THE HAMMOND ORGAN

SERVICE INFORMATION

SERIES K-100

HAMMOND ORGAN
"music's most glorious voice"

HAMMOND ORGAN COMPANY

4200 WEST DIVERSEY AVENUE · CHICAGO, ILLINOIS 60639 · AVENUE 3-2000

HS765

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SPECIFICATIONS

Cabinet Size:

45½″ Wide, 25″ Deep, 44½″ High (including music rack)

Weight of Console:

170 lbs.

Power Required:

110 to 120 Volts, 60 Cycles, 110 Watts. Also available for 50 cycles, and for 220 to 240 volts, 50-60 cycles.

Music Power Output (per EIA Standard RS-234):

25 Watts

MUSICAL TERMS

NOTE: Service personnel who lack a musical background should read this section in order to familiarize themselves with the musical terms used in this manual.

Notes on the organ (see Figs. 1 and 2) or any other keyboard instrument are arranged in a pattern of twelve keys which is repeated throughout the length of the keyboard. White keys are named with the first seven letters of the alphabet; black keys take their name from adjacent white keys. As an example, the black key between "F" and "G" may be called or notated F♯ (pronounced F sharp, meaning F "raised") or G♭ (pronounced G flat, meaning G "lowered").

The distance between notes is called an *interval* and is measured in half steps. A *half step* is the interval between any key and the adjacent key such as A to A♯, E to F, etc. The frequency ratio between any two notes a half step apart is 1:1.059. Exact frequencies for each note are shown in Table I.

Twelve half steps make an *octave*. Notes an octave apart will have the same letter name—C to C, F♯ to F♯, etc. The frequency ratio of any two notes an octave apart is 1:2. Other intervals are unisons, seconds, thirds, fourths, fifths, sixths, and sevenths, all measured by counting letters up the desired distance from any given note. The starting note is counted as one (or unison).

These intervals may have several variations, each containing a different number of half steps. For example, a *major third* has four half steps, and a *minor third* has three half steps. To be musically correct the interval of a third must be named from any letter to the third letter away (F to A♭, not F to G♯), even though the resulting sound is identical on the organ. For simplicity in this manual, however, all black keys and related circuitry will be named with sharps only, and musical technicalities will be overlooked.

Voice control tablets on the organ (frequently referred to as *stops*) are named in the pipe organ tradition, and may or may not resemble the instrument for which they are named. In the electronic organ the timbre or tone color of a stop is usually determined by electronic filters which alter the shape of the wave produced by the tone

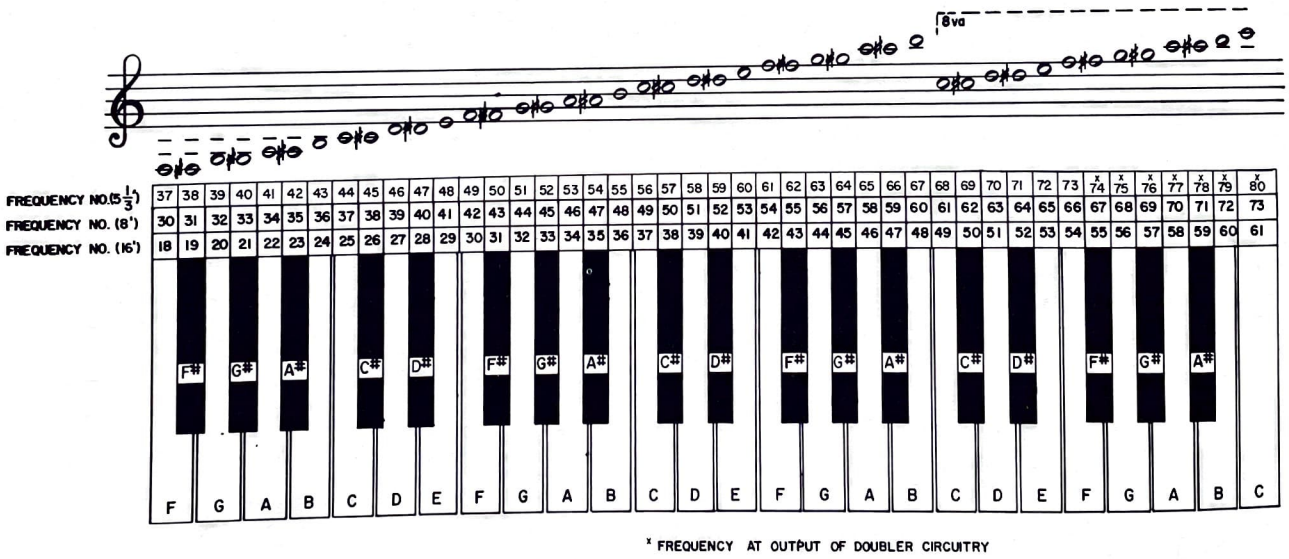

Fig. 1. Notes on Upper Keyboard.

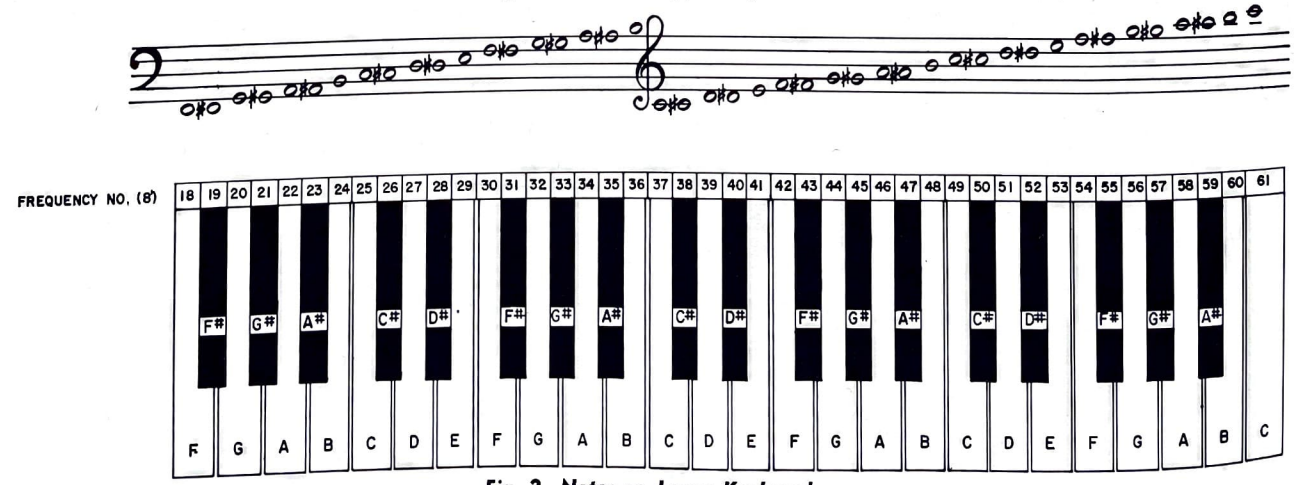

Fig. 2. Notes on Lower Keyboard.

generators. Footage indicated on the voice control tablets determines the pitch (frequency) of the keyboard notes. These footage terms (16′, 8′, and 5⅓′) are derived from the lengths of certain pipes in a conventional organ. 8′ stops produce a sound at the same frequency a piano would if the corresponding note were struck. 16′ stops produce sounds an octave lower than the corresponding piano note, and the 5⅓′ stop produces sounds a fifth higher. Thus if 8′ and 16′ tablets are used simultaneously on the organ, two notes an octave apart will sound for each key depressed.

Vibrato is a slow, regular variation in the pitch of notes. In this organ it is a frequency variation at a selected rate, produced simultaneously in each master oscillator by the vibrato oscillator.

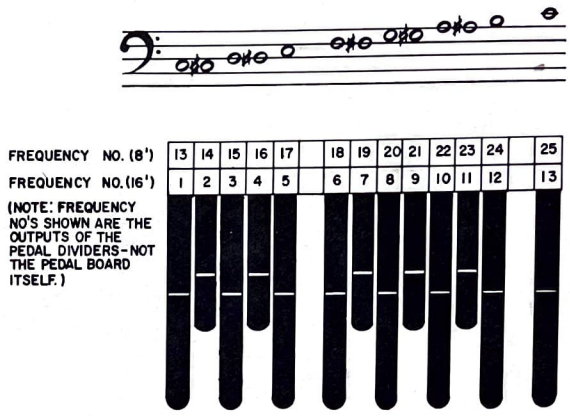

Fig. 3. Notes on Pedal Keyboard.

TABLE I.

EXACT FREQUENCIES OF MUSICAL NOTES.

Tone Generator Frequency Number	*Musical Note*	*Frequency in Cycles Per Second*	*Tone Generator Frequency Number*	*Musical Note*	*Frequency in Cycles Per Second*
1	C	32.703	41	E	329.627
2	C♯	34.647	42	F	349.228
3	D	36.708	43	F♯	369.994
4	D♯	38.890	44	G	391.995
5	E	41.203	45	G♯	415.304
6	F	43.653	46	A	440.000
7	F♯	46.249	47	A♯	466.163
8	G	48.999	48	B	493.883
9	G♯	51.913	49	C	523.251
10	A	55.000	50	C♯	554.365
11	A♯	58.270	51	D	587.329
12	B	61.735	52	D♯	622.253
13	C	65.406	53	E	659.255
14	C♯	69.295	54	F	698.456
15	D	73.416	55	F♯	739.988
16	D♯	77.781	56	G	783.991
17	E	82.406	57	G♯	830.609
18	F	87.307	58	A	880.000
19	F♯	92.498	59	A♯	932.327
20	G	97.998	60	B	987.766
21	G♯	103.826	61	C	1046.502
22	A	110.000	62	C♯	1108.730
23	A♯	116.540	63	D	1174.659
24	B	123.470	64	D♯	1244.507
25	C	130.812	65	E	1318.510
26	C♯	138.591	66	F	1396.912
27	D	146.832	67	F♯	1479.976
28	D♯	155.563	68	G	1567.982
29	E	164.813	69	G♯	1661.218
30	F	174.614	70	A	1760.000
31	F♯	184.997	71	A♯	1864.654
32	G	195.997	72	B	1975.532
33	G♯	207.652	73	C	2093.004
34	A	220.000	74	C♯	2217.460
35	A♯	233.081	75	D	2349.318
36	B	246.941	76	D♯	2489.014
37	C	261.625	77	E	2637.020
38	C♯	277.182	78	F	2793.824
39	D	293.664	79	F♯	2959.952
40	D♯	311.126	80	G	3135.964

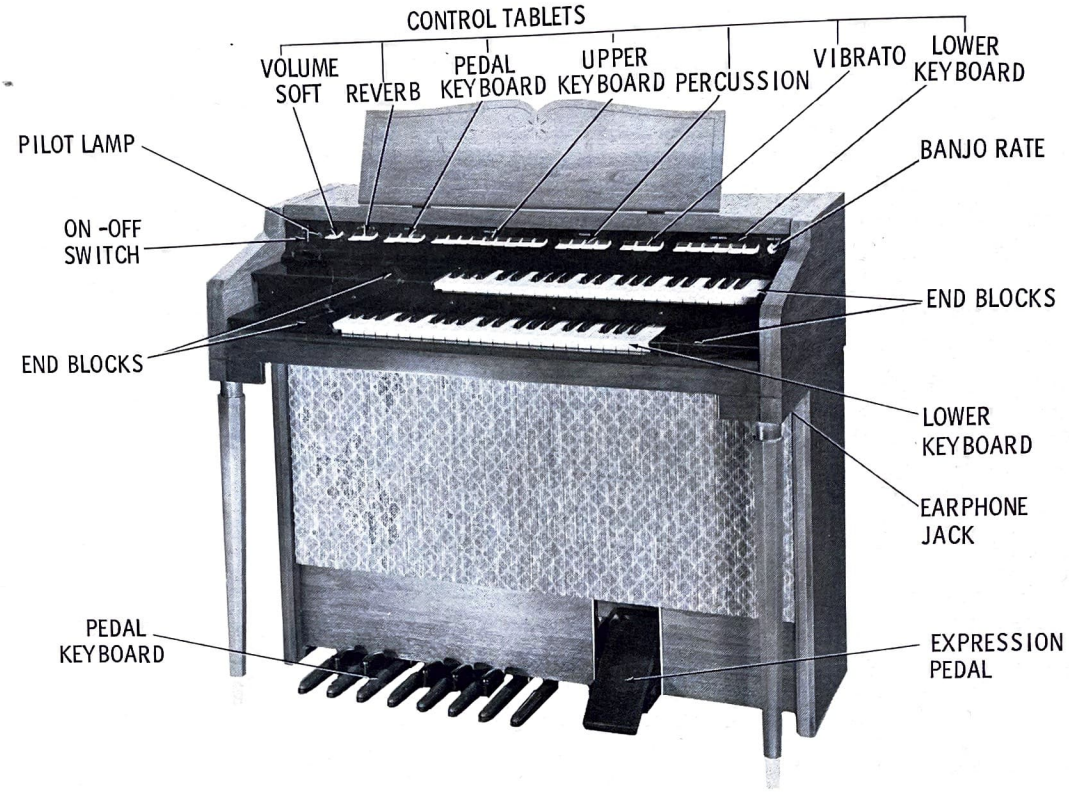

Fig. 4. Front View.

