THE HAMMOND ORGAN

SERVICE INFORMATION

2000 SERIES

HAMMOND ORGAN COMPANY
DIVISION OF HAMMOND CORPORATION
4200 DIVERSEY | CHICAGO, ILLINOIS 60639

HS/1167
PRINTED IN U.S.A.

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SPECIFICATIONS

Cabinet Size:

39 ½″ Wide, 21″ Deep, 41″ High (including music rack)

Weight (without bench):

125 lbs.

Power Required:

110 to 120 Volts, 60 Cycles, 80 Watts. Also available for 50 cycles and for 220 to 240 volts, 50-60 cycles.

Music Power Output:

15 Watts (per EIA Standard RS-234)

Prepared by HOWARD W. SAMS & CO., INC.

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 on page 24.

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.

Chords are combinations of three or more notes, sounded simultaneously, which are built up of thirds stacked one on another. A *major chord* consists of a *root* or starting note, a major third (up four half steps) and a minor third (up three more half steps). From the root to the top note of the chord is a fifth, so this note is referred to as the fifth of the chord.

A *minor chord* consists of a root plus a minor third (three half steps) plus a major third (four half steps). The seventh chord consists of a root, a major third, a minor third, and another minor third. The chord is named from the interval between the root and the highest note (a seventh). This is known musically as a dominant seventh chord. The *diminished chord* consists of a root plus two minor thirds.

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 generators. Footage indicated on the voice control tablets determines the pitch frequency of the keyboard notes. These footage terms (8′ and 16′) 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. Thus if 8′ and 16′ tabs 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 fixed rate, produced simultaneously in each tone generator by the vibrato oscillator.

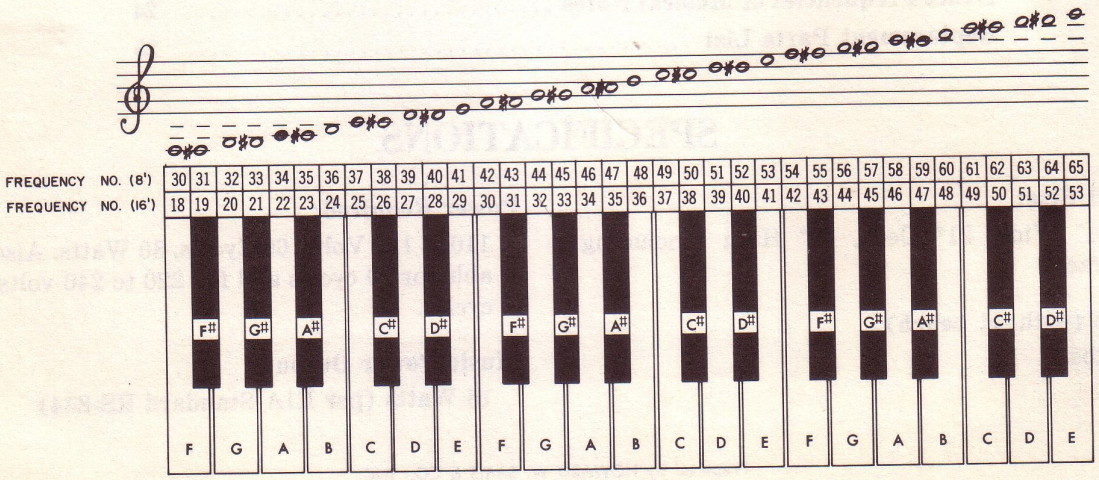


Fig. 1. Notes on Organ Keyboard.

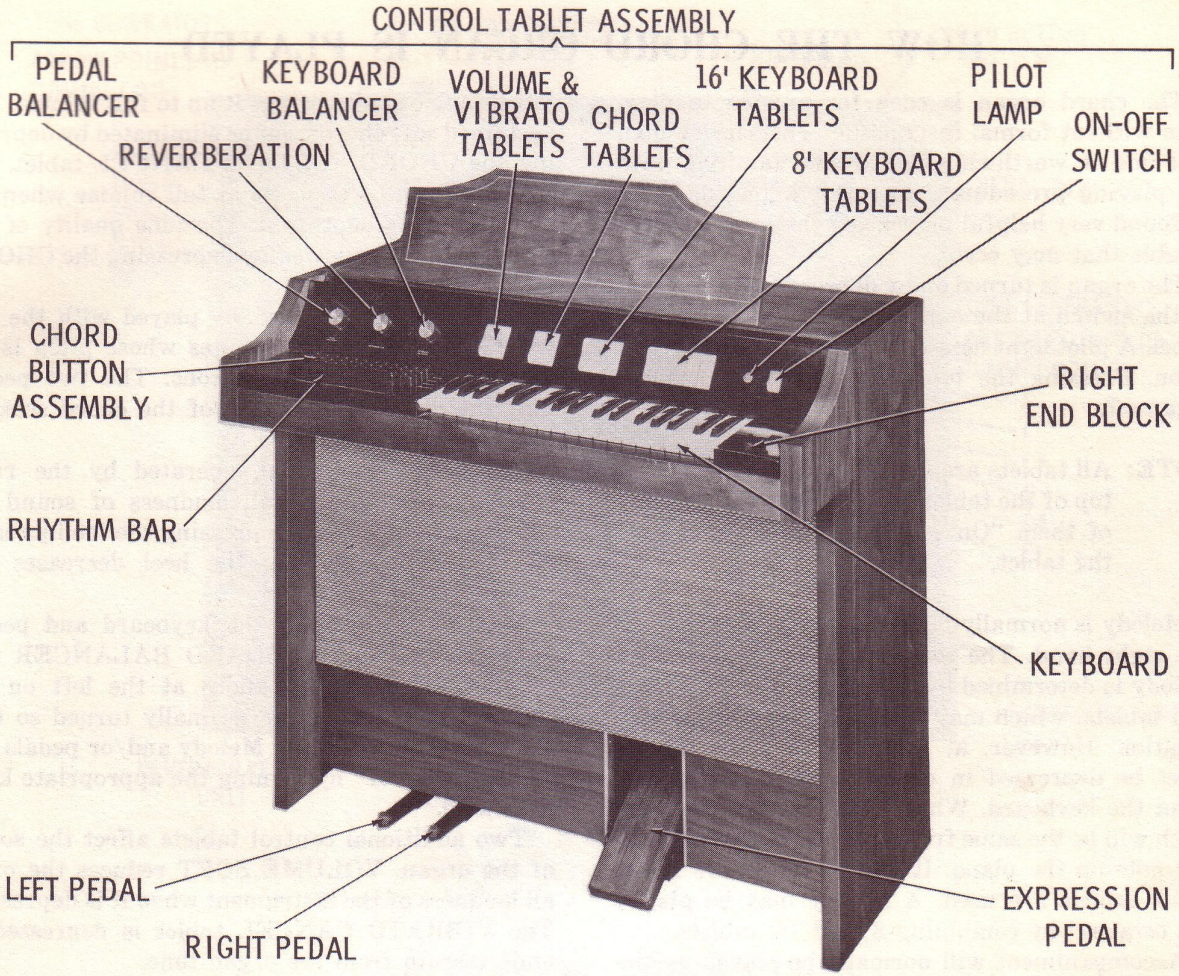


Fig. 2. Front View.

GENERAL DESCRIPTION

Models of the 2000 series are completely self-contained consoles, requiring no external tone cabinet. Each instrument has a single 36-note keyboard, a chord button unit of 48 buttons, and two pedals. Chord buttons provide major, minor, seventh, and diminished chords on each note. Circuitry is designed so that the left pedal sounds the root and the right pedal the fifth of whatever chord button is depressed.

Eight tablets—five 8′ stops (DIAPASON, FLUTE, VIOLIN, REED, HORN) and three 16′ stops (FLUTE, CELLO, REED)—enable the performer to vary the timbre of the keyboard tones over a wide range. Sound from the chord buttons is controlled by two tablets (CHORD SUSTAIN CANCEL, CHORD MUTE) and the rhythm bar. One tablet (VIBRATO CANCEL) turns the vibrato on or off, and one tablet (VOLUME SOFT) reduces the output of the organ when full power is not desirable.

An expression (or swell) pedal regulates the overall volume, while a KEYBOARD BALANCER control and a PEDAL BALANCER control are provided to adjust the volume of the keyboard and pedals in relation to the chord buttons. A reverberation unit with a control (REVERBERATION) to regulate the amount of reverberation is provided on the 2000 Series organ.

