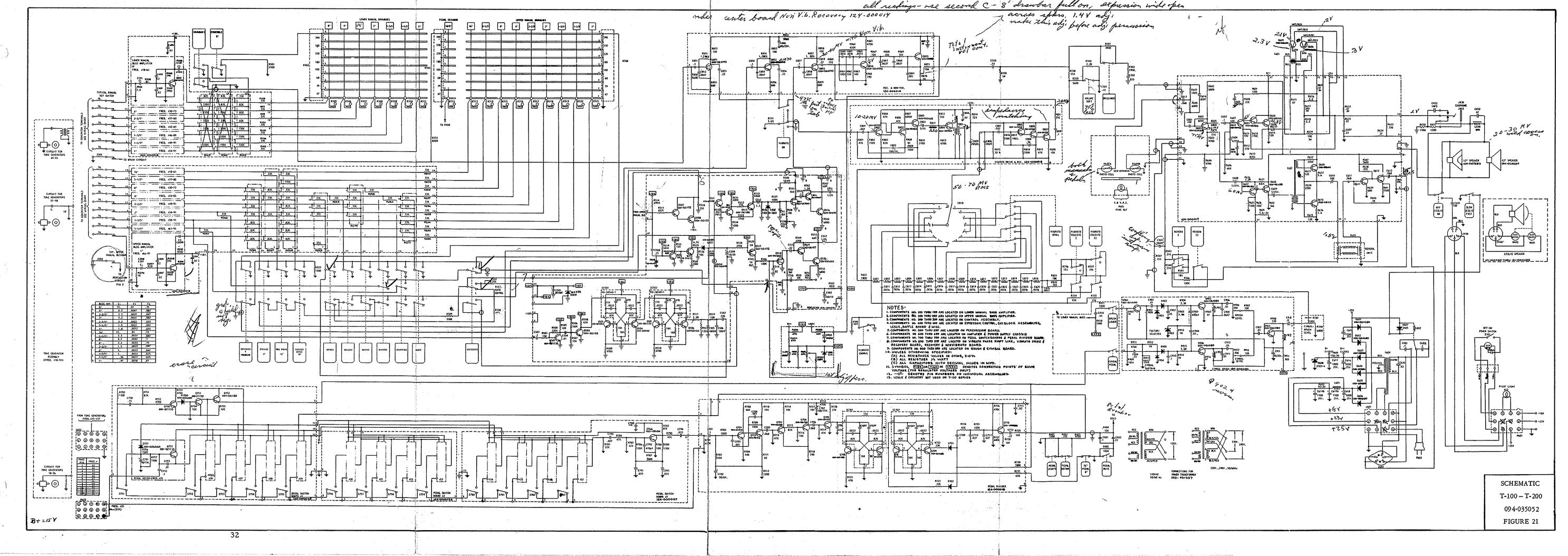


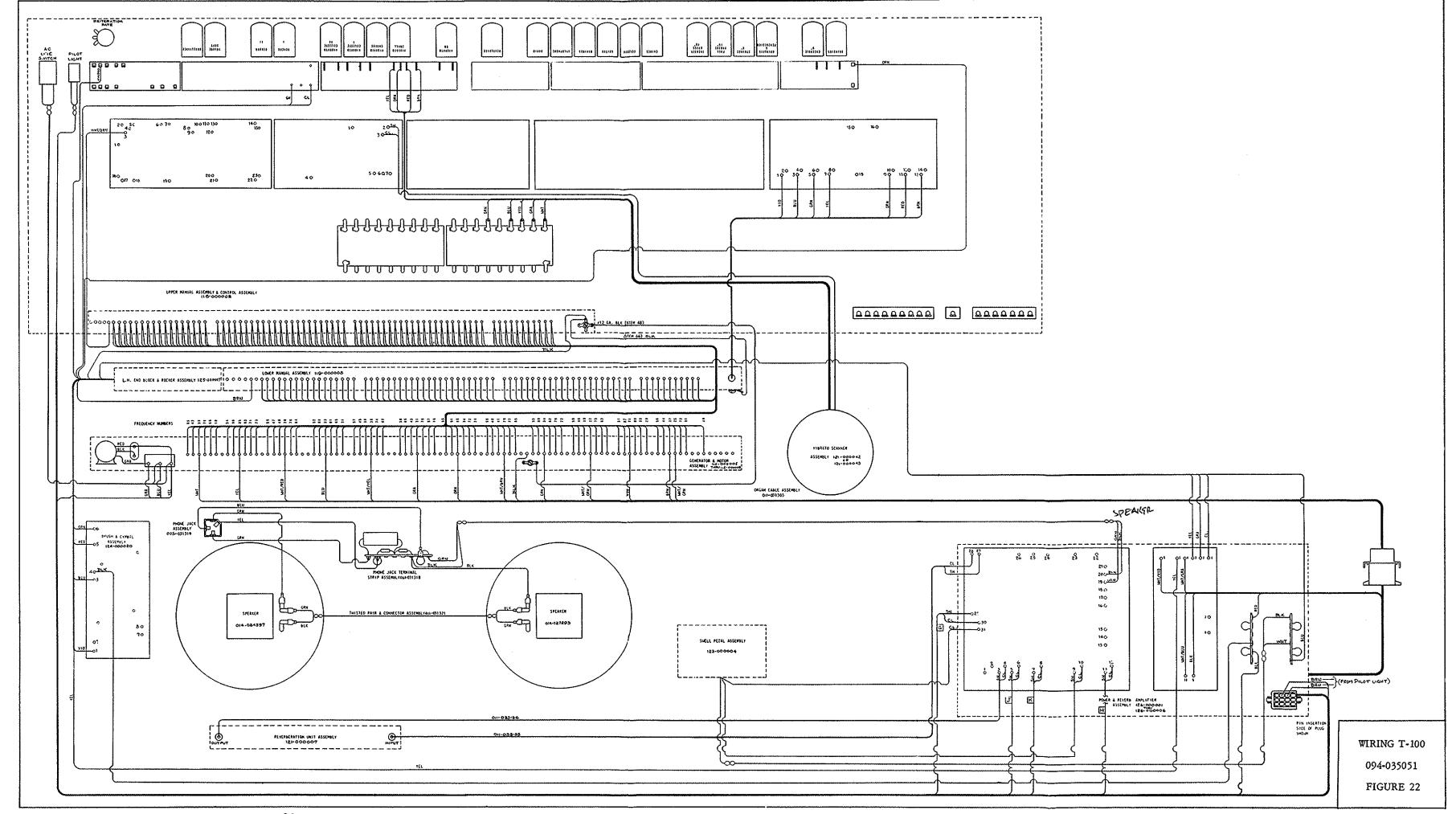