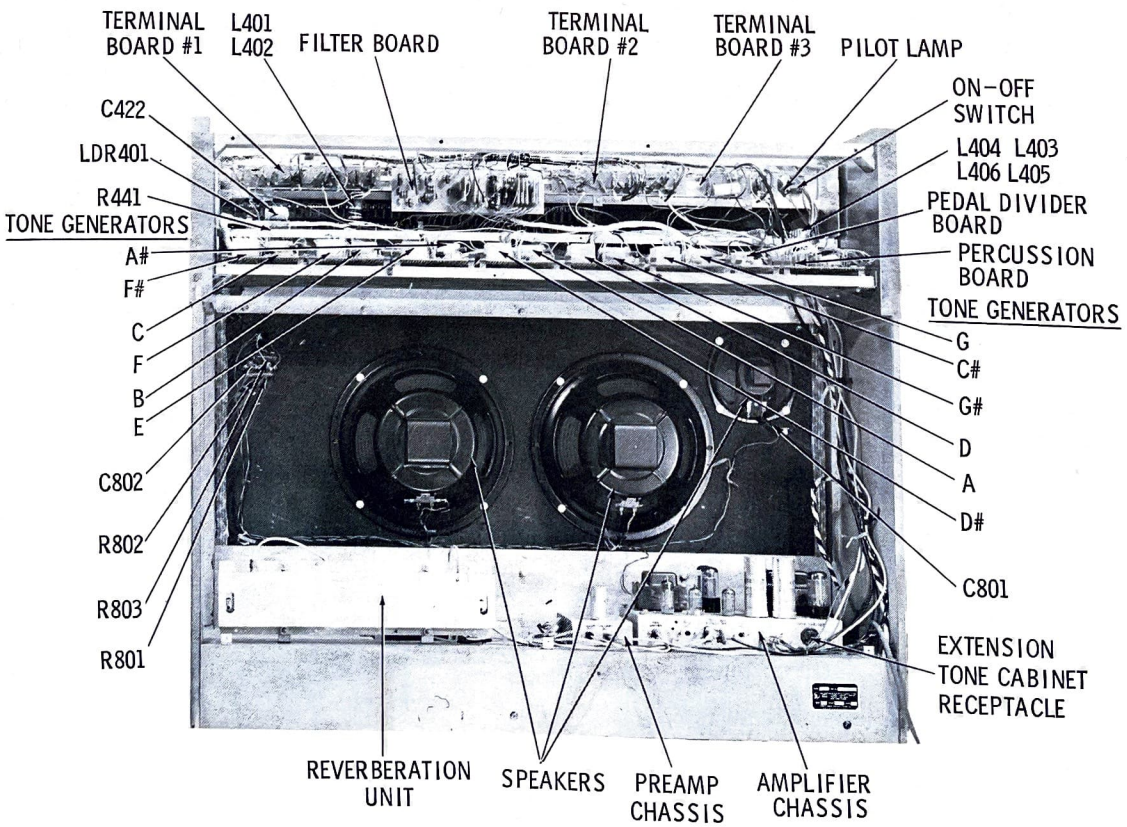

Fig. 5. Back View.

GENERAL DESCRIPTION

Models of this Series are completely self-contained consoles, requiring no external tone cabinet. (A receptacle is available, however, for connecting a tone cabinet, if desired.) Each instrument has two 44-note manual keyboards and a 13-note pedal keyboard. Two 12″ speakers and one 6″ speaker are used. They are disconnected when earphones are plugged into the jack provided for earphone listening.

The tone quality produced by the two manuals and the pedals is controlled by a wide selection of tablets or stops. Tone color of the upper manual can be varied by the use of three 16′ tablets (FLUTE, CELLO, CLARINET), five 8′ tablets (DIAPASON, FLUTE, VIOLIN, OBOE, TRUMPET), and one 5⅓′ tablet (QUINT). Four percussion tablets (HAWAIIAN GUITAR, NOVAVOX, BANJO, HARPSICHORD) add special effects to the tone colors available on the upper manual.

The lower manual has five 8′ stops (DIAPASON, MELODIA, FLUTE, STRING, HORN) and an ACCENT tablet. When the ACCENT tablet is used the volume of the lower manual is increased relative to the upper manual. Tone color, pitch range, and loudness of the pedals are determined by three tablets (16′ SUB BASS, 16′ MAJOR BASS, 8′ FLUTE).

The width of the vibrato is regulated by the VIBRATO WIDE tablet, and the speed of the vibrato is selected by the VIBRATO FAST tablet. Vibrato is not present until the VIBRATO ON tablet is depressed.

An expression (or swell) pedal regulates the overall volume. However, the maximum loudness may be reduced for small rooms by using the VOLUME SOFT tablet. Three degrees of reverberation may be added by using REVERB I, REVERB II, or both together. (Note that when both are off there is intentionally a small amount of reverberation remaining.)

Location of the major components on the organ console is shown in Fig. 4.

HOW THE ORGAN IS PLAYED

Playing an electronic organ involves principles which may be unfamiliar. The serviceman will find it worthwhile to acquaint himself with the playing procedures since this knowledge will be found very helpful in locating the sources of any troubles that may occur.

The organ OFF-ON switch is located at the left end of the control panel. A pilot light next to the switch glows when the organ is on.

Melody is normally played on the upper manual with the right hand. The tone color or timbre of the melody is determined by depressing one or more of the "UPPER MANUAL" tablets to the left of center on the control panel. Tablets may be used singly or in combination, but at least one of these tablets (or a percussion tablet) must be depressed in order to produce a sound from the upper manual. When 8′ tablets are used the pitch will be the same frequency as the corresponding note on a piano; it will be an octave lower if 16′ tablets are used. A melody may be played "in octaves" by combining 8′ and 16′ tablets. The 5⅓′ QUINT tablet is used mainly to give a baroque, oriental, or chorus effect to the other tablets.

"PERCUSSION" tablets give special effects to the notes of the upper manual. They are most effective when used one at a time without any "UPPER MANUAL" tablets, though combinations are possible.

Accompaniment will normally be played by the left hand using the lower manual. The five "LOWER MANUAL" tablets at the right are used to select a tone quality which will be suitable for accompanying the melody. Here again at least one tablet must be depressed in order to produce a sound from this manual. The ACCENT tablet may be used to make a left hand melody balance with a right hand accompaniment.

Low bass notes are supplied by the pedal keyboard which is normally played with the left foot. The three "PEDAL" tablets determine the tone color, pitch range, and loudness of the pedal notes. Balance between the upper, lower, and pedal keyboards is determined by which tablets are used.

The expression pedal, operated by the right foot, controls the overall loudness of sound developed by the organ. Depressing the toe increases the volume, and depressing the heel decreases the volume. When it is desired to restrict the maximum volume of the organ, the VOLUME SOFT tablet should be depressed.

Three tablets affect the vibrato. Depressing the VIBRATO ON tablet adds vibrato to the sound of the organ. The width of the vibrato effect (when used) is determined by the position of the VIBRATO WIDE tablet, and the speed by the position of the VIBRATO FAST tablet.

Reverberation gives a full and resonant sound to the organ. When REVERB I is depressed only a little reverberation is heard. REVERB II adds more, and REVERB I and II used together give a maximum amount.

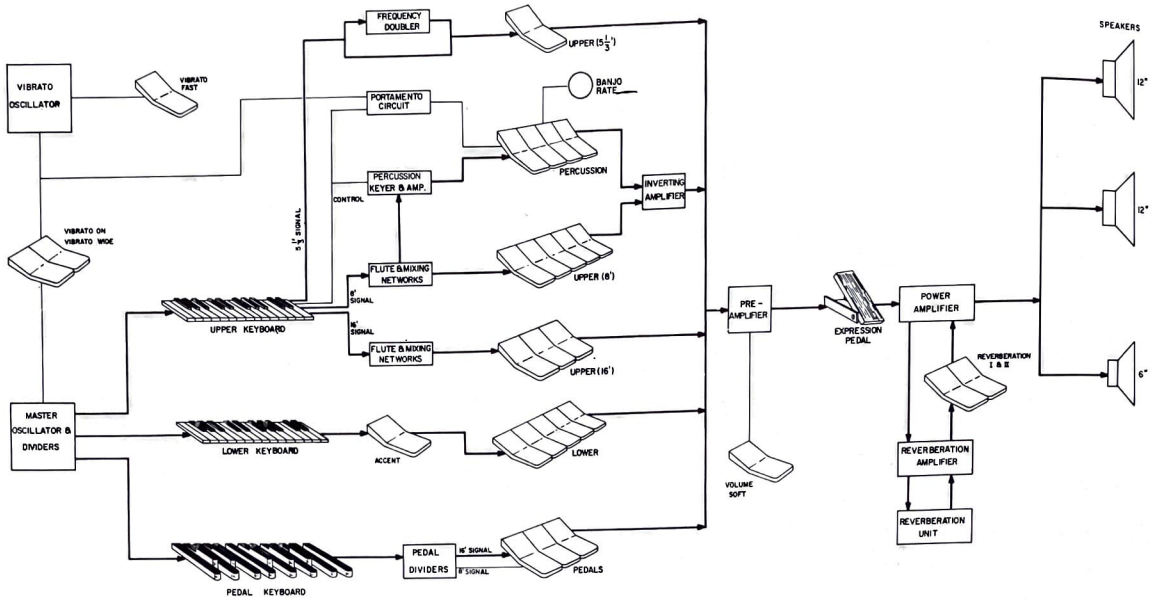

Fig. 6. Block Diagram.

THEORY OF OPERATION

General (See Block Diagram, Fig. 6)

The basic organ tones for the highest 8′ octave are generated by twelve transistor oscillators. Lower octaves are produced by frequency dividers locked to the basic oscillators. A vibrato oscillator, acting through its control tablets, produces pitch variations in the master oscillator, and consequently in the frequency dividers.

Each key contact of the upper, lower, and pedal keyboards is connected to the appropriate tone generator output. Tones selected by the keys pass through filters selected by the voice control tablets. The percussion voices pass through keyers which cause the tones to fade away (decay) after they sound instead of remaining at constant volume.

The pedal switches are followed by a frequency divider system which produces the deep bass notes. Tablets select 8′ or 16′ pitches. The output of all voice tablets is combined and fed into the preamplifiers, the expression pedal, and the power amplifier. The expression pedal is compensated in order to maintain a constant tone color as it varies the loudness. The power amplifier drives three speakers.

A portion of the signal is tapped off in the power amplifier, delayed by the reverberation unit, and returned to the power amplifier to give a "concert hall" effect to the sound of the organ.

Vibrato (See Schematic, Fig. 29)

Vibrato is produced by varying the bias voltage at the base of each master oscillator transistor. Since the frequency dividers are locked to the master oscillator, vibrato is present in all the tones produced in each generator. The low frequency voltage is generated by a low frequency oscillator (V601B) and fed to the VIBRATO ON tablet through C605 and R608. The VIB-RATE control (R601) is set to give the correct frequency to the vibrato oscillator. (See "Adjustments").

The output of the vibrato oscillator is disconnected from the tone generator until the VIBRATO ON tablet is depressed. In "ON" position the vibrato signal is fed to the VIBRATO WIDE tablet, which affects the size (peak-to-peak voltage) of the vibrato signal but not its rate of oscillation. When depressed the VIBRATO WIDE tablet will produce a greater frequency variation of the tone generators.

The VIBRATO FAST tablet affects the frequency of the vibrato oscillator. Depressing this tablet shorts out R602, which changes the rate of oscillation from a slow rate of approximately 6 cycles per second to a fast rate of approximately 7 cycles per second.

The VIBRATO WIDE and VIBRATO FAST tablets work independently of each other so any combination of vibrato tablet positions may be used. Vibrato oscillator circuitry is located on the preamplifier chassis.

Upper Manual or Keyboard (See Figs. 7, 25, and 29)

Three tones are fed from the tone generators into each key circuit of the upper keyboard—a 5⅓′ signal from Frequency Nos. 37 through 73,

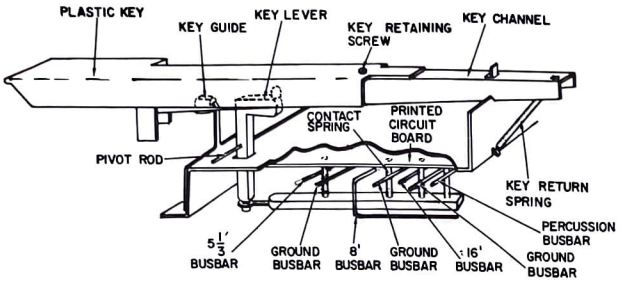

Fig. 7. Upper Keyboard—Key Construction.

an 8′ signal from Frequency Nos. 30 through 73, and a 16′ signal from Frequency Nos. 18 through 61. Each frequency number is connected to a different terminal on a printed wiring board under the keys, and printed circuitry connects each frequency to the proper resistors for each key.

When a key is depressed several switching actions take place. Various busbars act as the fixed switch contacts, and gold-plated coil springs serve as movable contacts. Signal is fed into the springs, which normally rest against grounded busbars. When a key is depressed, three springs (one each for 16′, 8′, and 5⅓′ signals) are moved away from the ground busbars and against the output busbars. A fourth spring contacts the D.C. busbar at the same time to control the percussion and portamento circuits.

The 5⅓′ output busbar is split into two sections, and the output of the lowest 37 notes is collected on one section. Since frequency numbers 74 to 80 are needed for the highest seven notes but are not generated by the tone generators, tones an octave lower (Frequency Nos. 62 through 68) are used. The output of these 7 notes is collected on the other section of the busbar and doubled in frequency in the bandpass doubler to provide Frequency Nos. 74 through 80. (Note that the doubler can handle any combination of these notes simultaneously.) This signal is then combined with the lower section and fed to the QUINT voice control tablet and filter.

The 8′ output busbar is divided into 22 sections with two output signals from each section. One output of each section is then recombined into five groups, each being fed into an 8′ flute filter. The other output of each of the 22 sections is recombined into 9 groups, and each group is fed into a keyer circuit. Details of these combinations are indicated on the schematic.

Each of the 8′ flute filters has a "bright" and a "flute" output. Flute outputs are combined and fed through the 8′ flute preamplifier to the 8′ flute tablet. Bright outputs are combined and fed through the bright preamplifier to the other 8′ tablets.

The 16′ output busbar is divided into three sections, each section feeding a 16′ flute filter. Each 16′ flute filter has a bright and a flute output. Flute outputs are combined and bright outputs are also combined, and the two are fed separately to the control tablets.

Lower Manual or Keyboard (See Figs. 8, 26, and 29)

One tone from the tone generators is fed into each key circuit of the lower manual (Frequency Nos. 18 through 61) through isolating resistor R951. When a key is depressed the contact wire touches the busbar, completing the signal circuit. Since the busbar is common to all keys of this manual, the output for all keys depressed is combined on the busbar and then is fed into the voice control tablets through the ACCENT tablet.

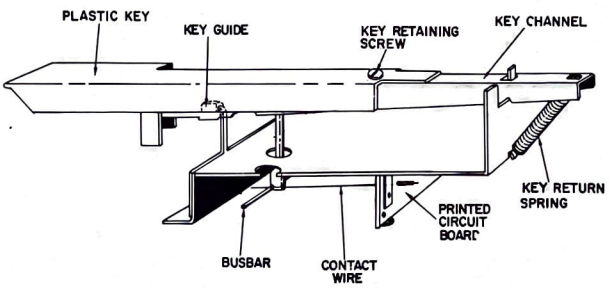

Fig. 8. Lower Keyboard—Key Construction.