Location of the major components on the organ console is shown in Fig. 2.

HOW THE CHORD ORGAN IS PLAYED

The chord organ is easy for anyone to play, even without formal instruction. The service man will find it worthwhile to become familiar with the playing procedures since this knowledge will be found very helpful in locating the source of any trouble that may occur.

The organ is turned on by depressing the bottom of the switch at the extreme right on the control panel. A pilot light next to it glows when the organ is on. Pressing the top of the button turns the organ off.

NOTE: All tablets are in "Off" position when the top of the tablet is depressed. To turn any of them "On", depress the lower end of the tablet.

Melody is normally played on the keyboard with the right hand. The tone color or timbre of the melody is determined by depressing the voice control tablets, which may be used singly or in combination. However, at least one of these tablets must be depressed in order to produce a sound from the keyboard. When 8′ tablets are used the pitch will be the same frequency as the corresponding note on the 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.

Accompaniment will normally be played by the left hand using the chord buttons. Since each button selects a full chord (as well as appropriate bass notes), only one button is played at a time. The chord sounds softly when the chord button is depressed; touching the rhythm bar with the left thumb or palm brings it up to full volume. The sustained soft chords can be eliminated by depressing the CHORD SUSTAIN CANCEL tablet, but the chords will still sound at full volume when the rhythm bar is depressed. The tone quality of the chords can be mellowed by depressing the CHORD MUTE tablet.

The two pedals (normally played with the left foot) produce deep bass notes whose pitch is determined by the chord buttons. The two pedals play the "root" and "fifth" of the chord selected in order to give variety.

The expression pedal, operated by the right foot, controls the overall loudness of sound developed by the organ. Depressing the toe increases the volume, depressing the heel decreases the volume.

Relative loudness of the keyboard and pedals is controlled by KEYBOARD BALANCER and PEDAL BALANCER knobs at the left on the control panel. These are normally turned so that the white dots point up. Melody and/or pedals can be "brought out" by turning the appropriate knob clockwise.

Two additional control tablets affect the sound of the organ. VOLUME SOFT reduces the overall loudness of the instrument when it is depressed. The VIBRATO CANCEL tablet is depressed to omit vibrato from the organ tone.

Reverberation adds a "concert hall" effect to the sound of the organ. When the REVERBERATION control is in its fully counterclockwise position the effect is the least; as the control is turned clockwise the amount of reverberation increases.

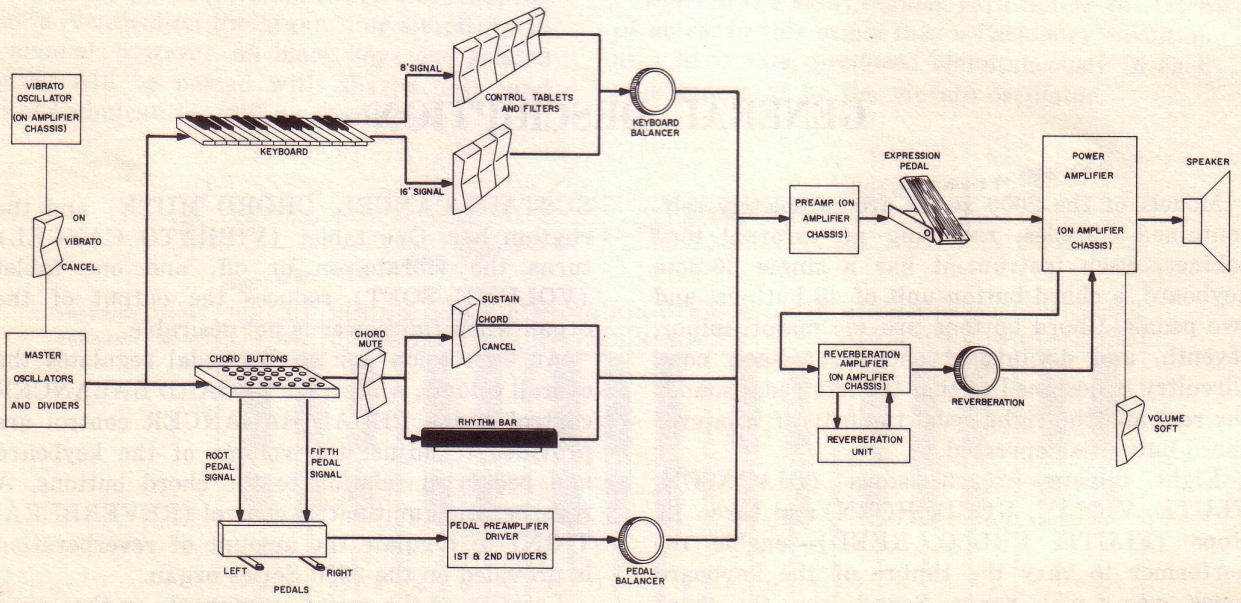


Fig. 3. Block Diagram.

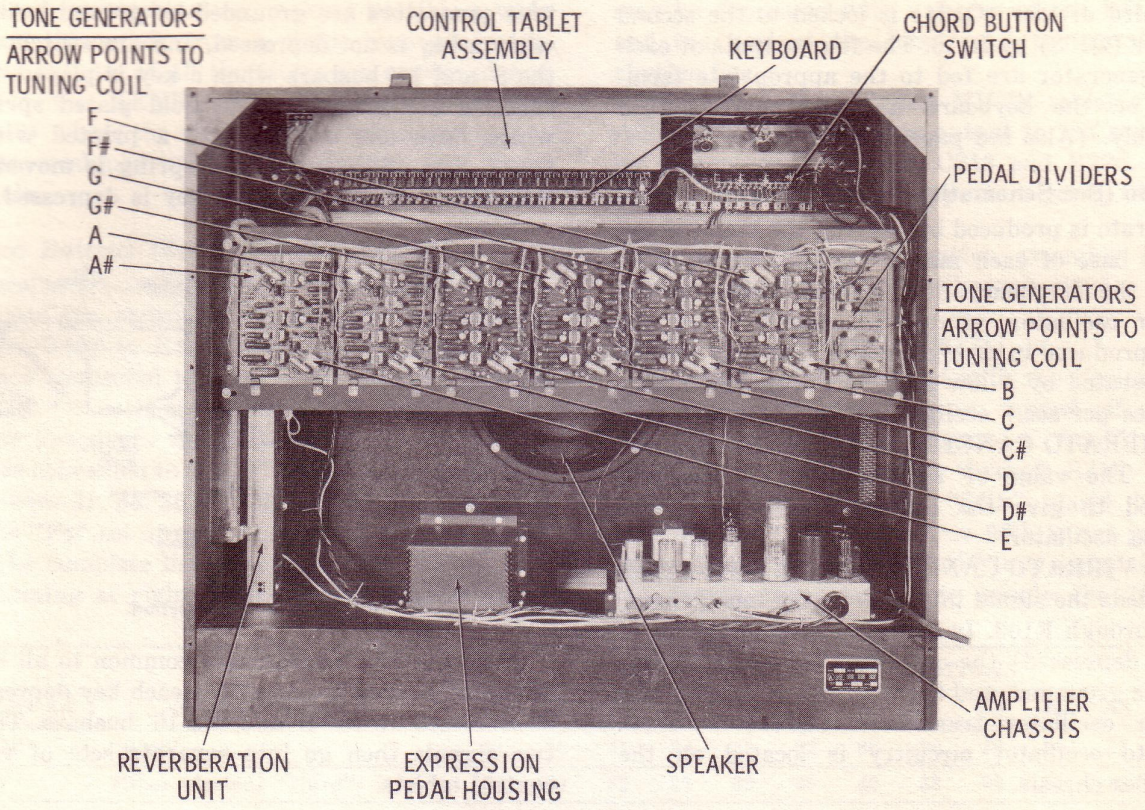


Fig. 4. Back View.

THEORY OF OPERATION

General (See Block Diagram, Fig. 3)

The Series 2000 organ uses transistorized oscillator circuits for generating the basic organ tones. Appropriate generators are then connected to each note of the keyboard and to the chord button assembly. Tones selected by the keyboard pass through the tone filters selected by the voice control tablets, and the level is adjusted before the tones enter the preamp portion of the amplifier.