124-000026 PEDAL KEYER NO. 2

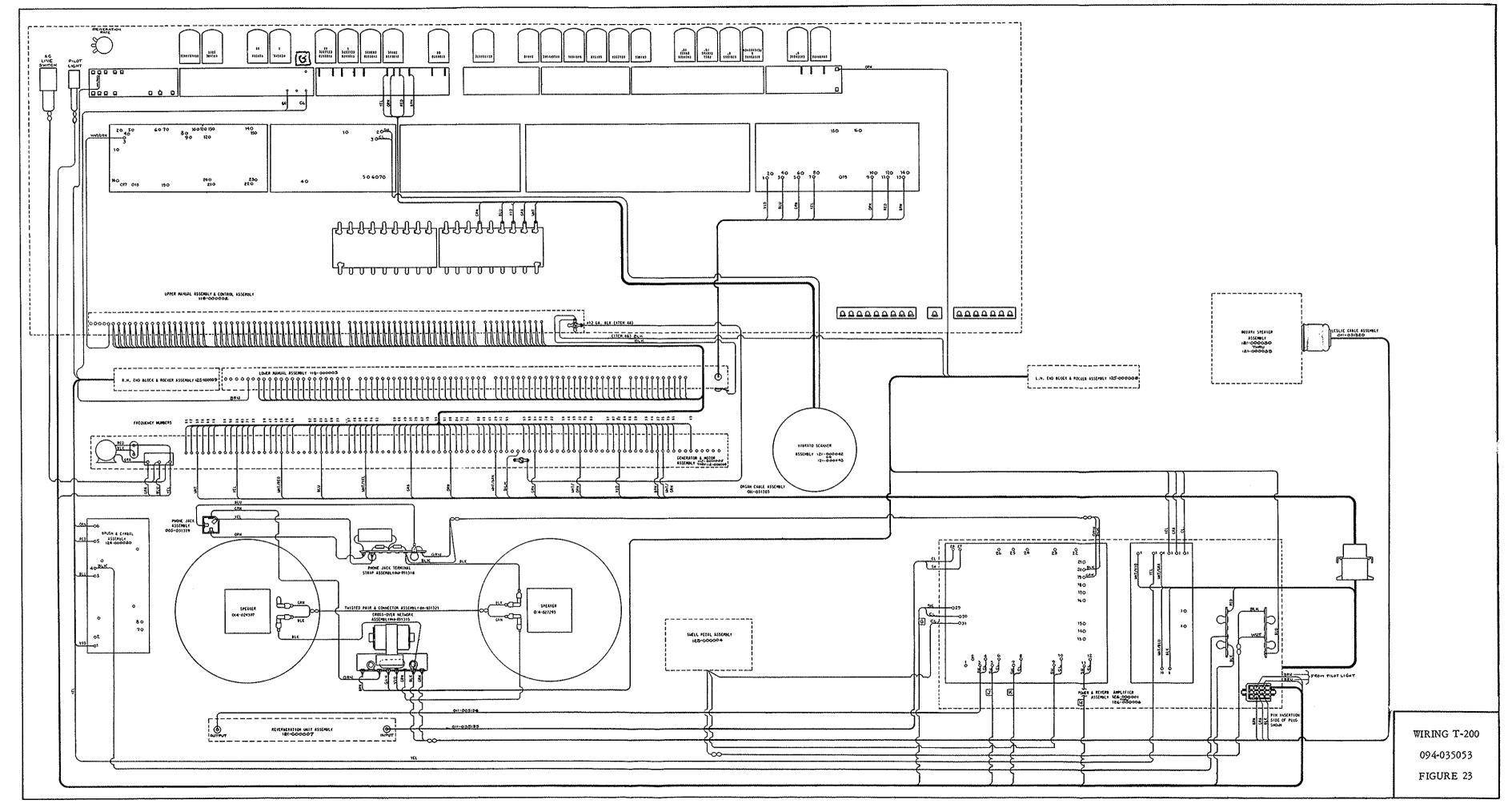