Pedal Keyboard (See Schematic, Fig. 29)

Frequency Nos. 25 through 37 are fed from the tone generator pedal outputs to the pedal keyboard. Switches on the pedal keyboard are connected in series in such a manner that when no pedals are depressed, the output is grounded. Depressing a pedal breaks the ground connection and applies the signal from the selected tone generator to the output through the series-connected switches of all the higher pedals. If more than one pedal is depressed at the same time, only the highest pedal note will sound.

Output of the pedal keyboard is fed to the pedal divider board.

Pedal Divider Board (See Schematic, Fig. 29)

Signal from the pedal keyboard is fed to the first pedal divider (Q201 and Q202) through a diode (D205) and a resistor (R217). This divider is a flip-flop which is triggered by the pedal signal. Since its output is half the frequency of the input signal, the divider drops the pedal tone one octave to give an 8′ pedal signal. The output of the first pedal divider is used to trigger the second pedal divider (also a flip-flop circuit), and again the output is half the frequency of the triggering signal, giving a 16′ pedal signal. The output of each flip-flop is sent separately to the pedal voice control tablets.

Percussion Keyers (See Schematic, Fig. 29)

Signal from the 22 sections of the 8′ output busbar (upper manual) is divided in printed net-

works, one part going to the 8′ flute filters and the other going to the percussion keyers. Percussion signals must pass through two diodes (D301 and D302) in a keyer (K1), or the corresponding diodes of the other keyers. (A total of nine keyers are used.) However, the amount the diodes will conduct is determined by the DC potential on the cathodes of the diodes. When they are negative full conduction occurs, but as they become less negative the diodes become gradually less conducting until they are cut off.

When a key is depressed signal is applied to the diode (D301). At the same time contact is made with the DC keying busbar which results in a negative charge on the cathodes of the diodes. Thus the note sounds at full strength the instant the key is depressed. As a capacitor (C301) discharges, cathodes of the diodes (D301 and D302) become less negative, cutting off the signal. As soon as the key is released, the capacitor (C301) is quickly charged, ready for the next keying. Thus the decay rates of percussion notes is carefully controlled by the keyers. From here signal goes to the percussion tablets through the percussion preamp.

If a note should be played while another note using the same keyer is depressed, the former will not sound if the latter has decayed since the keyer will still be cut off.

8′ Flute Filters (See Schematic Fig. 29)

One path of 8′ signals from the upper manual is through the 8′ flute filters. (The other signal path is into the percussion keyers.) Frequencies 30 through 37 enter one filter, 38 through 47 the second, 48 through 55 the third, 56 through 65 the fourth, and 66 through 73 the fifth. Component values in the filters vary with the group of frequencies handled in order to keep all tones in proper balance. The filters have a "Bright" and a "Flute" output. All of the bright outputs are fed to the bright preamp, and all of the flute outputs are fed to the flute preamp. These are single stage transistor amplifiers which restore some of the losses in the filter networks.

16′ Flute Filters (See Schematic Fig. 29)

The 16′ signals from the upper keyboard are fed into the 16′ flute filters. Frequencies 18 through 37 enter one filter, 38 through 49 the second, and 50 through 61 the third. Component values in the filters vary with the group of frequencies handled in order to keep all tones in proper balance. The filters have a "bright" and a "flute" output. All bright outputs are combined as are all flute outputs; they go then to the 16′ upper manual tablets.

Portamento (See Schematic Fig. 29)

Portamento is sliding into the correct pitch from below, such as is characteristic of Hawaiian guitars. On this organ, it is effective only when the HAWAIIAN GUITAR tablet is depressed. The effect is produced by applying a rapidly disappearing negative voltage to the base of the master oscillators which lowers the oscillator frequency about four per cent (and with it all tone generator outputs). As the pulse becomes less negative the oscillator returns to its normal frequency. This negative voltage is produced as follows:

When one key is depressed on the upper keyboard, a voltage divider is formed across the 3-volt supply consisting of R306 (or R309, or R312) and R208, which puts a positive voltage on capacitor C204. C204 differentiates this voltage into a rapidly rising, slowly decaying pulse which is applied to the base of transistor Q206. However, Q206 is biased (by transistor Q205, R215, and related circuitry) so that this pulse will not be sufficient to cause Q206 to conduct when only one key is operated.

If two or more keys are depressed, the voltage across R208 will place a higher positive voltage on C204, and transistor Q206 will conduct until this positive voltage decays. If the HAWAIIAN GUITAR tablet is depressed, this voltage will be transferred to the bases of the master oscillators, producing the portamento effect.

Voice Control Tablets and Tone Filters (See Schematic, Fig. 29)

Tablets can be divided into two groups depending on whether they select a tone color (voice control tablet) or regulate some function. The latter (VIBRATO, VOLUME SOFT, REVERBERATION, ACCENT) are discussed under the circuitry they serve.

Voice control tablets have tone filters associated with them to give a distinctive sound to the output. Since signal passes through this section only when voice control tablets are depressed, at least one tablet for each manual must be used before any sound is produced by the keys or pedals.

Voice control tablets are grouped by the keyboard they serve. Upper manual 16′ tablets receive signal from the bright and flute outputs of the 16′ flute filters. (The 16′ CLARINET also receives an 8′ signal from the 8′ bright preamp.) Output goes to the preamplifier chassis. 8′ tablets receive signal from the flute and bright preamps; output goes through the inverting amplifier to the preamplifier chassis. The 5⅓′ QUINT tablet receives signal from the bandpass doubler and from the 5⅓′ busbar. Signal then combines with the 8′ and

the 16′ voice control tablets and is fed into the preamplifier chassis.

Percussion tablets affect the sound of the upper keyboard. Signal for the NOVAVOX, HAWAIIAN GUITAR, and HARPSICHORD comes from the percussion keyers. After filtering and wave shaping these signals combine and are fed into the inverting amplifier. The HAWAIIAN GUITAR and NOVAVOX tablets also slow the percussion decay rate from approximately one second (used with the HARPSICHORD) to 2½ seconds, by grounding one end of resistor R332 in the keyer circuitry. The HAWAIIAN GUITAR tablet also switches the portamento control voltage into the vibrato circuitry, and an 8′ flute signal (from the 8′ flute preamp) into the inverting amplifier.

The BANJO tablet receives signal from the 8′ bright preamp. A semiconductor photocell interrupts the signal, which is then fed through the 8′ OBOE tone filter into the inverting amplifier. The photocell is pulsed by a neon lamp oscillator whose frequency is varied by the BANJO RATE control.

Lower keyboard tablets and tone filters receive signals through the ACCENT tablet; output goes to the preamplifier. Pedal tablets are fed by the 8′ and 16′ outputs of the pedal dividers. Output in this case goes to the preamplifier through C433.

Preamplifier (See Schematic, Fig. 29)

The preamplifier (V602) provides one stage of amplification. Negative feedback in this stage (R613) insures stability, uniform gain, and proper frequency response. When the VOLUME SOFT tablet is depressed a resistor (R484) is shorted out, and part of the signal from V602 is bypassed to ground through R617 and C436. The preamplifier chassis plugs into the amplifier chassis.

Expression Pedal (See Schematic, Fig. 29)

The input cable of the expression pedal connects to a jack in the preamplifier chassis. The pedal operates a shutter which varies the light falling on a light-dependent resistor. C501, R502, C502, and R503 form a compensating network to give the desired frequency response. The output cable connects to a jack on the amplifier chassis.

Amplifier Chassis (See Schematic, Fig. 19)

Three functions are served by components on the amplifier chassis; (1) a power amplifier, (2) a reverberation amplifier, and (3) the power supply.

Signal to the power amplifier is first attenuated by the GAIN adjustment (R704) which is set at the factory to limit the maximum signal and prevent distortion due to overdriving the output stage. After one stage of amplification (V702A), an electronic mixer-amplifier (V703B), an impedance-matching stage (V704A), a phase inverter (V704B), and a pushpull output (V705, V706) the signal is fed to two 12″ speakers and one 6″ speaker connected in parallel. A capacitor (C801) blocks low frequencies from the 6″ speaker.

Signal for the reverberation amplifier is taken from the plate of V702A, amplified (V702B), and transformer-coupled (T702) to the reverb unit. Output of the reverb unit is amplified (V703A), and attenuated by the REVERB tablets and the REVERB adjustment (R719). The REVERB adjustment is set at the factory to insure proper balance between the reverb and the direct signals, which are mixed by V703B.

The power supply uses V701 as a full wave rectifier. B+ power is tapped off a voltage divider at appropriate levels for all tube circuitry. Silicon rectifiers (D701, D702), working from low voltage taps on the power transformer high voltage winding, provide B+ for all transistor circuitry.

MAINTENANCE

Cleaning Keys and Woodwork

Clean plastic keys and control tablets lightly with a soft, damp cloth or chamois. Wiping with a dry cloth builds up an electrostatic charge which will attract dust particles from the air. If cleaning agents are necessary, use pure facial soap and lukewarm water. Dry without excessive rubbing. Do not use boiling water, strong solvents such as alcohol, dry cleaning fluids, or window cleaning fluids which contain such solvents.

Clean and dust the woodwork with a soft, damp cloth or chamois. If cleaning agents are necessary, use a soft cloth lightly dampened with a solution of mild soap and lukewarm water. Remove solution, using soft cloth dampened with clean water. Dry thoroughly, rubbing with the grain. Use a good grade liquid furniture wax or polish. *Avoid use of paste waxes or oil type polishes.* Excessive rubbing in one spot or at edges may result in damage to the finish.

Cleaning Switch Contacts

Electrical circuits in this organ are made and broken by several different types of switches. In the upper manual gold-plated coil springs are pushed against gold-plated busbars. In the lower manual contact wires are pushed against a busbar. The switches associated with the control tablets are similar to a conventional leaf switch, and are opened and closed by plastic fingers on

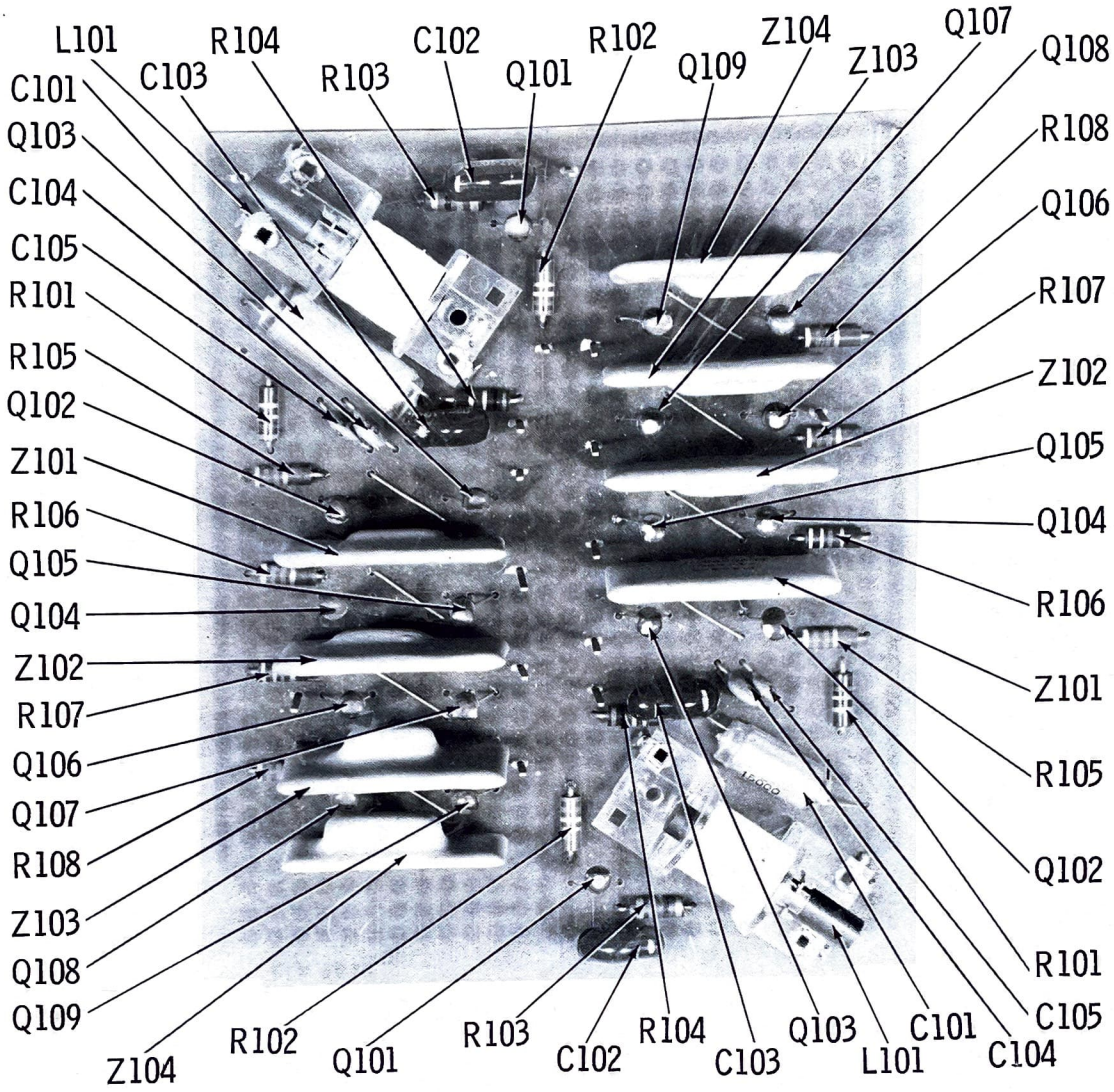

Fig. 9. Tone Generator Circuit Board—Component Identification.

the tablets. Pedal keyboard switches consist of a contact leaf moved against a fixed contact by the pedals through an actuator. In all cases precious metals are used for the contact area so there is little possibility of oxidation or corrosion under normal environmental conditions which would interfere with a good electrical contact.