Tones selected by the chord buttons are controlled in volume and duration by the rhythm bar and two chord tablets (CHORD SUSTAIN CANCEL, CHORD MUTE) before being mixed with the keyboard signal as it enters the preamp section of the amplifier.

The two pedal notes are tapped off of the output of the chord buttons. The right pedal sounds the fifth of the chord and the left pedal sounds the root of the chord. Signal from the pedals is amplified and converted into tones one and two octaves lower by transistorized frequency divider circuits. Level of the pedal signal is adjusted by the PEDAL BALANCER control before being mixed with the keyboard and chord button signals at the preamp input of the amplifier.

After passing through the preamp the combined signal (keyboard, chord button, pedals) is attenuated to the desired degree by the expression pedal circuitry. The power amplifier then amplifies the signal and feeds it to the speaker.

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.

Tone Generators (See Schematic, Fig. 21)

A separate tone generator is provided for each note of one octave—twelve generators in all. Each generator consists of a master transistor oscillator generating the highest frequency used of that particular note, and three frequency dividers supplying successively lower octaves of the same note. For example, in the "F" tone generator the master oscillator (Q101) will produce Frequency No. 54. A portion of this signal is tapped off by R106 and fed to the base of the first divider transistor (Q102). This locks the first divider on frequency so that the output of Q102 (Frequency No. 42) is exactly one octave below the master oscillator. Similarly the second divider (Q103) is locked to the first divider (Q102) by R107, and

the third divider (Q104) is locked to the second divider (Q103) by R113. The four outputs of each tone generator are fed to the appropriate terminals on the keyboard and the chord button assembly. (Also see page 23.)

Vibrato (See Schematic, Fig. 21)

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 bias voltage is generated by a low frequency (approximately 6 cycles per sec.) oscillator (V302B) and fed to the VIBRATO CANCEL tablet through C305 and R308. The value of resistor R301 is specially selected to give the correct frequency to the vibrato oscillator.

The VIBRATO CANCEL tablet in normal position feeds the signal into each of the tone generators through R103. In cancel position (bottom of tablet depressed) the output of the vibrato oscillator is grounded, and the bias on the bases of the master oscillator transistors (Q101) is fixed. Vibrato oscillator circuitry is located on the amplifier chassis.

Manual Keyboard (See Schematic, Fig. 21)

Two tones are fed from the tone generators into each key circuit—an 8′ signal into R601 and a 16′ signal into R602. When any key is depressed an action similar to that of a double pole double throw switch occurs. See Fig. 5. Signals from the tone generators are grounded by ground busbars when a key is not depressed, and are switched to the 8′ and 16′ busbars when a key is played. The contacts are made through gold plated springs which have one end fixed to a printed wiring board. The other end of the spring is moved by mechanical action when the key is depressed.

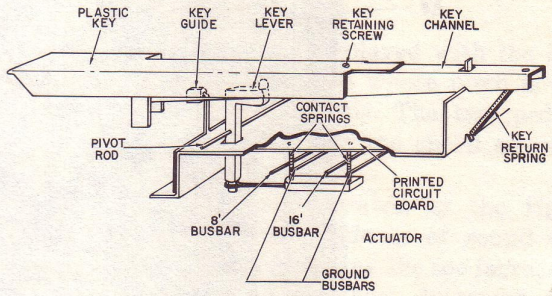


Fig. 5. Key Construction.

Since the four busbars are common to all keys of the keyboard the output for each key depressed is combined on the 8′ and the 16′ busbars. These two signals then go into separate sets of voice control tablets.

Voice Control Tablets (See Schematic, Fig. 21)

The voice control tablets are divided into two groups, 8′ and 16′. Each of these tablets has its own filter network which alters the wave shape of the signal and consequently gives a characteristic sound to the organ output. The tablets may be used

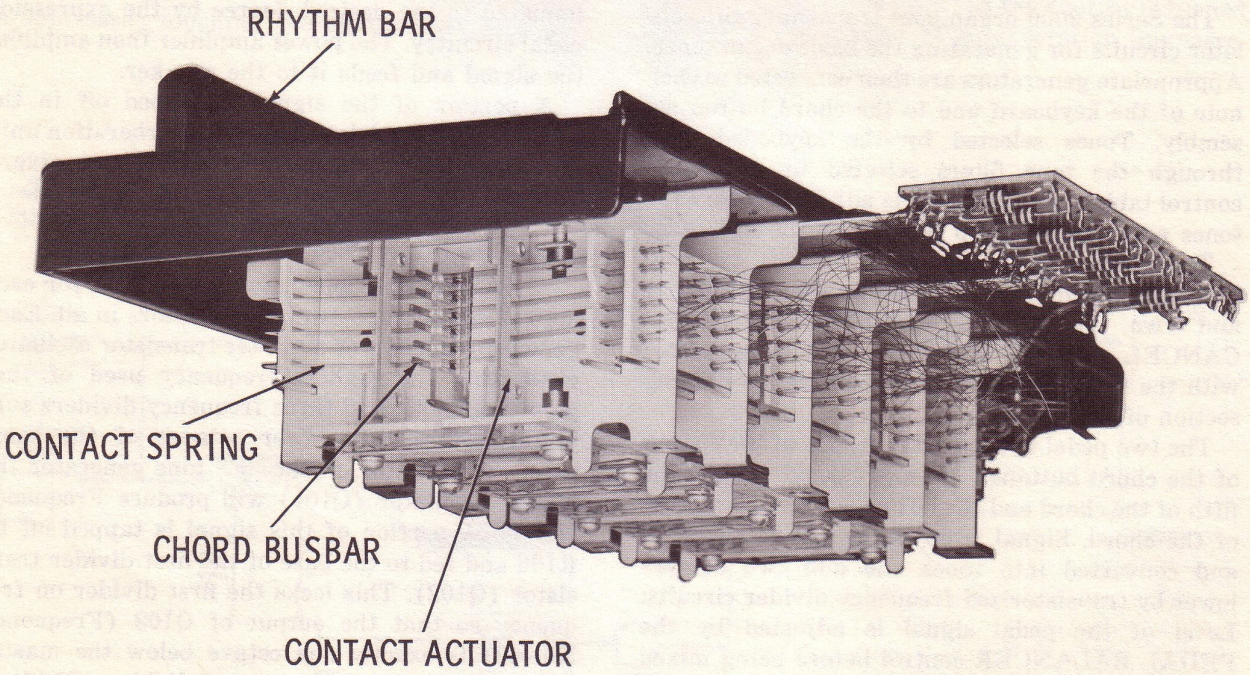


Fig. 6. Chord Button Switch Assembly.

singly or in combination, making possible a wide variety of sounds from a single tone generator.

The outputs of all the filters are combined and fed to the KEYBOARD BALANCER control (R222) where the signal level is regulated before being combined with chord button and pedal signals.

Chord Buttons (See Schematic, Fig. 21)

Twelve frequencies (Nos. 30 through 41) are fed into the chord button assembly through resistors R401 to R412 inclusive. The appropriate six are connected to a set of six contact springs, one set for each key column of buttons. For example Frequency Numbers 30, 33, 34, 36, 37 and 40 are connected to the "F" set of contact springs; Numbers 31, 34, 35, 37, 38, and 41 are connected to the "F♯" set of contact springs; etc. See Fig. 7 for the complete list of connections.

Running at right angles to and slightly below the contact springs are six chord output busbars. Each chord button presses a contact actuator which causes the appropriate contact springs to touch the chord busbars when a button is depressed. Depressing any chord button will produce three or four tones, depending on the shape of the actuator. See Fig. 8 for details of chord button output.

Outputs of these chord busbars are combined through isolating resistors R414, R415, R416, R418, R420, and R421, and are fed into the chord control circuits. The CHORD SUSTAIN tablet contacts are closed in normal position, feeding the chord signal (attenuated by R221) to the amplifier whenever a chord button is depressed. This background or sustained signal is eliminated when the bottom of the CHORD SUSTAIN CANCEL tablet is depressed.

If a chord button is depressed and then the rhythm bar is touched, the full chord signal will be fed into the amplifier. This makes it possible to give rhythm to the chords without releasing the chord button (which must remain depressed to supply pedal signals—see below). A chord button may be depressed with a finger of the left hand and the heel of the hand used to operate the rhythm bar.