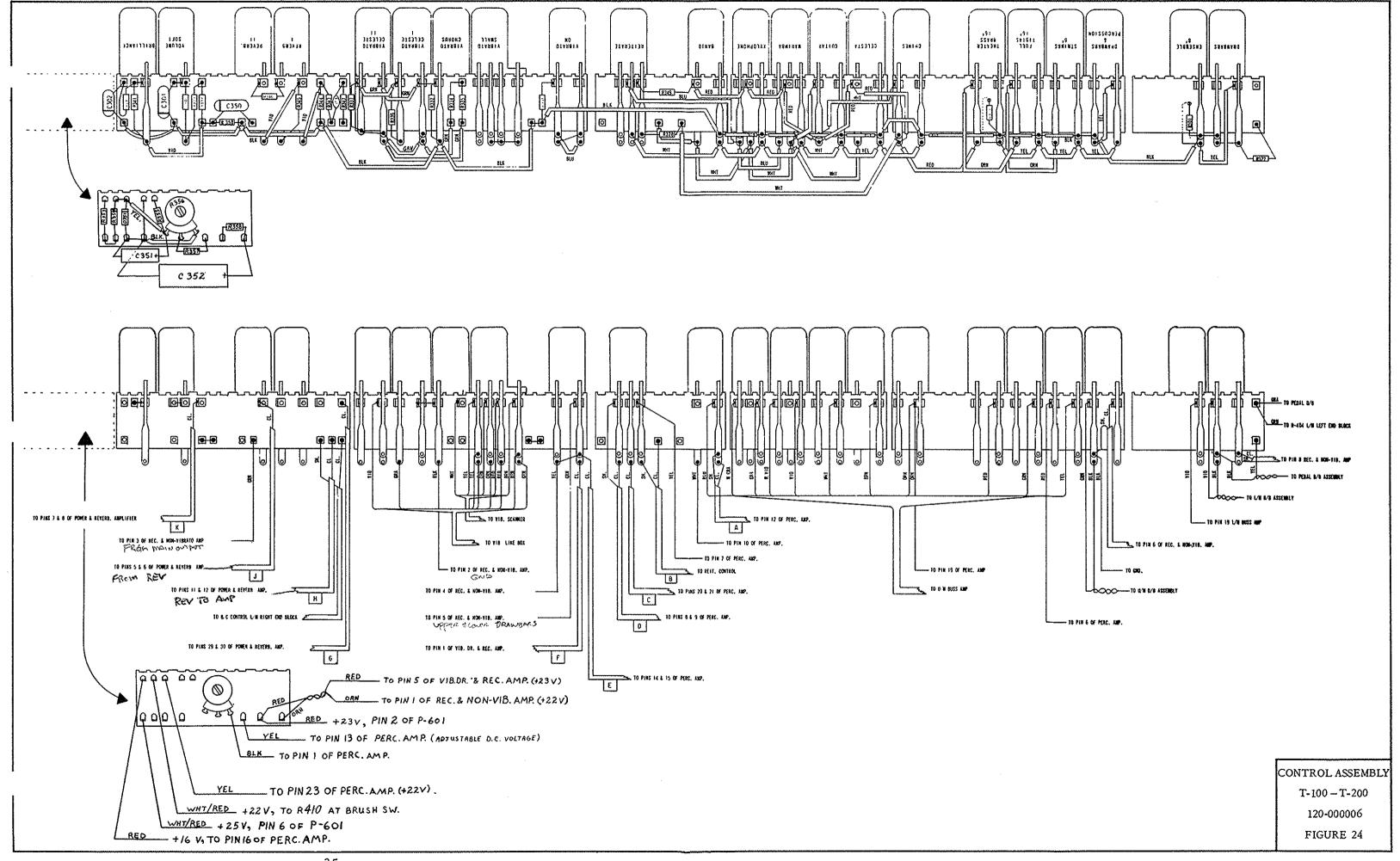