However, foreign material (dust, dirt, grease) can accumulate on the contact surfaces and cause a poor circuit connection. In some cases it can be dislodged by striking the key or tablet 15 or 20 times in a rapid staccato manner. If not, cleaning the affected contact surfaces is all that is required to restore normal operation.

Contacts on the control tablets and the pedal switches may be cleaned by wiping gently, taking care not to place a permanent bend in the contact spring. The corner of a small piece of stiff paper is handy for this purpose. In extreme cases it may be necessary to rub the contact surfaces *very gently* with a burnishing tool or a piece of very fine sandpaper (never use emery cloth or emery paper).

The key contacts may be similarly treated but use of any metal tool or sandpaper should be avoided, because of the danger of removing the plating.

Moving or Shipping

If the organ is moved, be sure that its weight is supported by the case and not by the pedals or pedal mechanism. Be careful not to put undue strain on the legs. If the organ is to be shipped by a carrier other than a regular furniture mover, it should be packed carefully in an original factory shipping carton.

Location of Console

The back of the console should be at least two inches from the wall for ventilation and for best acoustic results.

Replacing the Pilot Lamp

To replace the #12 pilot lamp, remove top of organ cabinet, remove control assembly cover, and pull the lamp out of its socket. The cap slides off easily.

Replacing Expression Pedal Lamp

Remove two pivot screws, lift pedal off, and pull out lamp from right side of plastic housing. Replace with #1866, which is the same as a #44, but has long life rating.

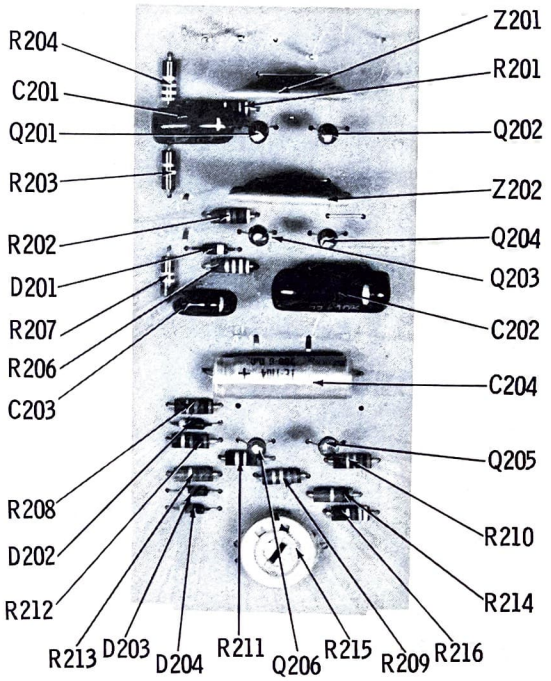

Fig. 10. Pedal Divider Circuit Board—Component Identification.

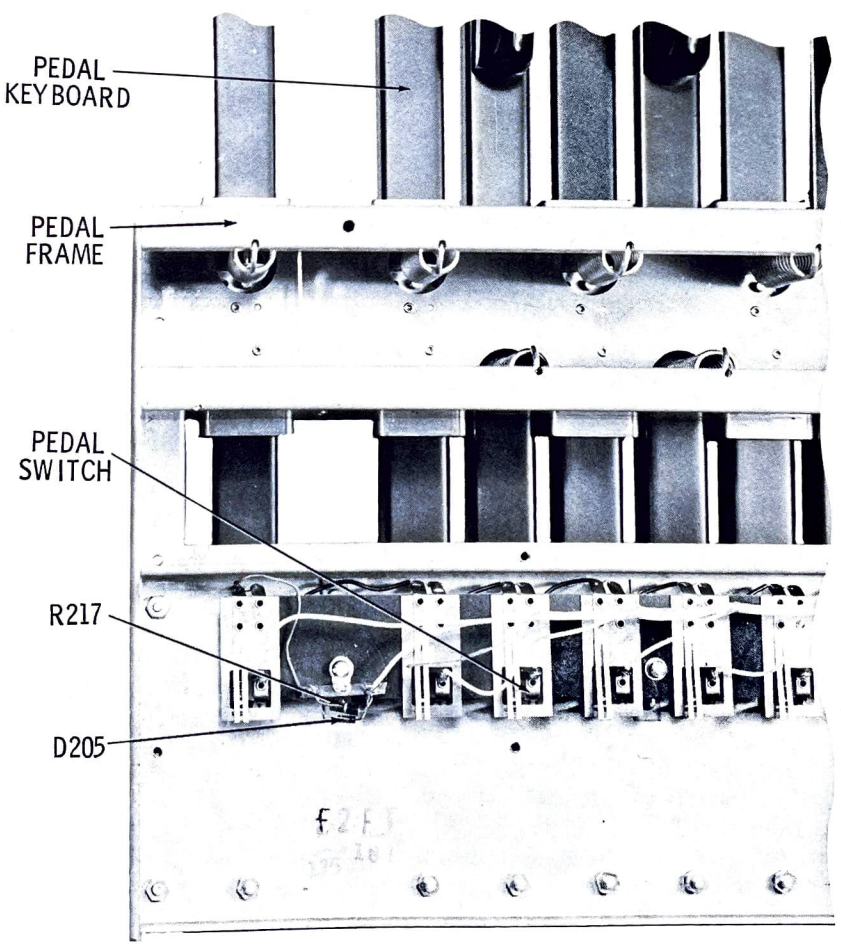

Fig. 11. Pedal Keyboard.

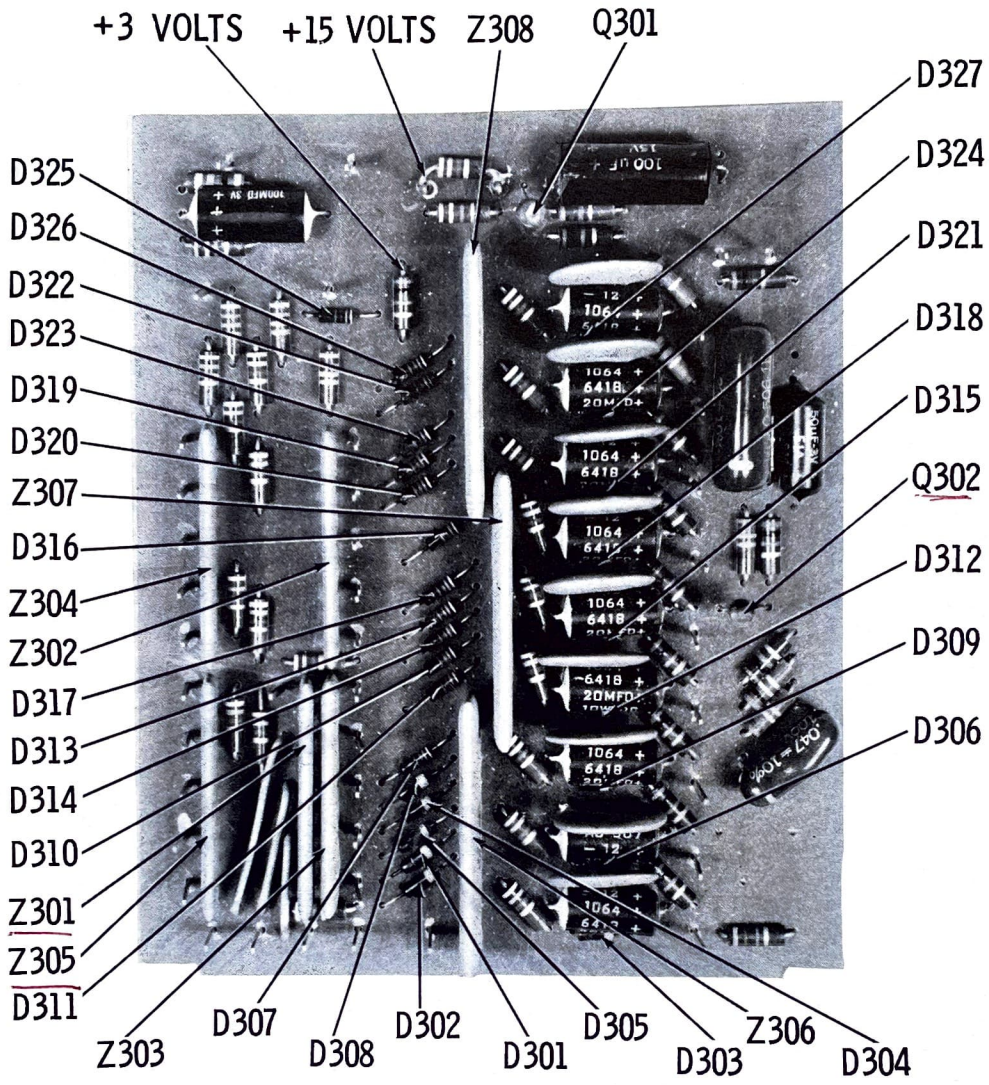

Fig. 12. Percussion Circuit Board—Diode, Transistor, and Printed Network Identification.

ADJUSTMENTS

Reverberation Adjustment (R719)
(See Fig. 22 for location)

The REVERB adjustment does not normally require changing after being set at the factory. The possibility of defective components in the reverberation amplifier circuitry should be explored thoroughly before any change is made.

To reset the reverberation adjustment, depress the expression pedal all the way, and depress 8′ DIAPASON (Upper Manual), VIBRATO ON, VIBRATO WIDE, VIBRATO FAST, REVERB I, and REVERB II tablets. All other tablets should be in "off" position. On underside of amplifier, ground the junction of R721 (470K) and R722 (1.5 meg). Connect an AC voltmeter between the amplifier chassis and the green lead to the 12″ speakers. While holding down the middle C, E, and G keys on the upper manual, turn the reververation adjustment until the voltmeter reads 0.4 volt rms.

Gain Adjustment (R704)

The gain adjustment does not normally require changing after being set at the factory. The possibility of defective components in the amplifier circuitry should be explored thoroughly before any change is made.

To reset the gain adjustment depress the expression pedal all the way and depress only the upper manual 16′ FLUTE tablet. All other tablets should be in "off" position. Connect an AC voltmeter between the amplifier chassis and the

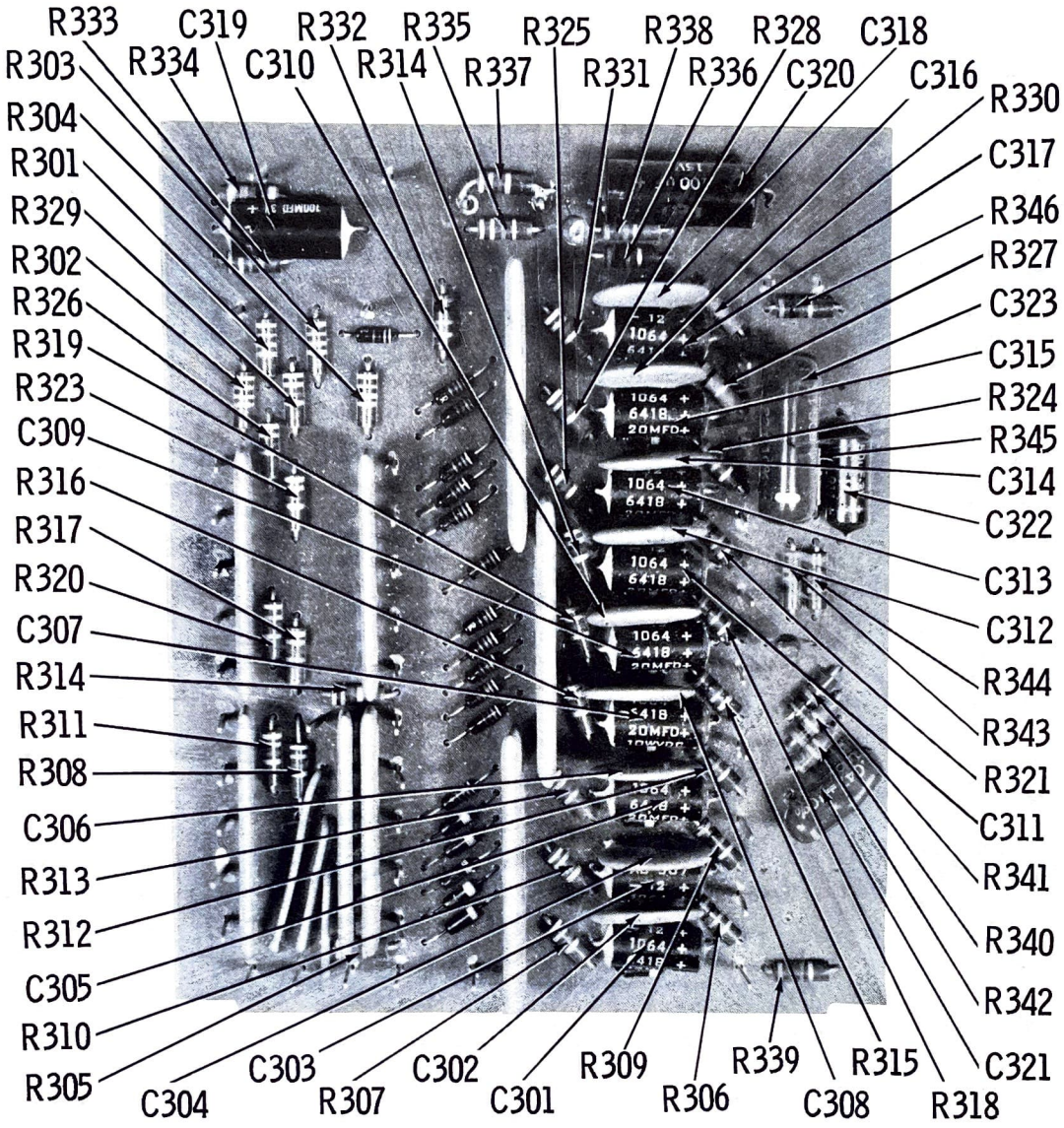

Fig. 13. Percussion Circuit Board—Resistor and Capacitor Identification.

green lead to one of the 12" speakers. While holding down the lowest "C" on the upper keyboard turn the gain adjustment until the voltmeter reads 1.7 volts.

Vibrato Rate Adjustment (R601)

The VIB-RATE adjustment does not normally require changing after being set at the factory. The possibility of defective components in the vibrato circuitry should be explored thoroughly before any change is made.