Depressing the CHORD MUTE tablet greatly mellows the chord button output to the amplifier by grounding it through C213 and R226. However, it does not affect the portion going through the pedals.

Output of the chord button assembly is fed directly into the amplifier through R225.

Pedals (See Schematic, Fig. 21)

Just two pedals are used with the Series 2000 chord organ. Two signals are tapped off of the chord button assembly output—a "root" signal from the top chord busbar through R413, and a "fifth" signal from the "fifth" chord busbar through R419. Since the true fifth is not present in the Diminished chord, R417 taps a signal from the fourth chord busbar to supply the "flatted fifth" note for the right pedal. There is no signal fed to the pedals unless a chord button is depressed.

		CHORD BUTTON DESIGNATIONS											
BUSBAR	*NOTE OF CHORD*	*F♯*	*B*	*E*	*A*	*D*	*G*	*C*	*F*	*B♭*	*E♭*	*A♭*	*D♭*
TOP	"Root"	31	36	41	34	39	32	37	30	35	40	33	38
2	Minor (flatted) "Third"	34	39	32	37	30	35	40	33	38	31	36	41
3	"Third"	35	40	33	38	31	36	41	34	39	32	37	30
4	Flatted "Fifth"	37	30	35	40	33	38	31	36	41	34	39	32
5	"Fifth"	38	31	36	41	34	39	32	37	30	35	40	33
BOTTOM	Dominant (flatted) "Seventh"	41	34	39	32	37	30	35	40	33	38	31	36

Chart shows frequency number of tone generator output connected to contact springs under chord buttons (through isolating resistors R401 to R412 inclusive). Switch assembly is viewed from the rear.

Fig. 7. Chord Button Switch Assembly Connections.

Pedal Divider Board (See Schematic, Fig. 21)

Signal from the pedals is fed to pedal preamp transistor Q105, and, through transformer T104, to driver transistor Q106. The first pedal divider (Q107 and Q108) is a flip-flop which is triggered by the pedal signal. This flip-flop output is half the frequency of the input signal so in effect it drops the pedal tone one octave. The output of the first pedal divider is used to trigger the second pedal divider (also a flip-flop circuit) and again the output of the flip-flop is half the frequency of the triggering signal. See Fig. 8 for pedal notes.

Outputs of both flip-flops are combined (R126, R127), and sent through a filter network (C214, R227, C215, R228, C216, R229) to the PEDAL BALANCER control. The output of this control combines with that of the chord buttons and the manual keyboard to form the input to the amplifier preamp.

CHORD BUTTON	F♯				B				E			
	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM
FREQUENCY NUMBERS USED IN CHORD			41				40				41	
	38	38	38	37	40	39	36	39	41	41	39	41
	35	34	35	34	36	36	34	36	36	36	36	35
	31	31	31	31	31	31	31	30	33	32	33	32
MUSICAL NOTES IN CHORD			E				D♯				E	
	C♯	C♯	C♯	C	D♯	D	B	D	E	E	D	E
	A♯	A	A♯	A	B	B	A	B	B	B	B	A♯
	F♯	F♯	F♯	F♯	F♯	F♯	F♯	F	G♯	G	G♯	G
LEFT PEDAL NOTE ("ROOT")	F♯	F♯	F♯	F♯	B	B	B	B	E	E	E	E
RIGHT PEDAL NOTE ("FIFTH")	C♯	C♯	C♯	C	F♯	F♯	F♯	F	B	B	B	A♯

CHORD BUTTON	A				D				G			
	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM
FREQUENCY NUMBERS USED IN CHORD			41				39				39	
	41	41	38	40	39	39	37	39	39	39	36	38
	38	37	34	37	34	34	34	33	36	35	32	35
	34	34	32	34	31	30	31	30	32	32	30	32
MUSICAL NOTES IN CHORD			E				D				D	
	E	E	C♯	D♯	D	D	C	D	D	D	B	C♯
	C♯	C	A	C	A	A	A	G♯	B	A♯	G	A♯
	A	A	G	A	F♯	F	F♯	F	G	G	F	G
LEFT PEDAL NOTE ("ROOT")	A	A	A	A	D	D	D	D	G	G	G	G
RIGHT PEDAL NOTE ("FIFTH")	E	E	E	D♯	A	A	A	G♯	D	D	D	C♯

CHORD BUTTON	C				F				B♭			
	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM
FREQUENCY NUMBERS USED IN CHORD			41				40				39	
	41	40	37	40	37	37	37	36	39	38	35	41
	37	37	35	37	34	33	34	33	35	35	33	38
	32	32	32	31	30	30	30	30	30	30	30	35
MUSICAL NOTES IN CHORD			E				D♯				D	
	E	D♯	C	D♯	C	C	C	B	D	C♯	A♯	E
	C	C	A♯	C	A	G♯	A	G♯	A♯	A♯	G♯	C♯
	G	G	G	F♯	F	F	F	F	F	F	F	A♯
LEFT PEDAL NOTE ("ROOT")	C	C	C	C	F	F	F	F	A♯	A♯	A♯	A♯
RIGHT PEDAL NOTE ("FIFTH")	G	G	G	F♯	C	C	C	B	F	F	F	E

CHORD BUTTON	E♭				A♭				D♭			
	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM	MAJ	MIN	7TH	DIM
FREQUENCY NUMBERS USED IN CHORD			40				40				38	
	40	40	38	40	40	40	37	39	38	41	36	41
	35	35	35	34	37	36	33	36	33	38	33	38
	32	31	32	31	33	33	31	33	30	33	30	32
MUSICAL NOTES IN CHORD			D♯				D♯				C♯	
	D♯	D♯	C♯	D♯	D♯	D♯	C	D	C♯	E	B	E
	A♯	A♯	A♯	A	C	B	G♯	B	G♯	C♯	G♯	C♯
	G	F♯	G	F♯	G♯	G♯	F♯	G♯	F	G♯	F	G
LEFT PEDAL NOTE ("ROOT")	D♯	D♯	D♯	D♯	G♯	G♯	G♯	G♯	C♯	C♯	C♯	C♯
RIGHT PEDAL NOTE ("FIFTH")	A♯	A♯	A♯	A	D♯	D♯	D♯	D	G♯	G♯	G♯	G

Fig. 8. Output of Chord Buttons and Pedals.

Amplifier Chassis (See Schematic, Fig. 21)

The amplifier chassis contains five sections—a vibrato oscillator (V302B, discussed previously), a preamplifier (V301, V302A), a reverberation amplifier (V303A and V303B), a power amplifier (V304, V305, V306), and a power supply (V307).

Signals from the manual keyboard, the chord buttons, and the pedals are all combined at the input of the preamp section of the amplifier. After two stages of amplification (V301, V302A) the signal is fed through a jack on the amplifier chassis to the expression pedal.

The expression pedal is connected to jacks on the amplifier chassis with input and output cables. The pedal operates a potentiometer by means of a rack and gear. C501, R502, C502, and R503 form a compensating network to give the desired frequency response.

A gain adjustment (R322) is provided where the signal enters the power amplifier section of the amplifier chassis. This is a screwdriver slot adjustment, set at the factory, to provide the proper amount of driving signal. The power amplifier consists of an amplifier stage (V304A), a driver stage (V304B) and a push-pull output (V305, V306).

Signal for the reverberation amplifier is tapped off at the gain adjustment control (R322). After a stage of amplification (V303A) this signal is fed to the reverberation unit. The signal is delayed in the reverberation unit, amplified (V303B), attenuated (R235, REVERBERATION control), and returned to the power amplifier where it is mixed with the original signal.

The VOLUME SOFT tablet is connected at the point where the reverberation and direct signals are combined and fed into the power amplifier. Depressing the bottom of this tablet bypasses a portion of the signal to ground through R236 and C218, reducing the volume of the organ.

The power supply uses V307 as a full wave rectifier. B+ power is tapped off a voltage divider (consisting of R353, R354, R355, R356, R357, R358, R359 and R360) at appropriate levels, with filtering to reduce AC ripple. R359 is adjustable so the—12 volt supply to the tone generators can be set accurately, since this voltage affects the pitch of the oscillators.