124-000027 PEDAL KEYER NO. 3

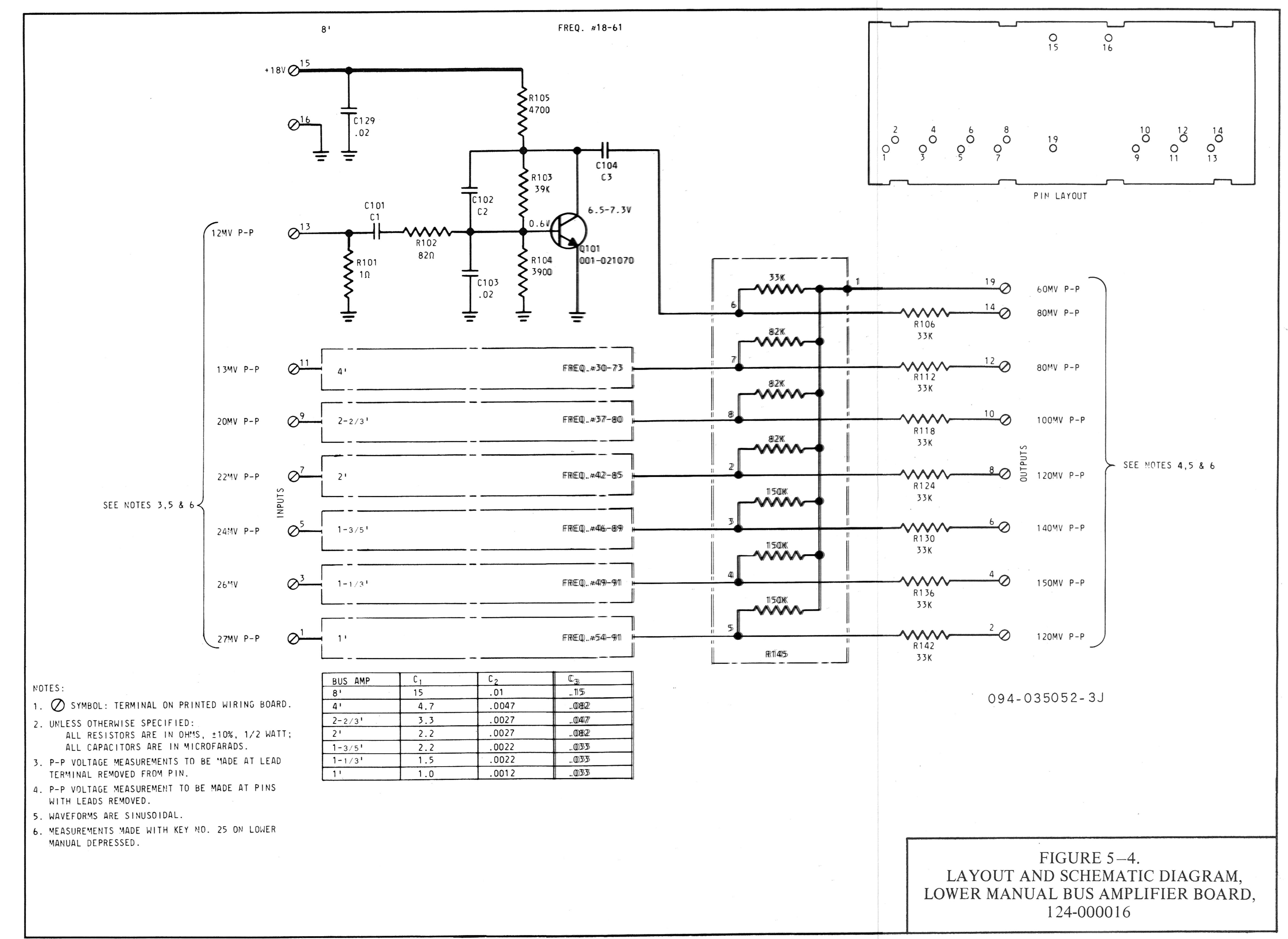