To reset the VIB-RATE adjustment play the organ using VIBRATO ON, VIBRATO WIDE, and VIBRATO FAST tablets as well as any voice control tablets desired (but not the percussion tablets). Turn the control to some point in mid-range satisfactory to the customer. Be sure also to try the organ with the VIBRATO FAST tablet off.

Resistor R337

Resistor R337 is selected at the factory so the output of the 3-volt regulator will be 3.0 volts. If any components in this circuitry are replaced it might be necessary to change the value of this resistor. Before any change is made, however, the 15-volt supply should be checked and any changes necessary to correct this supply should be made. Then select by trial and error a resistor with value between 3900 and 5600 ohms that results in an output of 3.0 volts.

Measure these voltages between ground and the points indicated in Fig. 12. Check portamento adjustment (next paragraph) after replacing R337.

Portamento Adjustment (R215)

The portamento adjustment is located on the pedal divider board. It does not normally require

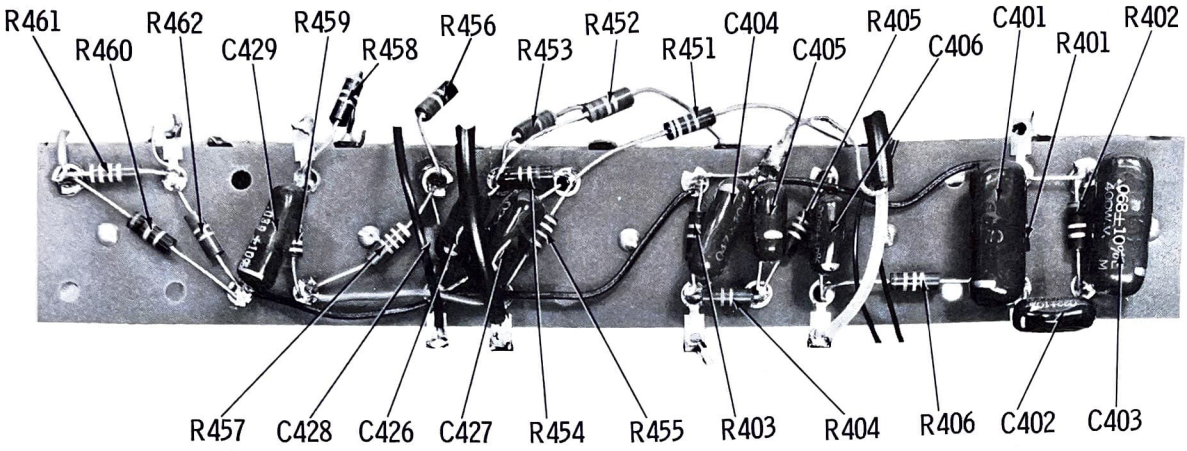

Fig. 14. Terminal Board #1—Component Identification.

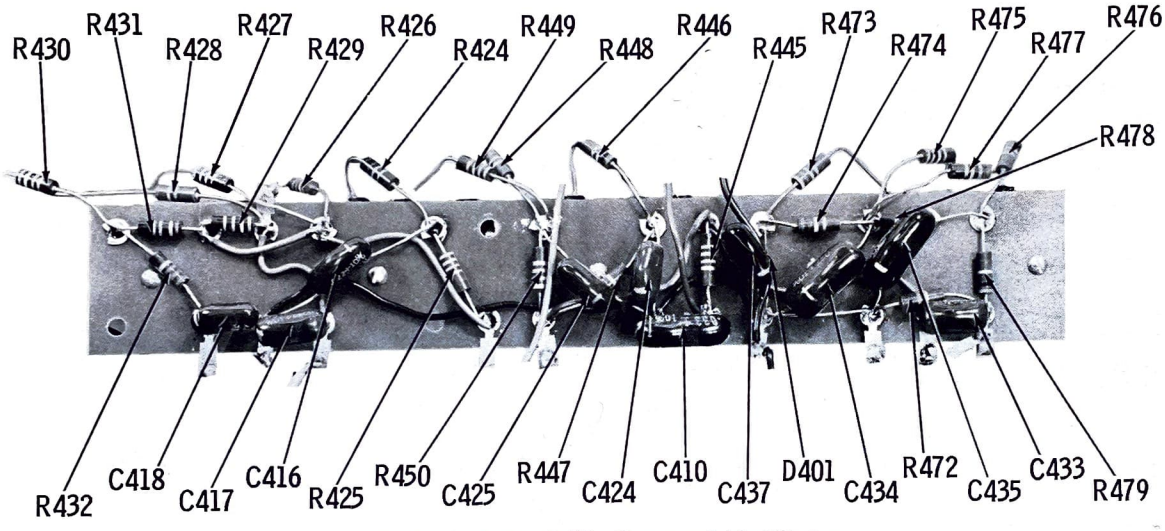

Fig. 15. Terminal Board #2—Component Identificaton.

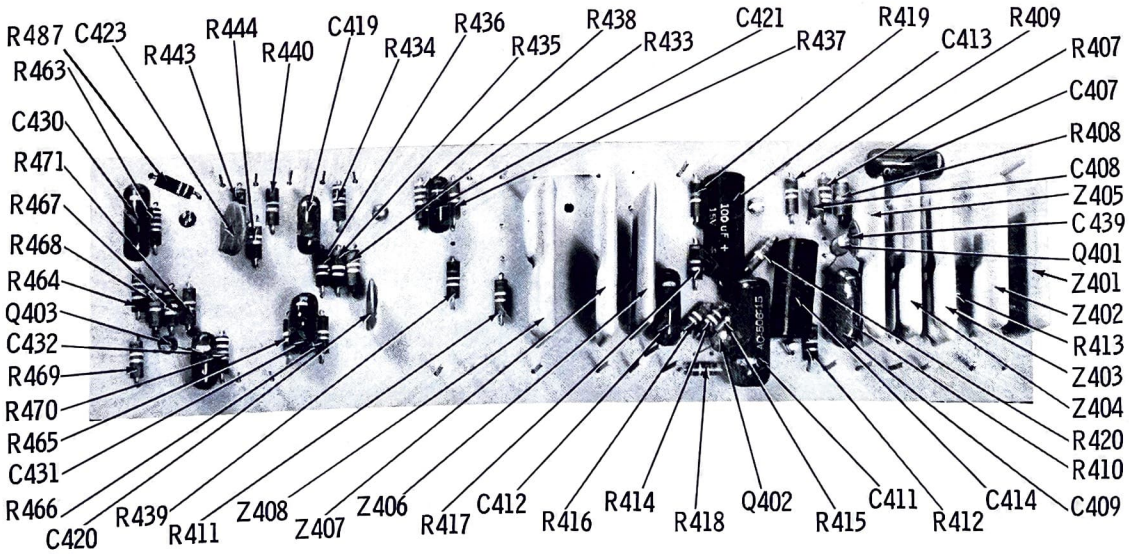

Fig. 16. Filter Board—Component Identification.

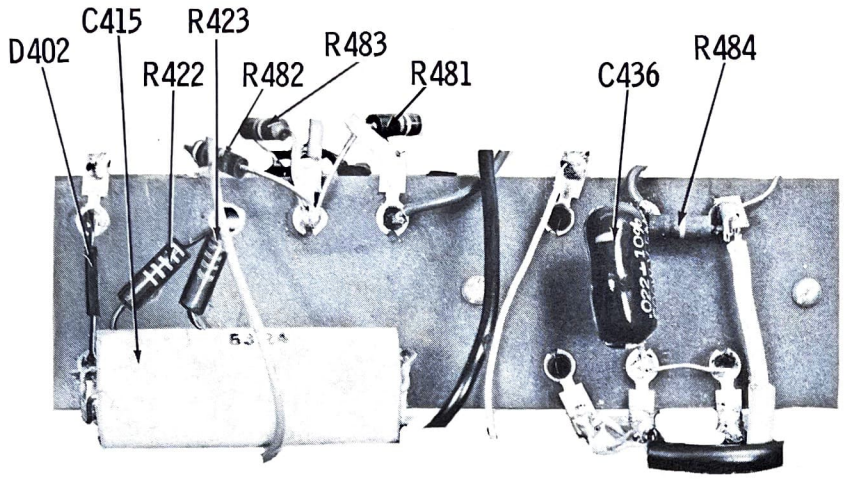

Fig 17. Terminal Board #3—Component Identification.

changing after being set at the factory. The possibility of defective components in the portamento circuitry should be explored thoroughly before any change is made.

To reset the portamento adjustment depress only the HAWAIIAN GUITAR tablet. Set the adjustment so that playing two notes gives a portamento effect, but playing one note does not. Hold each note down at least two seconds, and allow at least two seconds before playing another note.

Tuning Procedure

Tuning the organ using an electronic indicator is a simple and quick procedure. Tuning by ear is a job for a trained and experienced organ or piano tuner only. DO NOT ADJUST THE TUNING SLUGS UNLESS YOU HAVE PROPER EQUIPMENT AND/OR TRAINING.

The organ has been accurately tuned before leaving the factory and can be expected to remain in tune indefinitely under normal circumstances. However, after long use under extremely adverse conditions, it is possible that some components will have changed in value sufficiently to alter the frequency of the oscillators so the notes will not be in tune with each other.

All tones of the same letter name are generated by a single tone generator which has a master oscillator for the highest octave and frequency dividers for the other octaves. Changing the pitch of a note is done by moving the core of L101 on the proper generator. The core is held firmly in place but can be moved readily with the fingers by twisting the core as it is pushed or pulled. This adjusts the master oscillator and changes the pitch of all notes of that letter name. Consequently, tuning the twelve notes within the highest octave will tune the entire organ.

If the interval of an octave should be out of tune, a defective frequency divider would be indi-

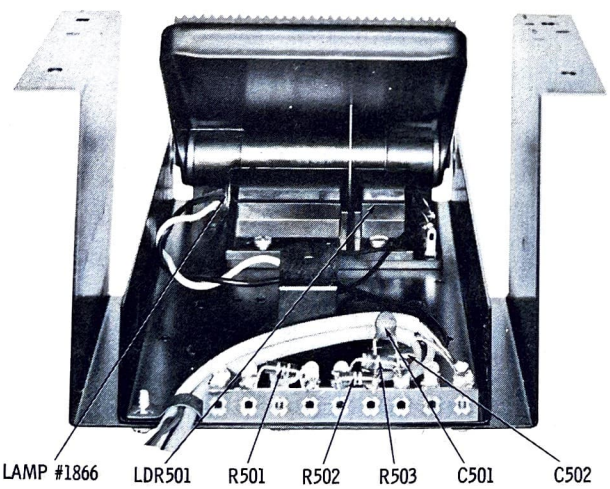

Fig. 18. Expression Pedal—Component Location.

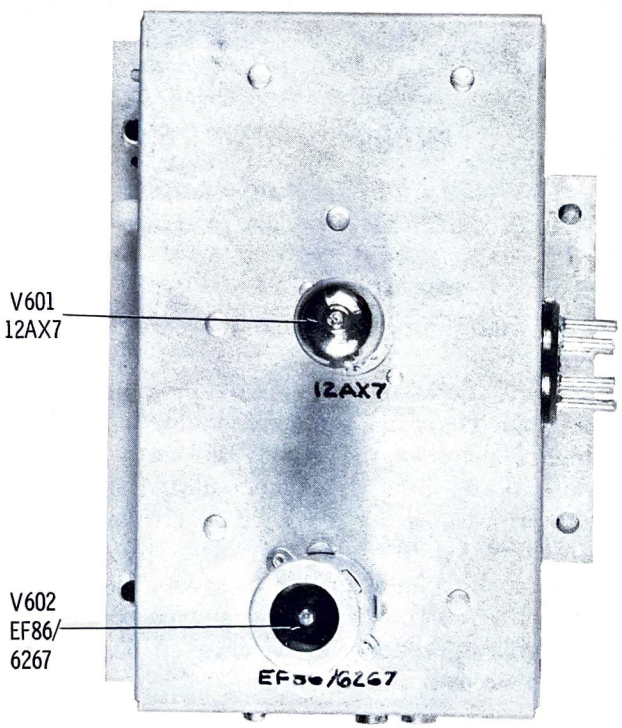

Fig. 19. Preamplifier Chassis—Top View.

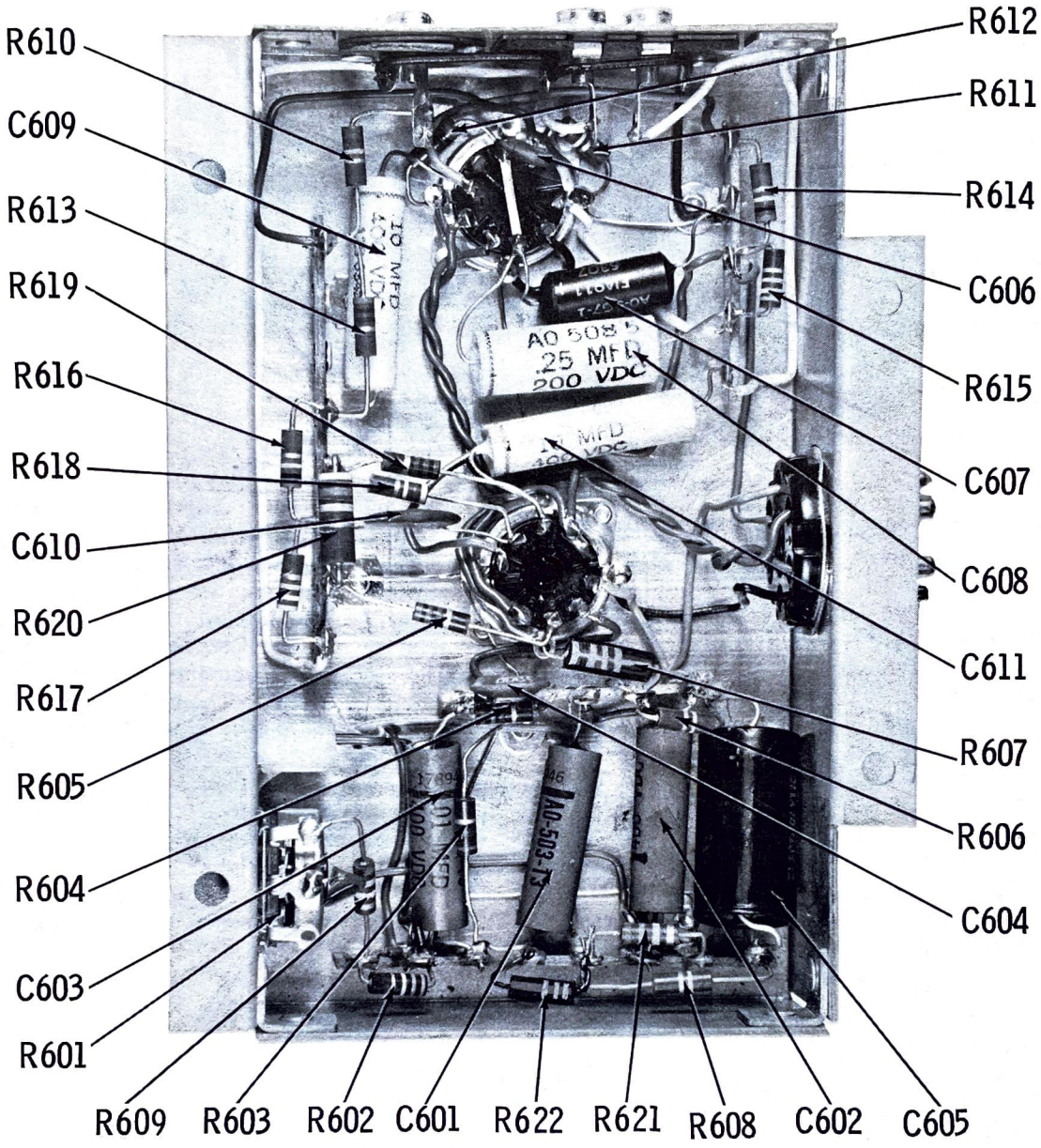

Fig. 20. Preamplifier Chassis—Bottom View—Component Identification.

cated, and tuning the master oscillators cannot correct this.