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 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 three different types of switches. Below the keyboard gold-plated springs are pushed against gold-plated busbars. In the chord button assembly flexible contact springs are pushed against chord busbars by contact actuators. The switches on the control panel are similar to a conventional leaf switch, and are opened and closed by plastic fingers on the tablets. Contact springs of the chord buttons, control panel, and pedal switches have crossed wire palladium alloy contact surfaces. 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, button, 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 panel 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 keyboard contacts may be similarly treated, but use of any metal tool or sandpaper should be avoided, because of the danger of removing the plating.

Contacts at the ends of the chord button switch assembly can be treated in the same way, but the inner ones are very difficult to reach. The contact

springs should not be removed, except in cases of extreme emergency, because they are difficult to replace correctly. It is possible to rub a contact clean by unhooking the bent end of a busbar from the notch where it is held, and sliding the busbar endwise a short distance while holding down the offending button.

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. 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 pilot lamp, unscrew the red plastic cap. The lamp can then be unscrewed and a new #765 lamp inserted. This lamp is rated at 7 volts, .065 amp.

ADJUSTMENTS

Gain Adjustment—R322 (See Fig. 11 for location)

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

To reset the gain adjustment depress the expression pedal all the way and set the REVERBERATION control to its maximum counterclockwise position. Depress the lower end of the VIBRATO CANCEL tablet and leave all other tablets in "Off" position. Connect an AC voltmeter to the voice coil terminals of the speaker. While holding down the C MAJOR chord button, turn the gain adjustment control until the voltmeter reads 0.6 volts.

−12 Volt Adjustment—R359 (See Fig. 9 for location)

The −12 volt adjustment does not normally require changing after being locked at the factory. The tone generator oscillators will work satisfactorily if this voltage is within ±10% of its optimum value. This voltage can be measured on any of the tone generator printed boards at the terminal to which yellow leads are connected.

To reset the −12 volt adjustment control, loosen the locking nut on the control and turn the shaft with a screwdriver while observing the voltage on an accurate DC voltmeter.

Tuning Procedure

Tuning the organ using an electronic indicator

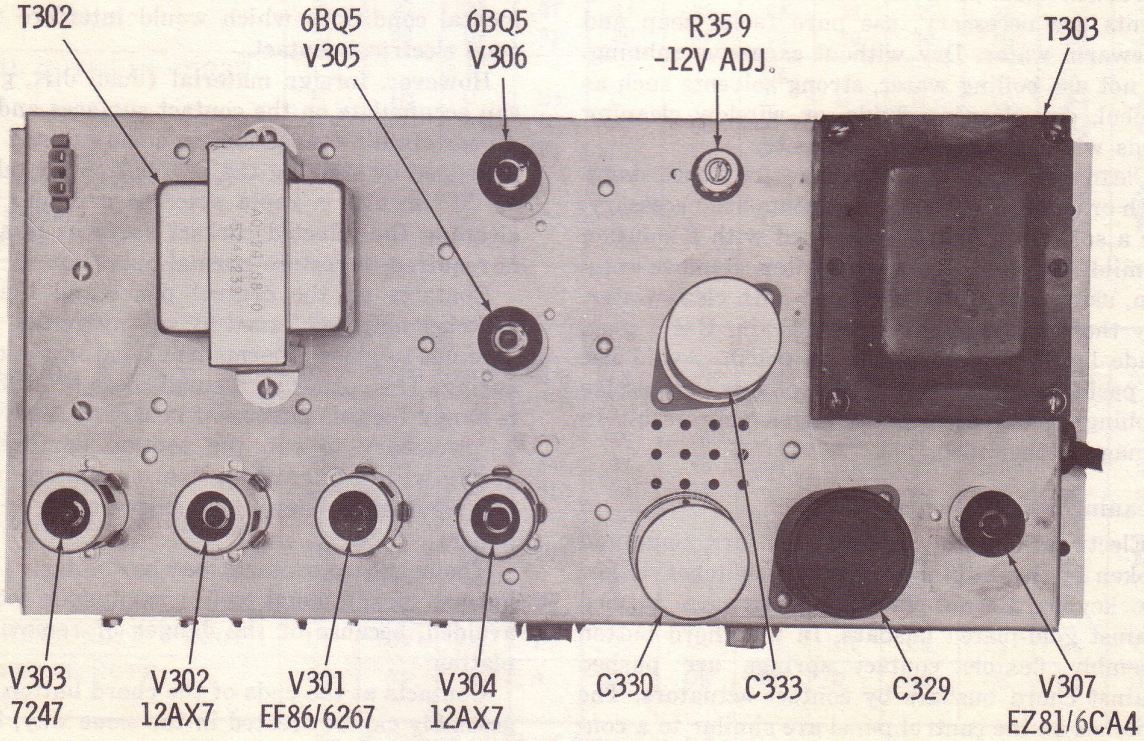


Fig. 9. Amplifier Chassis—Top View.

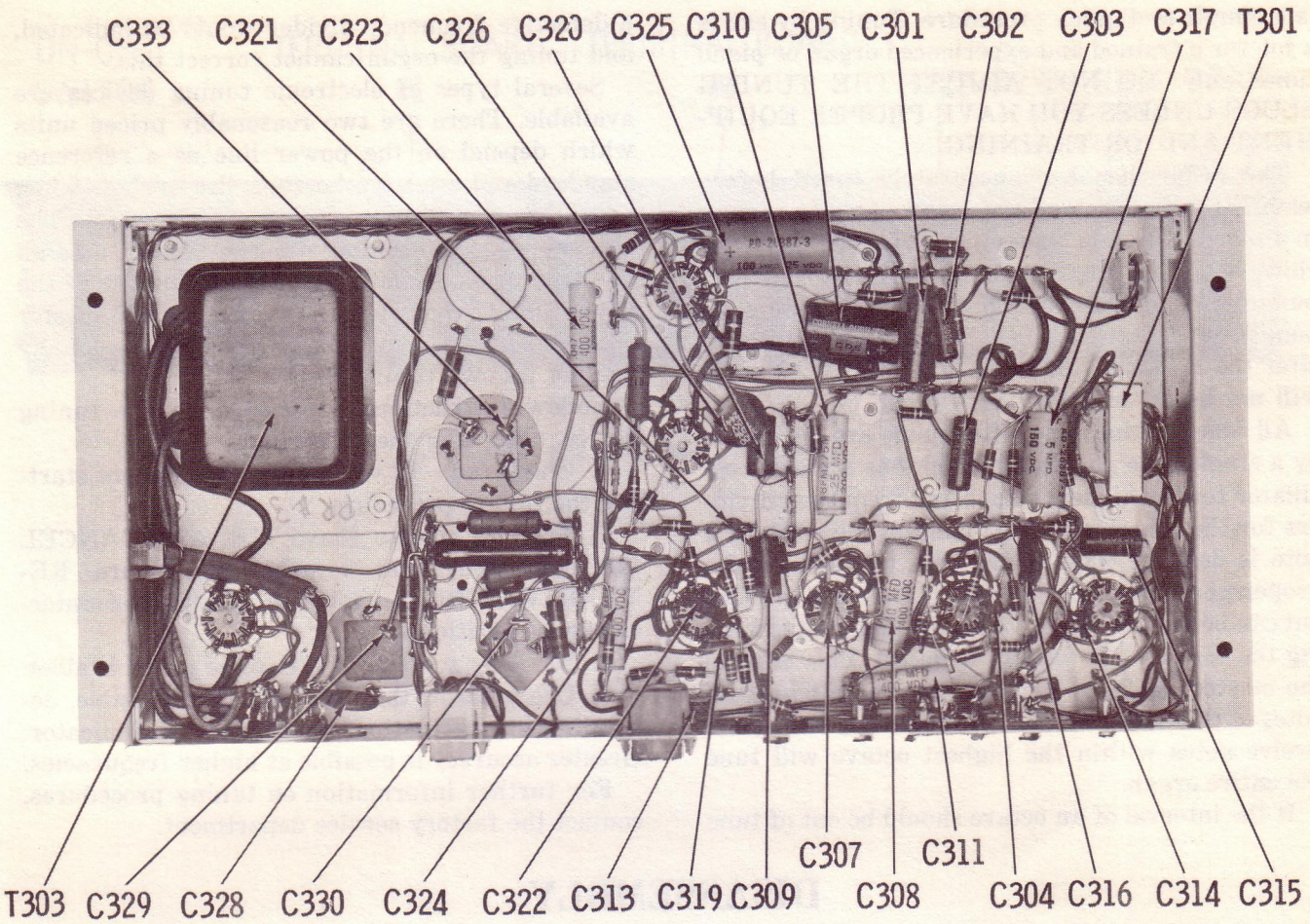


Fig. 10. Amplifier Chassis—Bottom View—Capacitors.