FIGURE 20

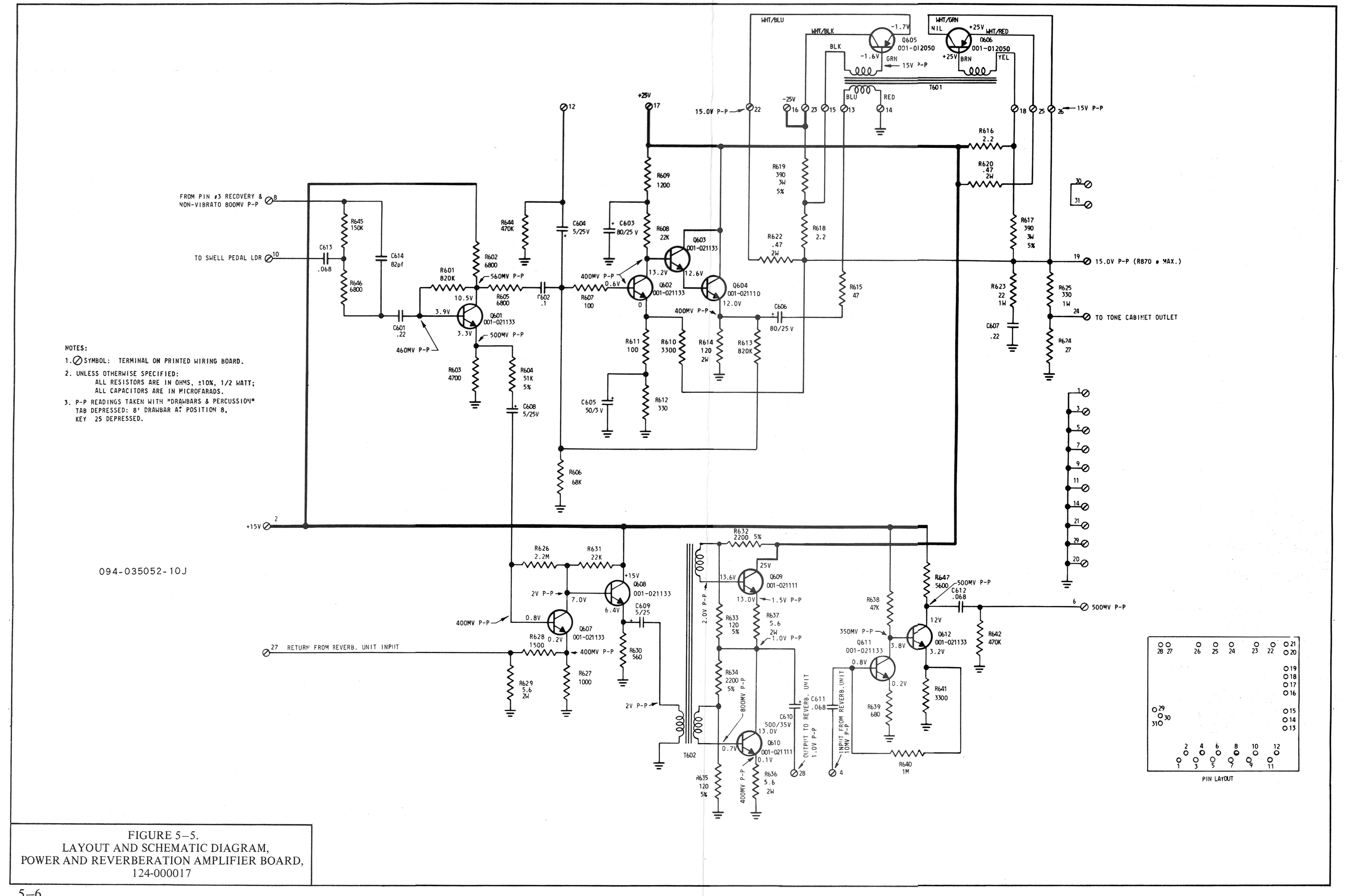