Several types of electronic tuning devices are available. There are some reasonably priced units which depend on the power line as a reference standard and use a stroboscope disc to show when notes are tuned to the correct frequency. The Hammond AO-26 tuning standard, which uses an oscilloscope as an indicator, is independent of the power line frequency. It has a very stable master oscillator which can be checked occasionally against its own tuning fork.

Following instructions supplied with the tuning device, observe the following:

1. Check the +15 volt supply before starting the tuning procedure.
2. Use only the 8′ FLUTE voice control tablet. Be sure vibrato or reverberation tablets are not depressed.
3. Use notes of the highest octave possible, depending on the instructions provided with the indicator. Greater accuracy is possible at higher frequencies.

For further information on tuning procedures, contact the factory Service Department.

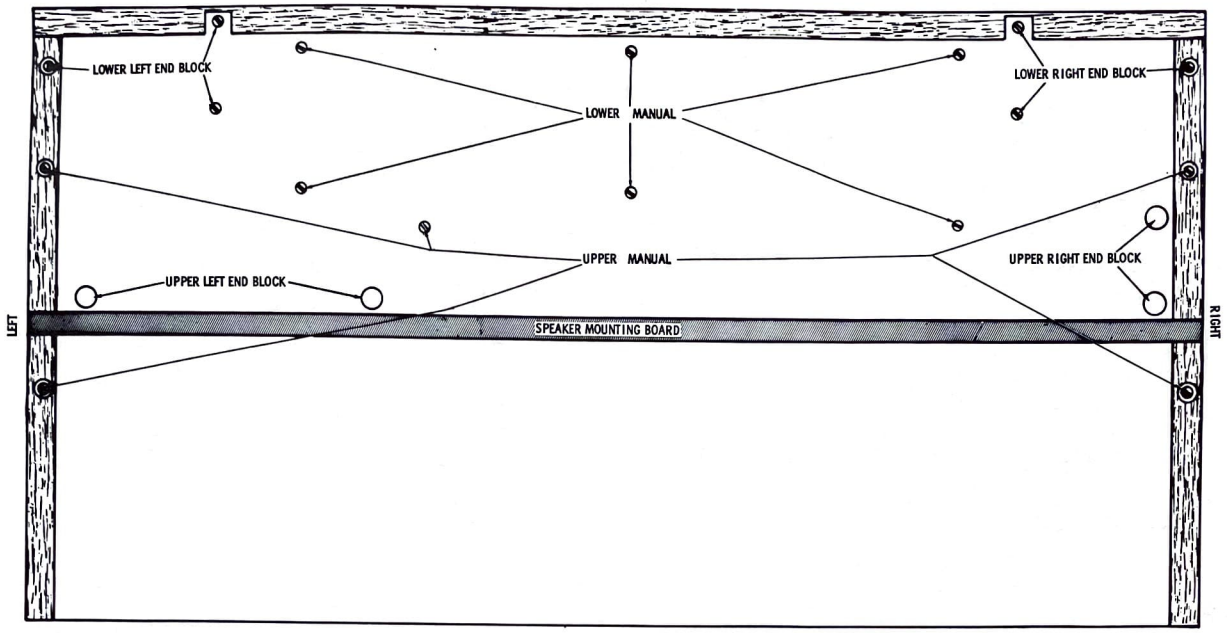

Fig. 21. Retaining Screw Locations Under Keyboard.

DISASSEMBLY

Pedal Keyboard

Four screws hold the pedal keyboard: two behind the amplifier chassis and two at the very bottom of the back of the cabinet. The organ should be laid on its left end (on a soft pad) before removing the pedals.

Lower Manual and Lower End Blocks

Remove trim strip between manuals. Refer to Fig. 21 and remove screws marked "Lower Right End Block," "Lower Left End Block" and "Lower Manual." Slide manual slightly forward and lift front of manual up.

NOTE: It may be necessary to unfasten some of the tone generator boards and loosen cable clamps in order to have sufficient slack in cables so the lower manual can be moved into a servicing position.

Control Tablet Assembly

For access to control tablet switches and filter circuitry, remove top of organ by taking out two screws from back brace and lifting the top straight up. (Friction catches hold front corners.) Note the shims provided to level the top. They must be replaced exactly as they were found.

The metal cover of the control tablet assembly may be pulled off after removing ten hex head metal screws.

Upper Manual

The upper manual is fastened on a mounting plate with the control tablet assembly and the upper end blocks. The control tablet assembly must be removed before the upper manual can be moved. Take off the top of the organ cabinet and remove the metal cover of the control tablet assembly (see above). Unfasten two screws from each end of the control tablet assembly and lay it back, taking care that coil (L401) does not catch on the upper manual. Support control tablet assembly on blocks. DO NOT ALLOW IT TO REST ON THE TONE GENERATOR BOARDS.

Remove screws marked "Upper Manual" on Fig. 21. Lift up front of manual with the mounting plate. Bottom of the upper manual is accessible through a hole in the mounting plate. If necessary the keyboard may be removed from the mounting plate by taking out the retaining screws.

Upper manual end block retaining screws (2 each, for right and left) can be reached from underneath through holes in the cabinet shelf. The front of the left end block can be lifted up far enough to see under since spring clips are used as retainers at the front corners.

Keyboard Key

1. To remove plastic key only, take out key retaining screw (Figs. 7 and 8) and pull plastic

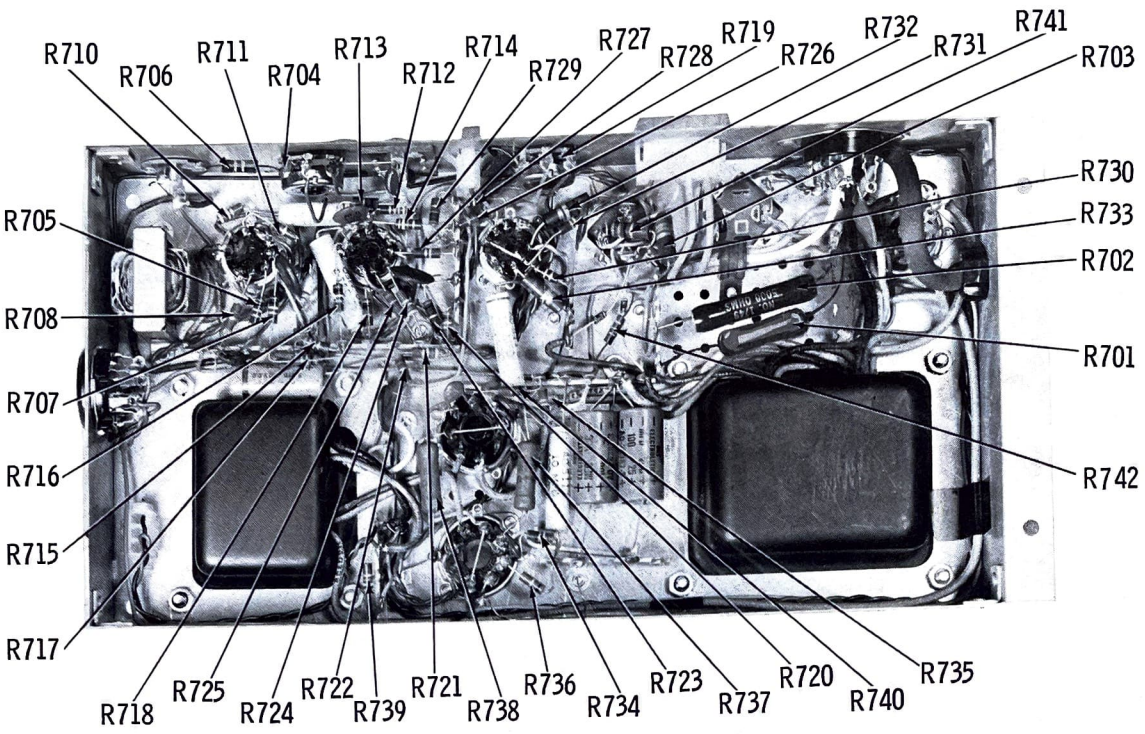

Fig. 22. Amplifier Chassis—Bottom View—Resistor Identification.

key forward after keyboard has been removed from the cabinet.

2. To remove key and channel assembly:
   a. Unhook key return spring.
   b. Lift back of key channel off of keyboard frame.
   c. Slide key and channel assembly forward and off of key guide.

NOTE: To remove a black key it is necessary to remove both adjacent white keys.

Expression Pedal

1. Disconnect blue plug from amplifier and white plug from preamplifier.
2. Remove 12 hex head screws with washers and lift off pedal cover.
3. Lift up expression pedal assembly.

SERVICE SUGGESTIONS

General

When looking for the source of defective operation in the organ, signal paths as shown on the block diagram (Fig. 6) should be kept in mind. A malfunction at any given point would show up at every point further along that signal path, but any alternate signal paths that might exist would continue to operate properly.

For example, a defect in the expression pedal circuitry would affect the sound of the entire organ since all signals go through it. Defective operation of the inverter amplifier would be noticeable only when 8′ stops (and some percussion tablets) on the upper keyboard are used; all other tablets on that keyboard, the lower keyboard, and the pedal keyboard would not be affected. Similarly, if one tone generator is defective, all sounds originating in that generator will be faulty wherever they appear, but other notes will not be affected.

When circuitry is to be checked, substitute tubes known to be good (or test suspect tubes on a high quality tube checker), and compare existing voltages and waveforms with those shown on the schematic to isolate the defective components.

Transistor substitution is generally not desirable unless voltage measurements and waveforms give strong indication that a specific transistor is defective.

Before attempting to replace individual components or assemblies, however, the service technician should examine the total operation in order to have as many clues as possible to the exact source of the trouble. Refer to the following suggestions on how to localize the trouble.

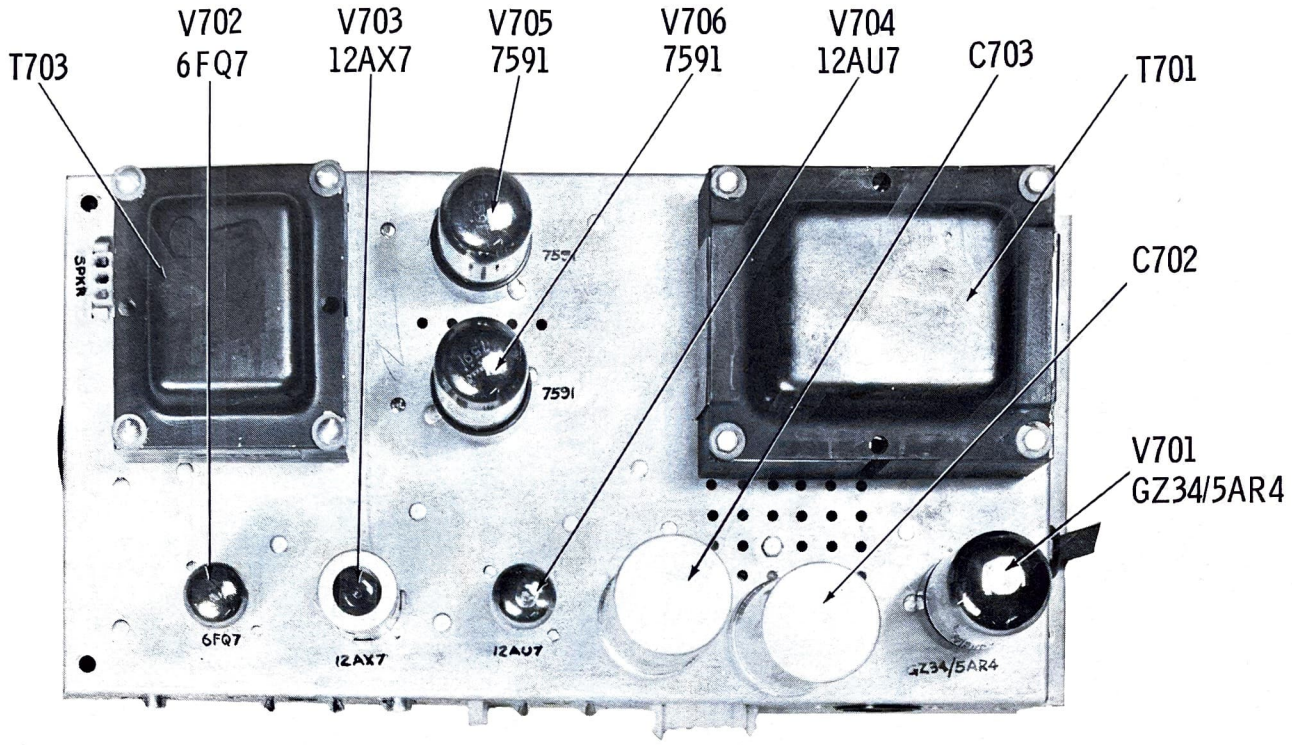

Fig. 23. Amplifier Chassis—Top View.