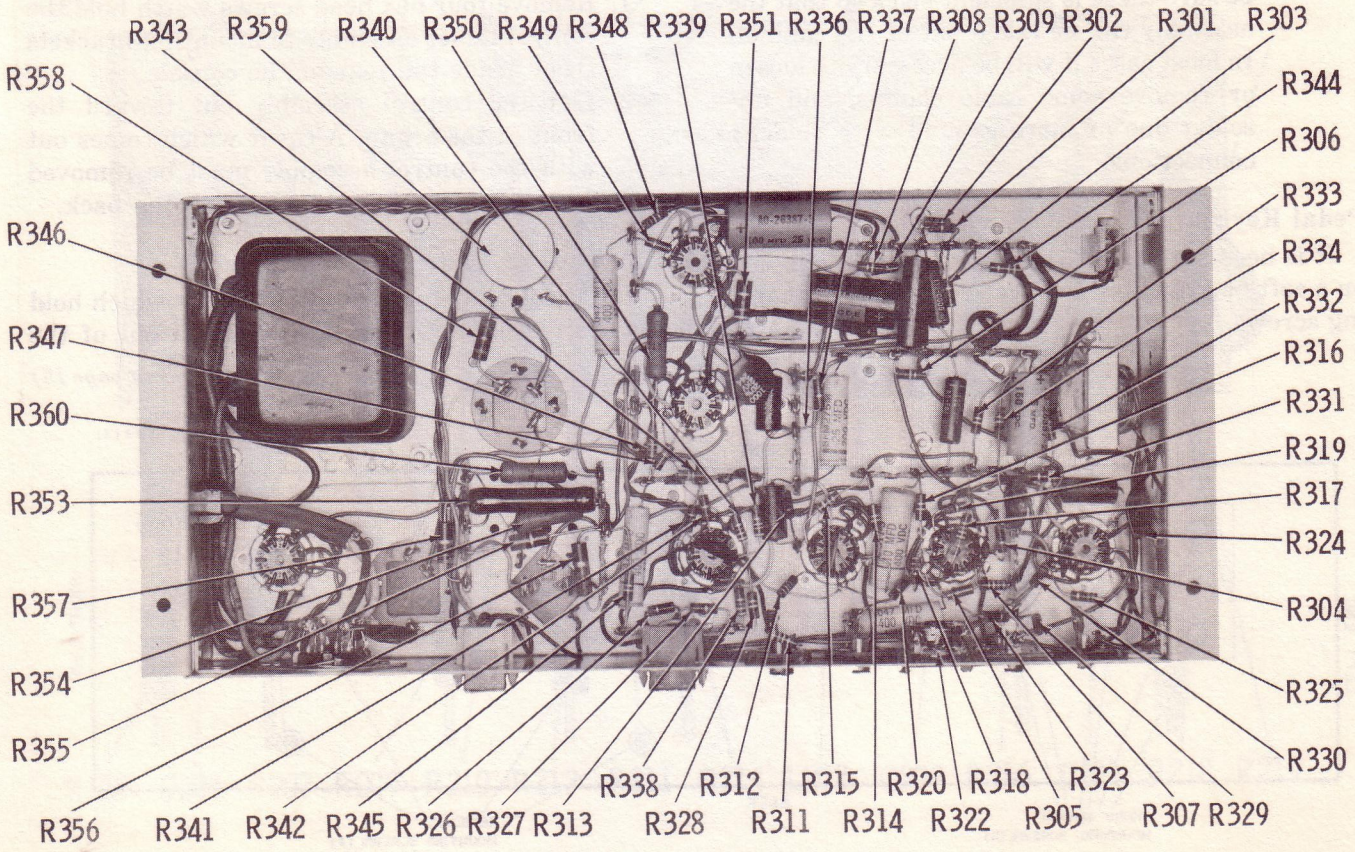


Fig. 11. Amplifier Chassis—Bottom View—Resistors.

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 humidity 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 indicated, and tuning the organ cannot correct this.

Several types of electronic tuning devices are available. There are two 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.

Follow instructions supplied with the tuning device, observing the following:

1. Check the −12 volt adjustment before starting the tuning procedure.
2. Turn off vibrato (have VIBRATO CANCEL tab depressed) and reverberation (turn REVERBERATION control to its maximum counterclockwise position).
3. Use only the 8′ FLUTE voice control tablet.
4. Use notes of the highest octave possible, depending on instructions provided with indicator. Greater accuracy is possible at higher frequencies.

For further information on tuning procedures, contact the factory service department.

DISASSEMBLY

NOTE: Before starting to remove any assembly check all cables and wires attached to it to be sure there is sufficient slack so that the assembly can be taken out of the cabinet. In most cases it will be necessary to loosen or remove some cable clamps, and unsolder one or more ground wire (black) connections.

Pedal Keyboard

It is necessary to set the instrument on one end on a soft pad in order to have access to the mounting screws.

Control Tablet Assembly

1. Remove four hex head screws which hold the control tablet assembly to mounting brackets from inside the rear of the console.
2. Lift the control assembly out toward the front of the organ. A cover which comes out with the control assembly must be removed for access to the components on the back.

Keyboard or Chord Button Assembly

Refer to Fig. 12, and remove screws which hold the desired unit in place. Pull the unit out of the

(Continued on page 15)

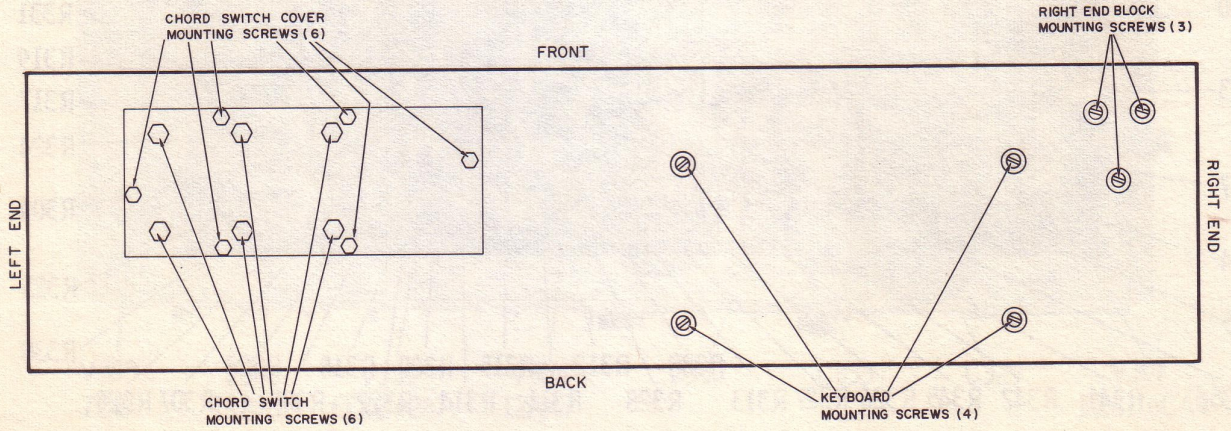


Fig. 12. Retaining Screw Locations Under Keyboard.

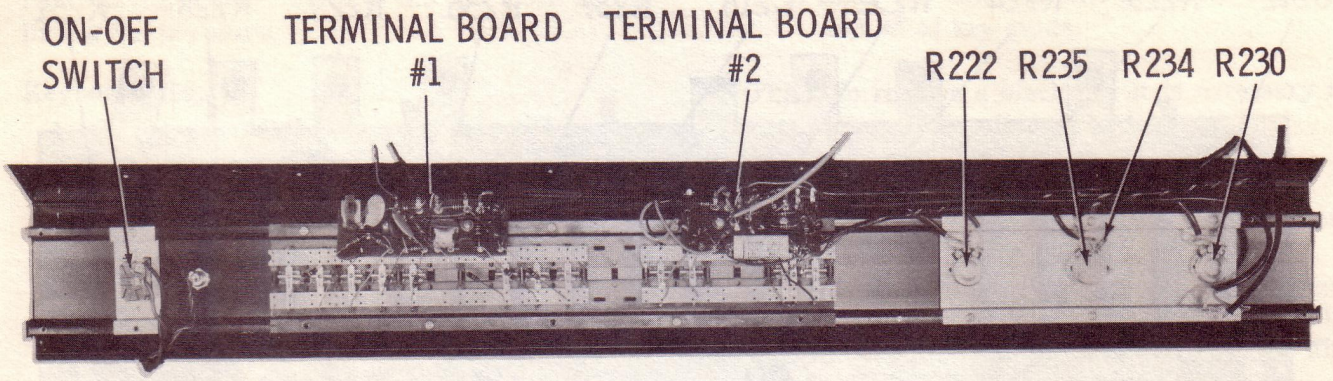


Fig. 13. Control Panel Assembly.