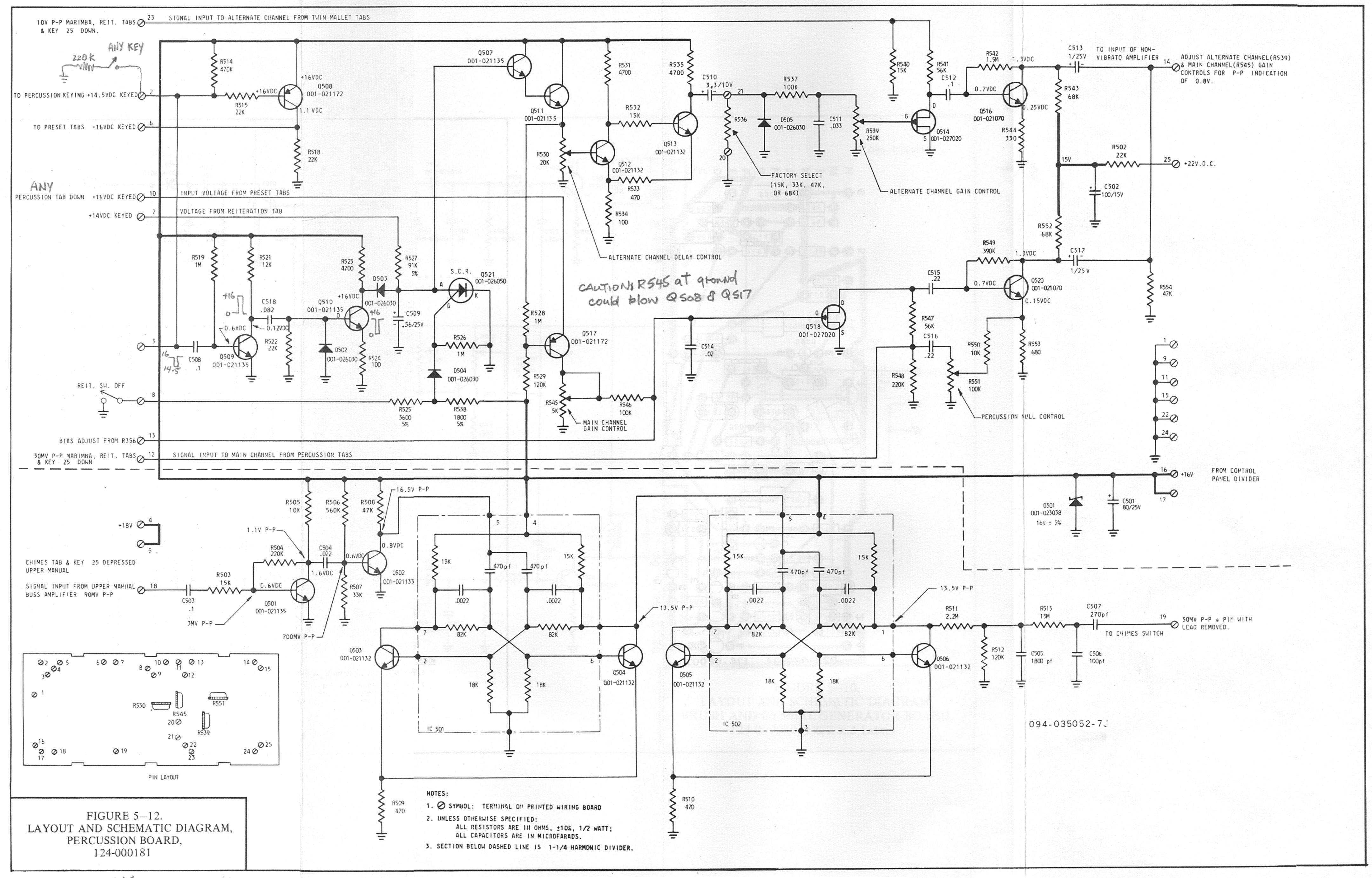












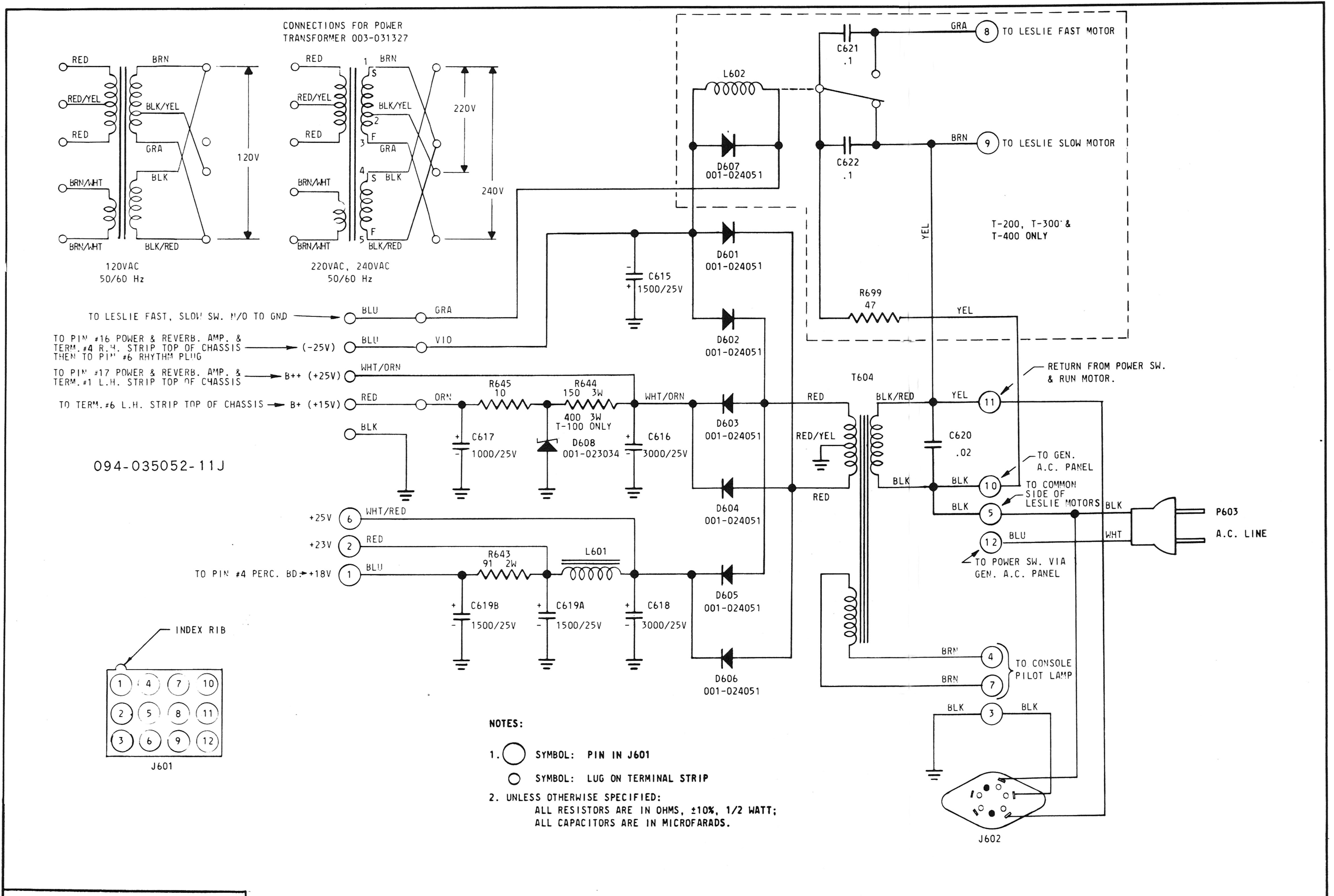