Entire Instrument Dead

If no sound is produced by the organ the trouble is probably in the power supply, power amplifier, expression pedal, or preamplifier circuitry. First check tubes in these areas. If trouble persists, depress the expression pedal all the way, and proceed as follows:

1. Verify that AC power is being received.
   a. If pilot lamp lights when organ is turned on, AC power is O.K.
   b. If pilot lamp does not light, check lamp, power switch, AC outlet, and power transformer (T701).
2. Check rectifier tube (V701), and other power supply circuit components. Voltages are readily accessible for measurement at the following points:

Filament (6.3 V)	Pins 1 & 2 of P702
450 V	Pin 2 of P707
225 V	Pin 9 of P702 or Pin 3 of P707
+15 V	Pin 11 of P702 or red wire connection to any tone generator board.

3. Check power amplifier circuitry by removing P705 (blue) from power amplifier chassis and inserting an unwired plug into this jack. Touch the center terminal with a bare wire.
   a. A loud pop or hum indicates the power amplifier is functioning. Replace P705 in its proper socket and go to step 4.
   b. If no sound is heard check V702, V703, V704, V705, V706 and related circuitry including the earphone jack for defective components.
4. Check expression pedal circuitry by removing P601 (white) from preamplifier chassis and grasping the center of the plug firmly.
   a. A loud hum indicates the expression pedal circuitry is functioning. Replace P601 in its socket and go to step 5.
   b. If no sound is heard, check cable connections and expression pedal circuit components. Note that volume remains fully on if expression pedal lamp is not lighted.
5. Check preamplifier circuitry by removing P603 (black) from preamplifier chassis and inserting an unwired plug into this socket. Touch the center terminal with a bare wire.
   a. A loud pop or hum indicates the preamplifier circuitry is functioning. Check cable to which P603 (black) is attached before ruling out the possibility of defects in this area.
   b. If no sound is heard check V601, V602, and related circuitry for defective components.

All Sound Weak or Distorted

Defective components in the power supply, power amplifier, expression pedal, or preamplifier may cause the organ to sound weak or distorted. These are the same sections that are referred to in the previous section—"Entire Instrument Dead", and the same check procedure can

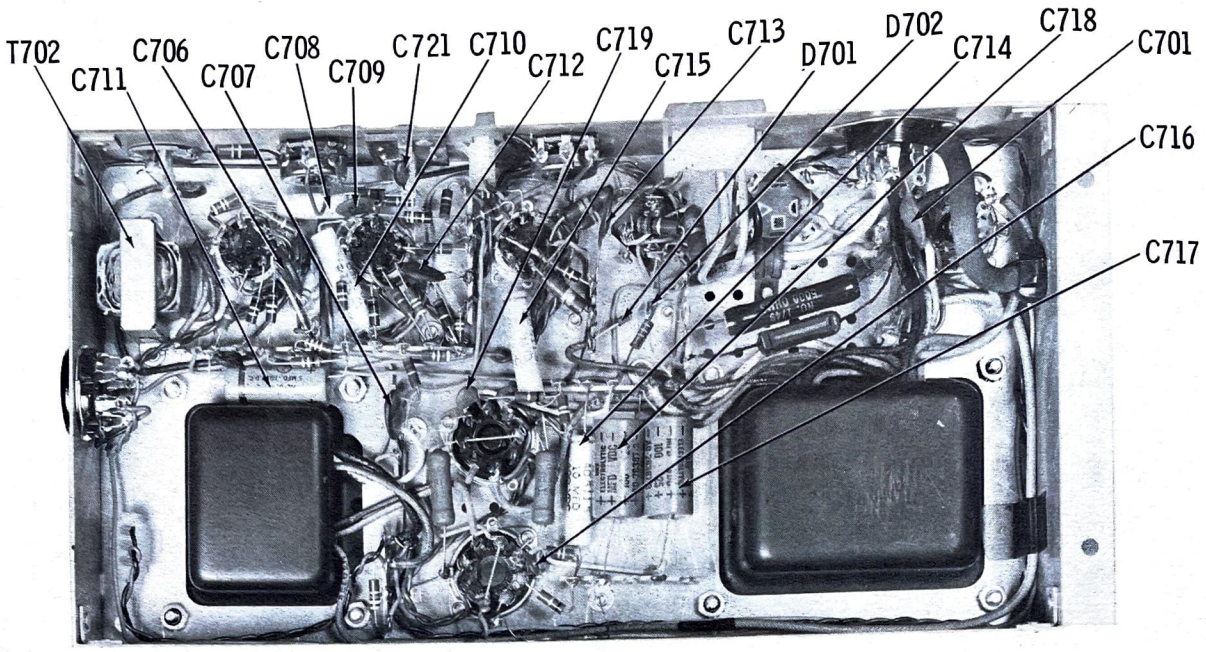

Fig. 24. Amplifier Chassis—Bottom View—Transformer, Capacitor, and Diode Identification.

be used. However, in this case a noise check may not be adequate, and it may be necessary to check amplifier and preamplifier voltages against those shown on the schematic. Be sure to check for a defective speaker or crossover component by disconnecting two of the three speakers, leaving only one of the 12″ speakers operating.

No Vibrato

Check vibrato oscillator (V601B) and related circuitry to isolate defective component. Clean contacts on vibrato tablets.

No Pedal Notes

Check pedal divider circuit board to isolate defective components. Be sure +15 volt supply is present at orange wire terminal.

No 8′ Stops on Upper Manual

Check inverter amplifier and related circuitry to isolate defective components.

Individual Tablets Fail to Function

When one or more tablets fail to function, dirty or damaged contacts are normally at fault. Determine which stops need attention and refer to "Cleaning Switch Contacts" under "Maintenance" for proper procedure.

Individual Notes Fail to Sound

It is important to determine a pattern of faulty operation in order to isolate defective components. If a tone of a certain frequency number is faulty everywhere it occurs on the organ, then the tone generator circuitry is at fault. If it sounds one place and not another, switch contacts or wire connections are more likely to be the source of trouble. Also, circuitry on any one tone generator is interrelated, so that when a given frequency divider fails, all notes lower in pitch produced by that generator will sound incorrectly or not at all. Proceed as follows:

1. With only the 5⅓′ QUINT tablet (upper manual) depressed, play each note separately, starting at the highest. Refer to Fig. 1 and make a note of the letter names and frequency numbers where a defect is found. (If all seven top notes are defective, frequency doubler circuitry is probably at fault.)
   a. Repeat on the upper manual using the 8′ FLUTE tablet.
   b. Repeat on the lower manual using the 8′ FLUTE tablet.
   c. Repeat on the pedal keyboard, using the 8′ tablet, then a 16′ tablet.
2. If all faulty tones have the same letter name, and if everywhere a given frequency number is used it is faulty, the trouble is probably on that tone generator board. Refer to the following section to isolate defective components.
3. If no pattern is apparent, the trouble is probably due to dirty switch contacts. Refer to "Cleaning Switch Contacts" under "Maintenance".

Servicing Tone Generator Boards

If defective operation has been traced to a tone generator, probably the quickest and easiest procedure is to replace the entire printed circuit

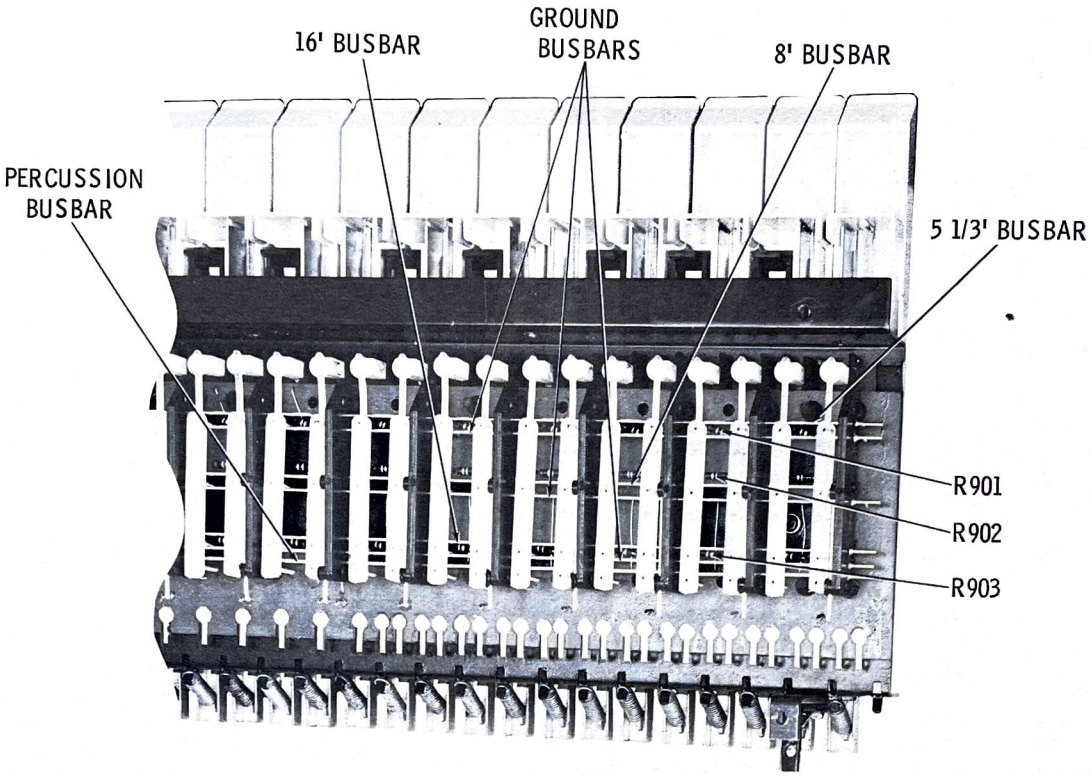

Fig. 25. Upper Keyboard—Bottom View.

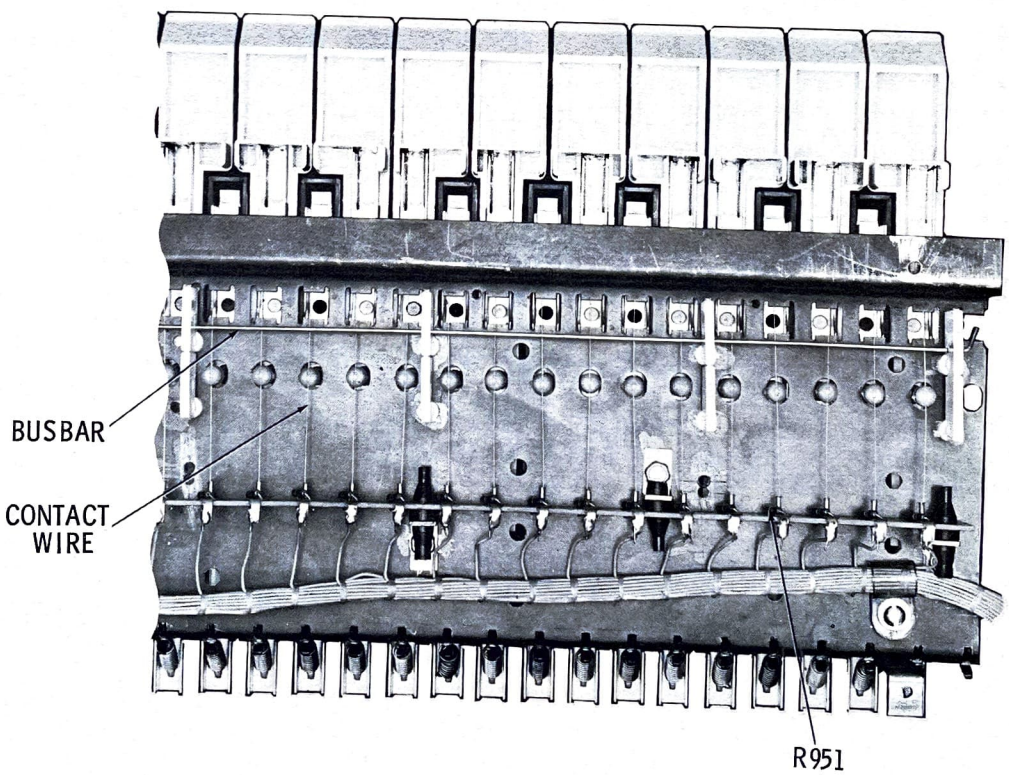

Fig. 26. Lower Keyboard—Bottom View.

board on which the generator is located. (Each board contains two tone generators.) If this is not possible, proceed as follows:

1. Locate the defective master oscillator or frequency divider, keeping in mind the following:
   a. If all frequencies of a given letter name sound incorrectly, defective component is most likely to be in the master oscillator circuitry.
   b. If all but the highest frequency of a given letter name sound incorrectly, defective component is in first frequency divider circuitry.
   c. If two highest frequencies are correct but lower frequencies sound incorrectly, the defective component is in the second frequency divider circuitry, etc. Frequency numbers can be determined from Figs. 1 and 2, and location of the circuitry from Fig. 28.
2. In order to isolate the defective component check signal waveforms and voltage as shown on the schematic. Check circuit and component continuity and resistance. Examine the board closely for damaged components or breaks in printed foil.
3. Observe the following precautions when removing and replacing components on a printed board:
   a. Use only a low-wattage soldering iron (maximum—40 watts), and apply heat for as short a time as possible. Rectangular tips should be used on printed networks.
   b. Use a heat sink (such as pointed nose pliers) when soldering transistor leads.
   c. Do not use force to remove or insert components.

SPECIAL EQUIPMENT

Earphones

A jack is provided for connecting monaural earphones if someone wishes to practice without disturbing others. Dynamic type phones will give best results, although other types can be used.

To use stereo earphones a stereo-to-monaural adapter such as Switchcraft #352 is plugged into the earphone jack on the organ, and the earphone plug is inserted into the adapter.

Radio-Phonograph Connection

A radio, phonograph, or microphone amplifier can be connected to play through the organ speakers. Fig. 27 shows how to connect it. The organ may be played at the same time.