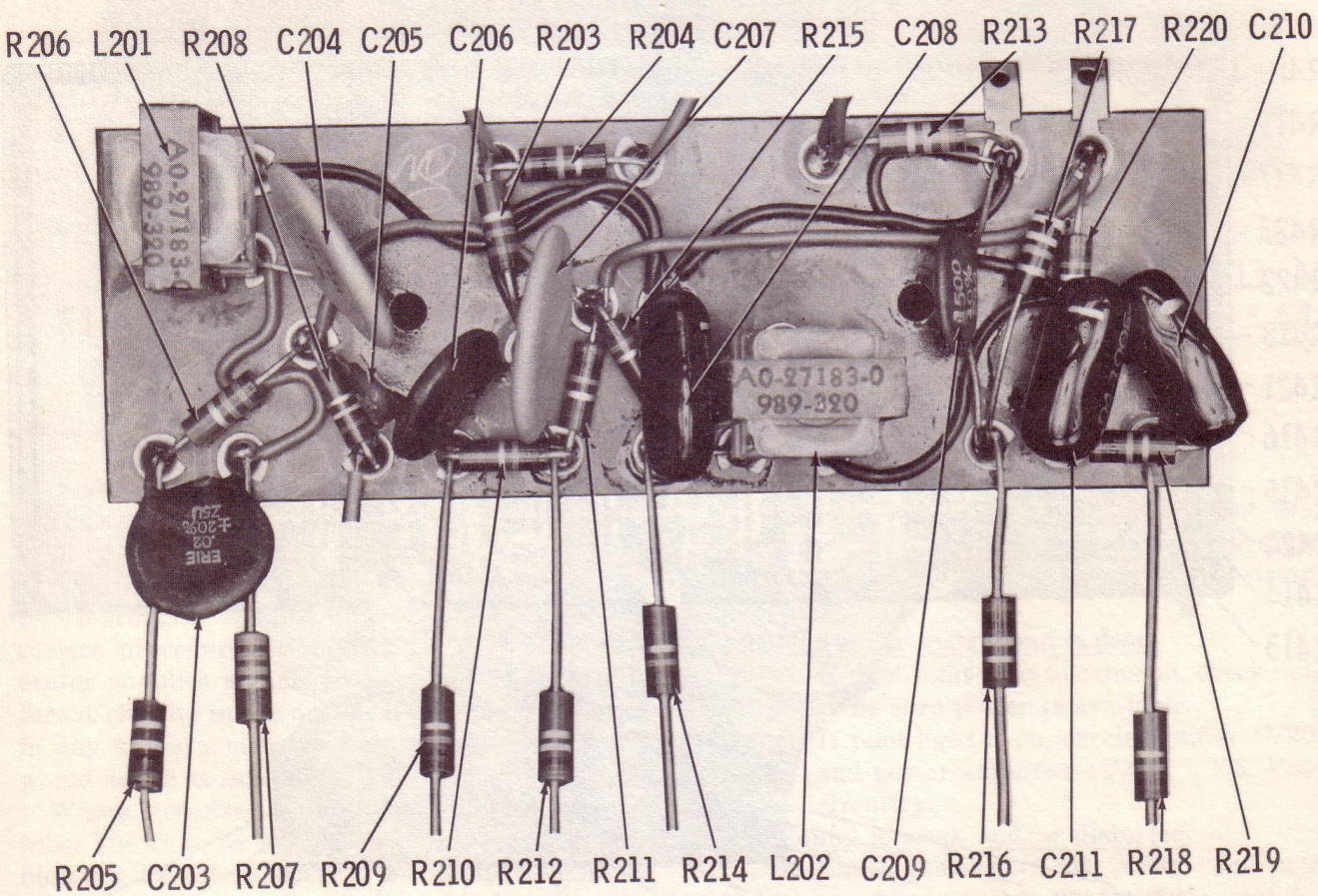


Fig. 14. Terminal Board No. 1 in Control Panel Assembly.

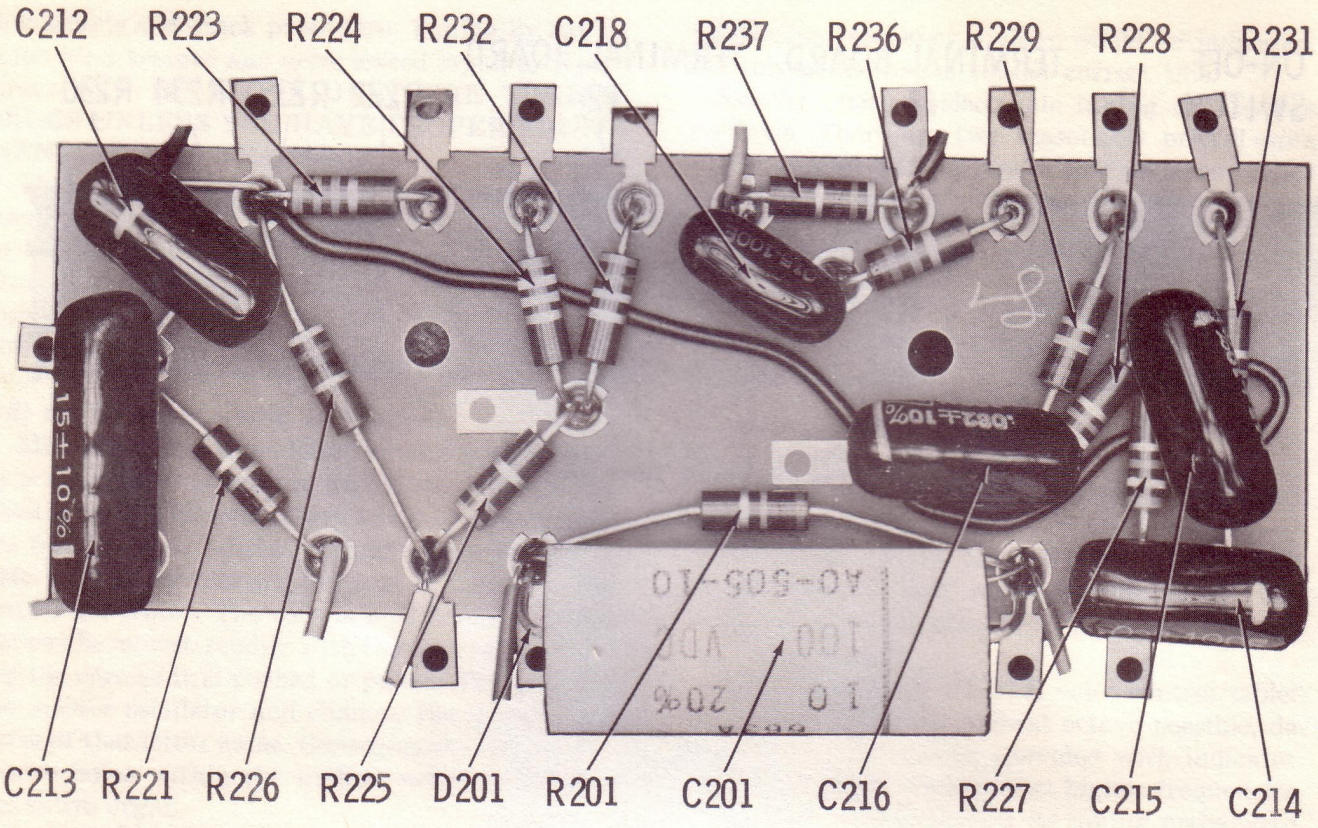


Fig. 15. Terminal Board No. 2 in Control Panel Assembly.