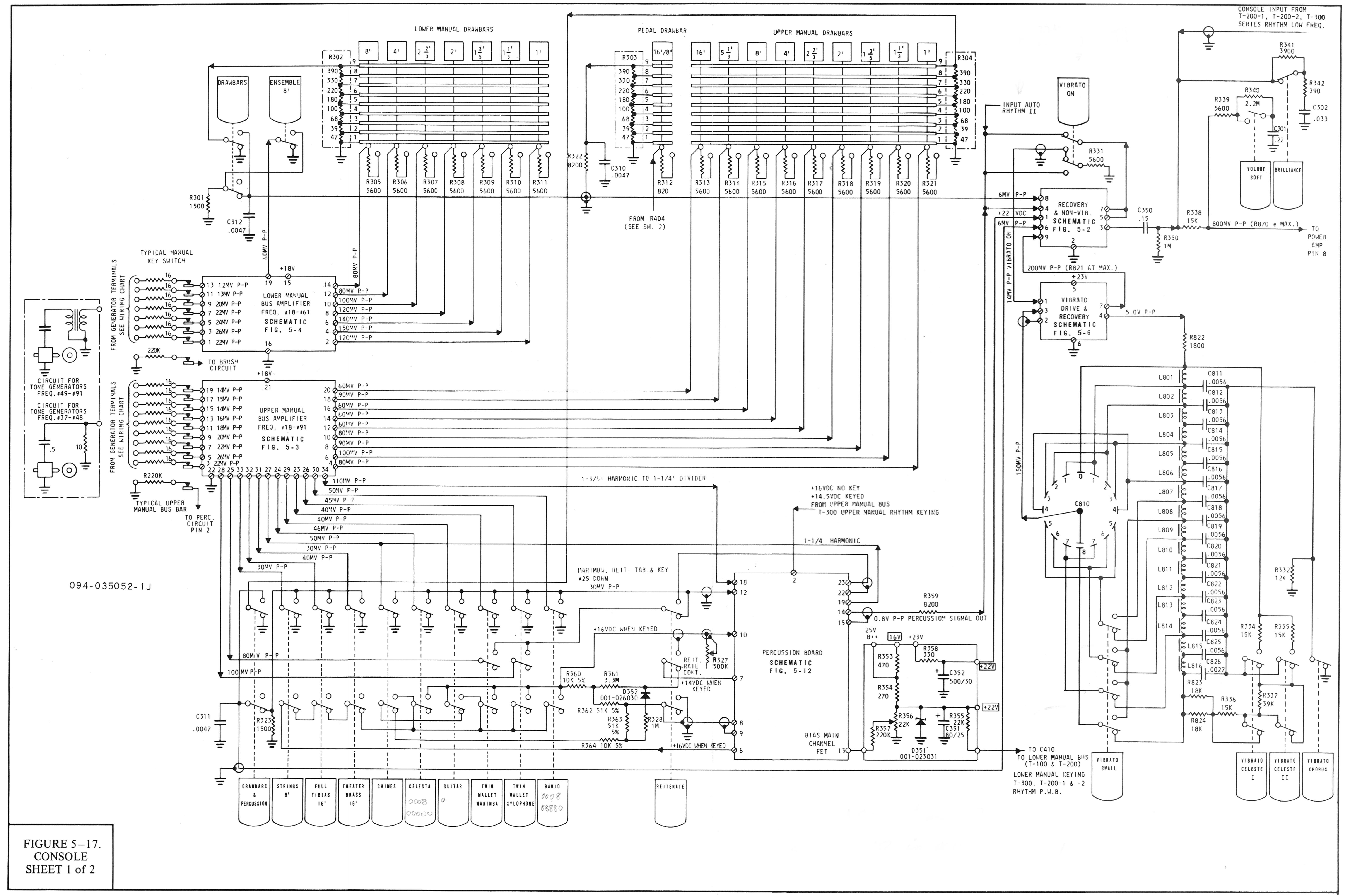


FIGURE 5-16.