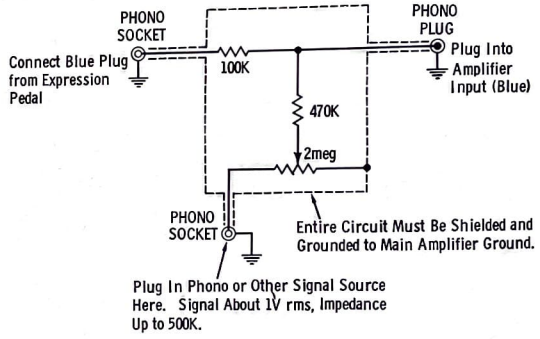

Fig. 27. Earphone Jack Connections.

REPLACEMENT OF ELECTRICAL PARTS

Most resistors, capacitors, and tubes used in this organ are standard values, obtainable at electronics supply houses. Refer to the schematic for values, ratings and tolerances of these components.

Transformers, transistors, coils, printed networks, and other items which might be difficult to obtain may be ordered from the factory. Refer to the parts list which follows and order by part number.

NOTE: Corresponding components of the tone generators have the same reference number. When it is necessary to refer to a particular component on a specific generator, the letter name of that generator is added as a suffix to the reference number of the component. Thus L101 used in the F♯ tone generator is referred to as L101-F♯. Where no suffix appears, the component is identical in all twelve generators.

REPLACEMENT PARTS LIST

Ref. No.	*Part No.*	*Description*
		TRANSISTORS
Q101	01-2105	Master Oscillator. 2N2923 is a satisfactory substitute.
Q102 thru Q109	01-2106*	Frequency Divider. 2N2923 is a satisfactory substitute.
Q201 thru Q204	01-2106*	Pedal Divider. 2N2923 is a satisfactory substitute.
Q205	01-2102	Portamento Clamp. 2N3394 is a satisfactory substitute.
Q206	01-2104	Portamento Gate. 2N2923 is a satisfactory substitute.
Q301	01-2103	Voltage Regulator. 2N3394 is a satisfactory substitute.
Q302	01-2108	Percussion Preamplifier. 2N3391 is a satisfactory substitute.
Q401, Q402	01-2104	Flute and Bright Preamplifiers. 2N2923 is a satisfactory substitute.
Q403	01-2107	Inverting Amplifier. 2N3391A is a satisfactory substitute.
		DIODES
D201 thru D205	01-2603-0	Signal Diode. 1N461A is a satisfactory substitute.
D301 thru D327	01-2603-0	Signal Diode. 1N461A is a satisfactory substitute.
D401	01-2603-0	Signal Diode. 1N461A is a satisfactory substitute.
D701, D702	01-2405-0	Power Rectifier. 1N4001 or 1N 2069 are satisfactory substitutes.
		CAPACITORS
C101-F♯, -F,-E	AO-514-11	.022 mfd, ±5%, Polystyrene
C101-D♯, -D,-C♯	AO-514-12	.025 mfd, ±5%, Polystyrene
C101-C, -B,-A♯	AO-514-9	.015 mfd, ±5%, Polystyrene
C101-A, -G♯,-G	AO-514-10	.018 mfd, ±5%, Polystyrene
C702A	AO-28522-0	40 mfd @ 500V, Electrolytic
B		40 mfd @ 500V, Electrolytic
C703A	AO-28519-0	50 mfd @ 450V, Electrolytic
B		50 mfd @ 450V, Electrolytic
C		500 mfd @ 25V, Electrolytic
D		500 mfd @ 25V, Electrolytic
C301, C303, C305, C307, C309, C311, C313, C315, C317		22 mfd @ 4V, Tantalum
		COILS
L101-C	AO-28560-12	Tuning Coil for C Generator
L101-B	AO-28560-11	Tuning Coil for B Generator
L101-A♯	AO-28560-10	Tuning Coil for A♯ Generator
L101-A	AO-28560-9	Tuning Coil for A Generator
L101-G♯	AO-28560-8	Tuning Coil for G♯ Generator
L101-G	AO-28560-7	Tuning Coil for G Generator
L101-F♯	AO-28560-6	Tuning Coil for F♯ Generator
L101-F	AO-28560-5	Tuning Coil for F Generator
L101-E	AO-28560-4	Tuning Coil for E Generator
L101-D♯	AO-28560-3	Tuning Coil for D♯ Generator
L101-D	AO-28560-2	Tuning Coil for D Generator
L101-C♯	AO-28560-1	Tuning Coil for C♯ Generator
		MISCELLANEOUS
LDR401	PO-28529-2	Light Dependent Resistor
LDR501	PO-30152-1	Light Dependent Resistor
Lamp	1866	(Long life version of #44)
		RESISTORS, VARIABLE
R215	AO-28571-0	3000Ω, 2 Watt, Portamento Adjustment
R442	AO-20293-33	2 meg, BANJO RATE Control
R601	AO-20293-1	1 meg, VIB-RATE Adjustment
R704	AO-20293-52	500K, GAIN Adjustment
R719	AO-20293-52	500K, REVERB Adjustment
		SPEAKERS
SP801, SP802	AO-24346-0	12", PM
SP803	AO-27153-0	6", PM
		TRANSFORMERS
T701	AO-28526-1	Power, for 120 volt, 60 cycle
T701	AO-28526-2	Power, for 120 volt, 50 cycle
T701	AO-28526-3	Power, for 234 volt, 50-60 cycle
T702	AO-27311-0	Reverberation Driver
T703	AO-28527-1	Output
		PRINTED NETWORKS
Z101-C, -B, -A♯, -A, -G♯, -G	AO-28528-1	Frequency Divider
Z101-F♯, -F, -E, -D♯, -D, -C♯	AO-28528-2	Frequency Divider
Z102-C, -B, -A♯, -A, -G♯, -G	AO-28528-3	Frequency Divider
Z102-F♯, -F, -E, -D♯, -D, -C♯	AO-28528-4	Frequency Divider
Z103-C, -B, -A♯, -A, -G♯, -G	AO-28528-5	Frequency Divider
Z103-F♯, -F, -E, -D♯, -D, -C♯	AO-28528-6	Frequency Divider
Z104-C, -B, -A♯, -A, -G♯, -G	AO-28528-7	Frequency Divider
Z104-F♯, -F	AO-28528-8	Frequency Divider
Z201, Z202	AO-28540-1	Frequency Divider (Pedal)
Z301 thru Z305	AO-28541-1	Isolation Network
Z306 thru Z308	AO-28542-1	Keyer Network
Z401	AO-28539-1	8′ Flute Filter
Z402	AO-28539-2	8′ Flute Filter
Z403	AO-28539-3	8′ Flute Filter
Z404	AO-28539-4	8′ Flute Filter
Z405	AO-28539-5	8′ Flute Filter
Z406	AO-28538-1	16′ Flute Filter
Z407	AO-28538-2	16′ Flute Filter
Z408	AO-28538-3	16′ Flute Filter

*These transistors are used in matched pairs. When ordering from factory specify color dot on original.

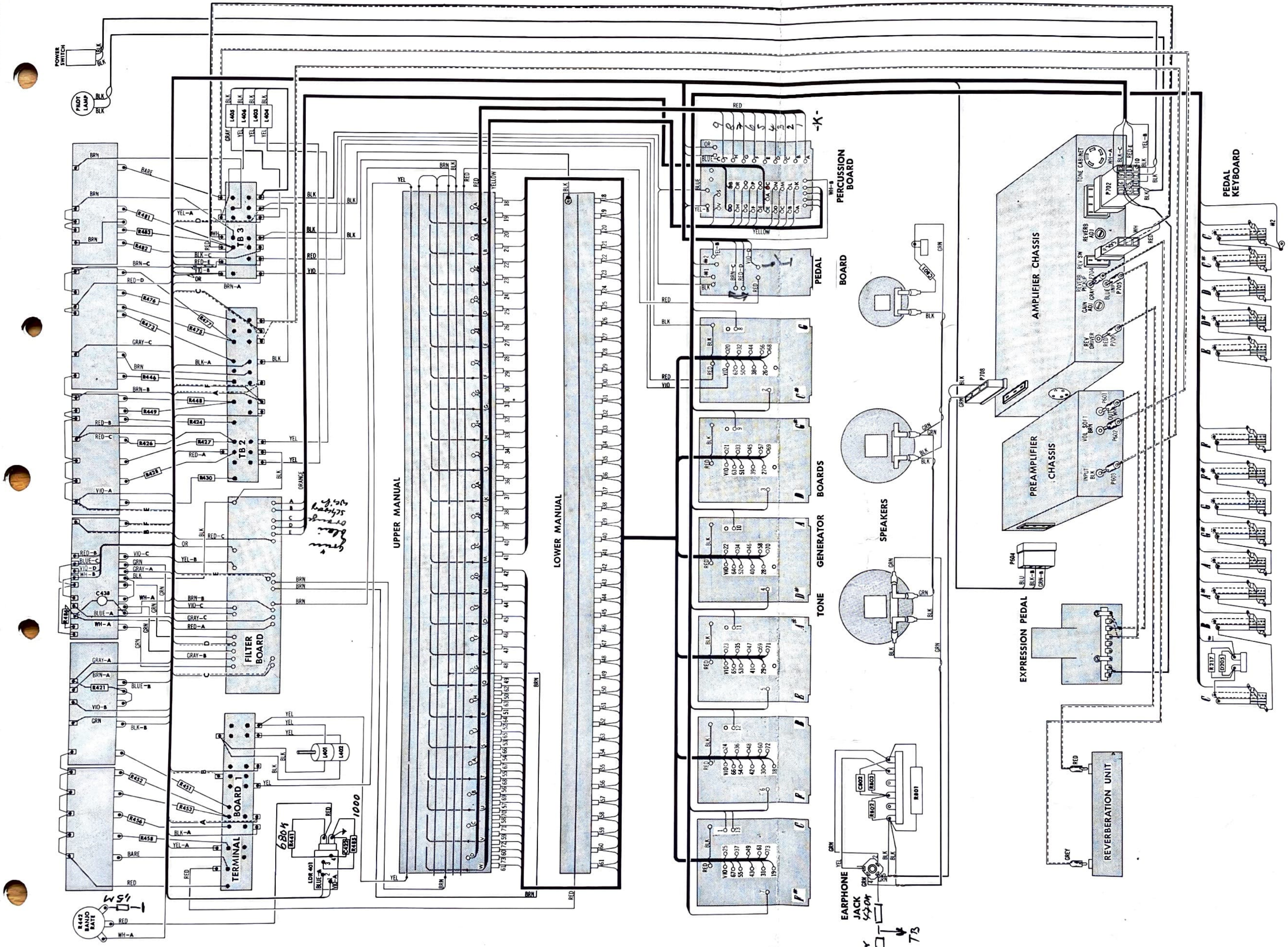

Fig. 28. Wiring Diagram.

01 - 2102 = 2N3394
01 - 2104 = 2N2923
01 - 2106 = 2N2923
01 - 2107 = 2N3391A
01 - 2108 = 2N3391

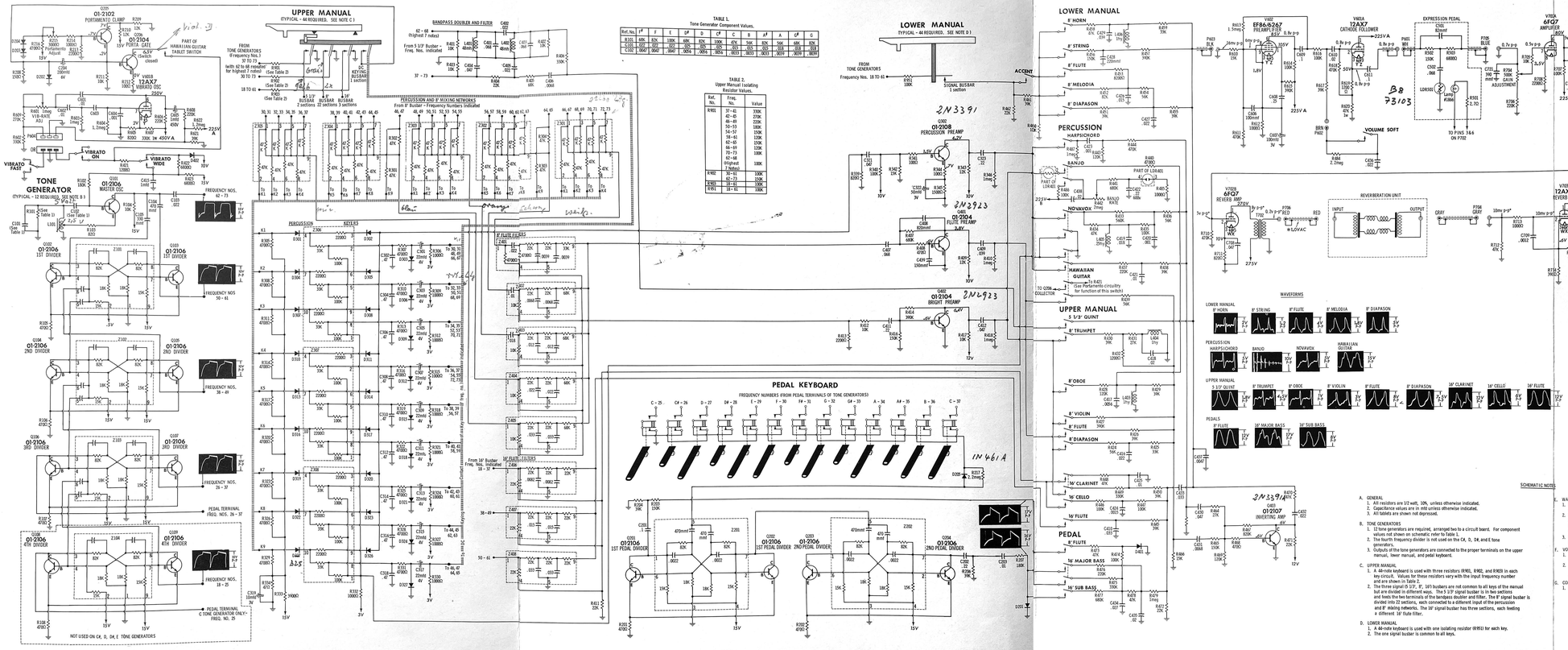

Fig. 29. Schematic.