SCHEMATIC DIAGRAM,
POWER SUPPLY



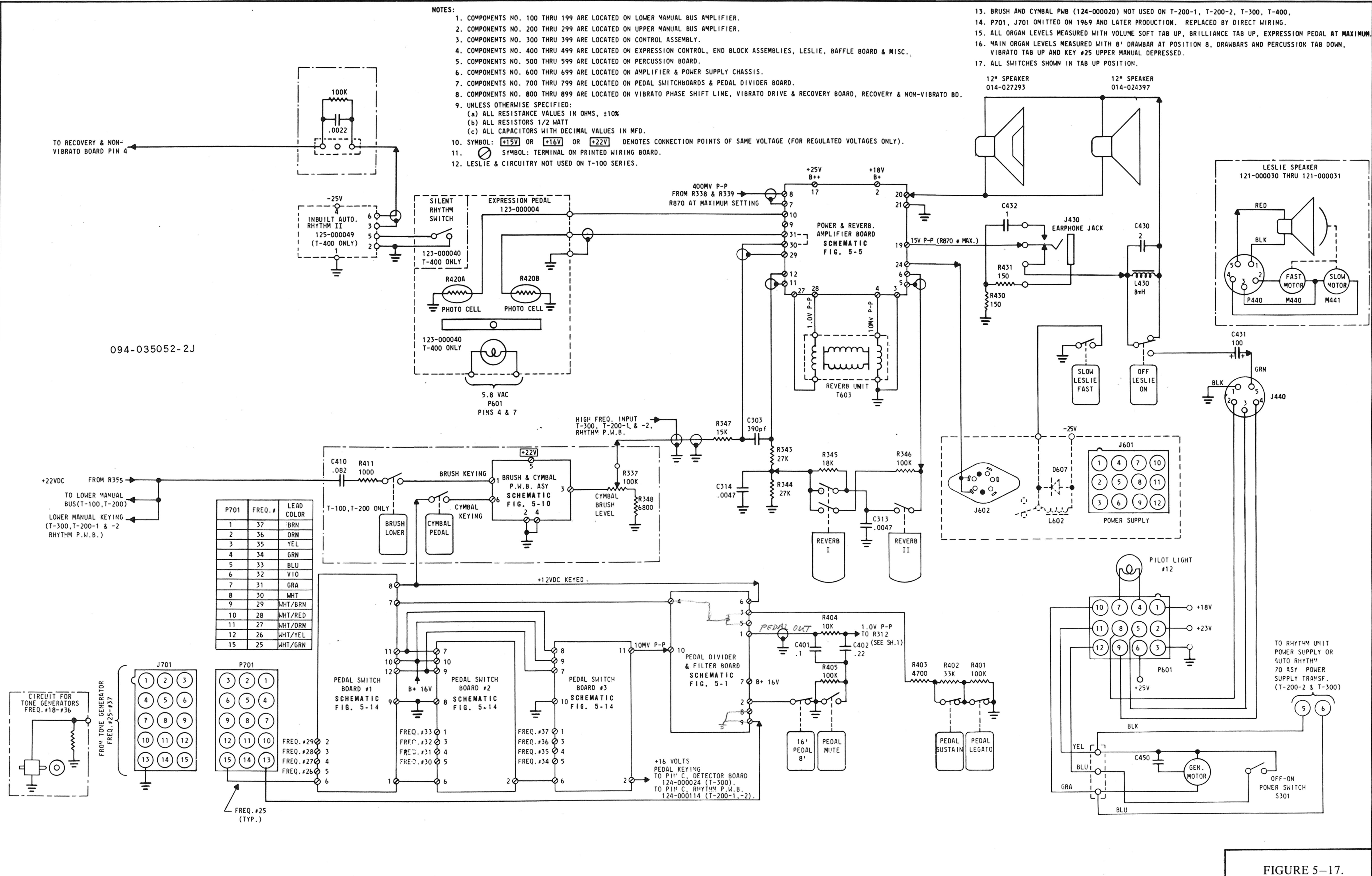


FIGURE 5–17. CONSOLE SHEET 2 of 2