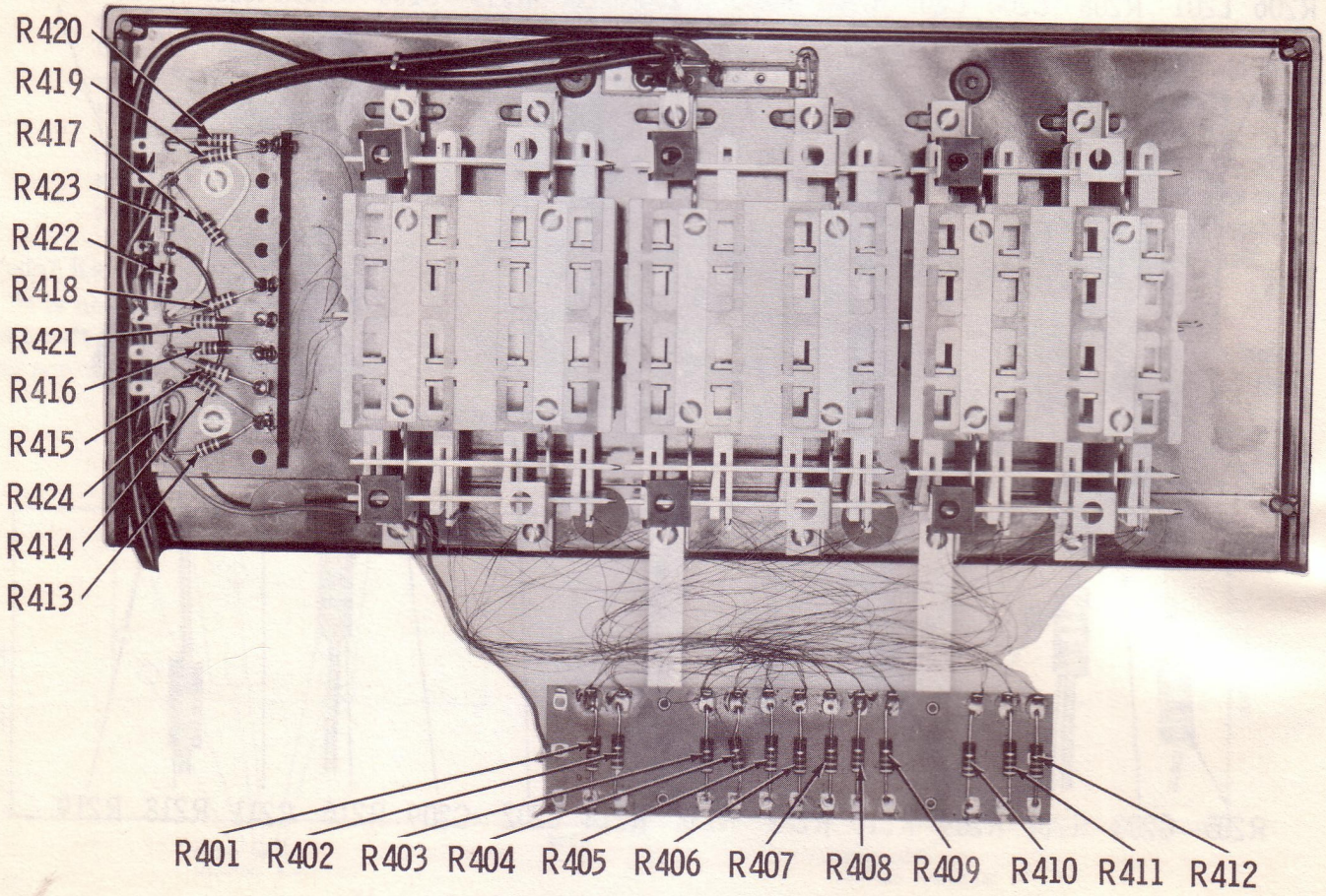


Fig. 16. Chord Button Switch Assembly.

front of the cabinet. Remove the end block before lifting the keyboard.

Keyboard Key

1. To remove plastic key only, take out key retaining screw (Fig. 5) and pull plastic 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 and white plugs from amplifier.
2. Remove eight hex head screws with washers and lift off pedal cover.
3. Take out four screws with lockwashers, and lift up expression pedal assembly.

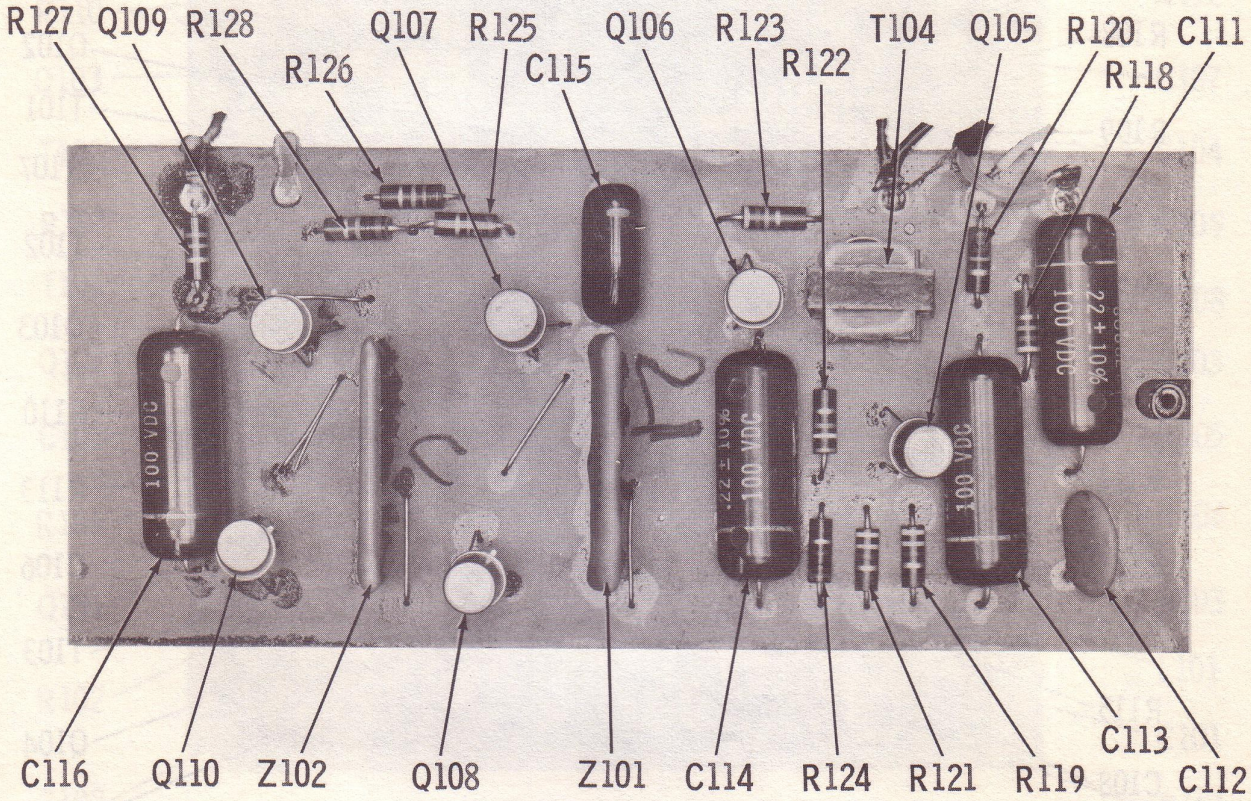


Fig. 17. Pedal Divider Circuit Board.

SERVICE SUGGESTIONS

The following list suggests areas to investigate when a malfunction of the organ occurs. Care should be taken to investigate the defective operation thoroughly to avoid unnecessary and involved service procedures. For example, each tone generator supplies signals to as many as three different circuits in the organ. If the tone is present in any of these circuits the tone generator itself would not be at fault.

Where 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 as far as possible the defective components. (Also see page 23.)

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

1. <u>The entire instrument is dead.</u>
   a. If pilot light fails to come on, check outlet to be sure power is available.
   b. If pilot light is on, check rectifier (V307) and power amplifier (V304, V305, V306) circuitry.
2. <u>Sound is weak and/or distorted.</u>
   a. Check preamp (V301, V302) and power amplifier (V304, V305, V306) circuitry.
   b. Check setting of gain adjustment. (See "Adjustments").

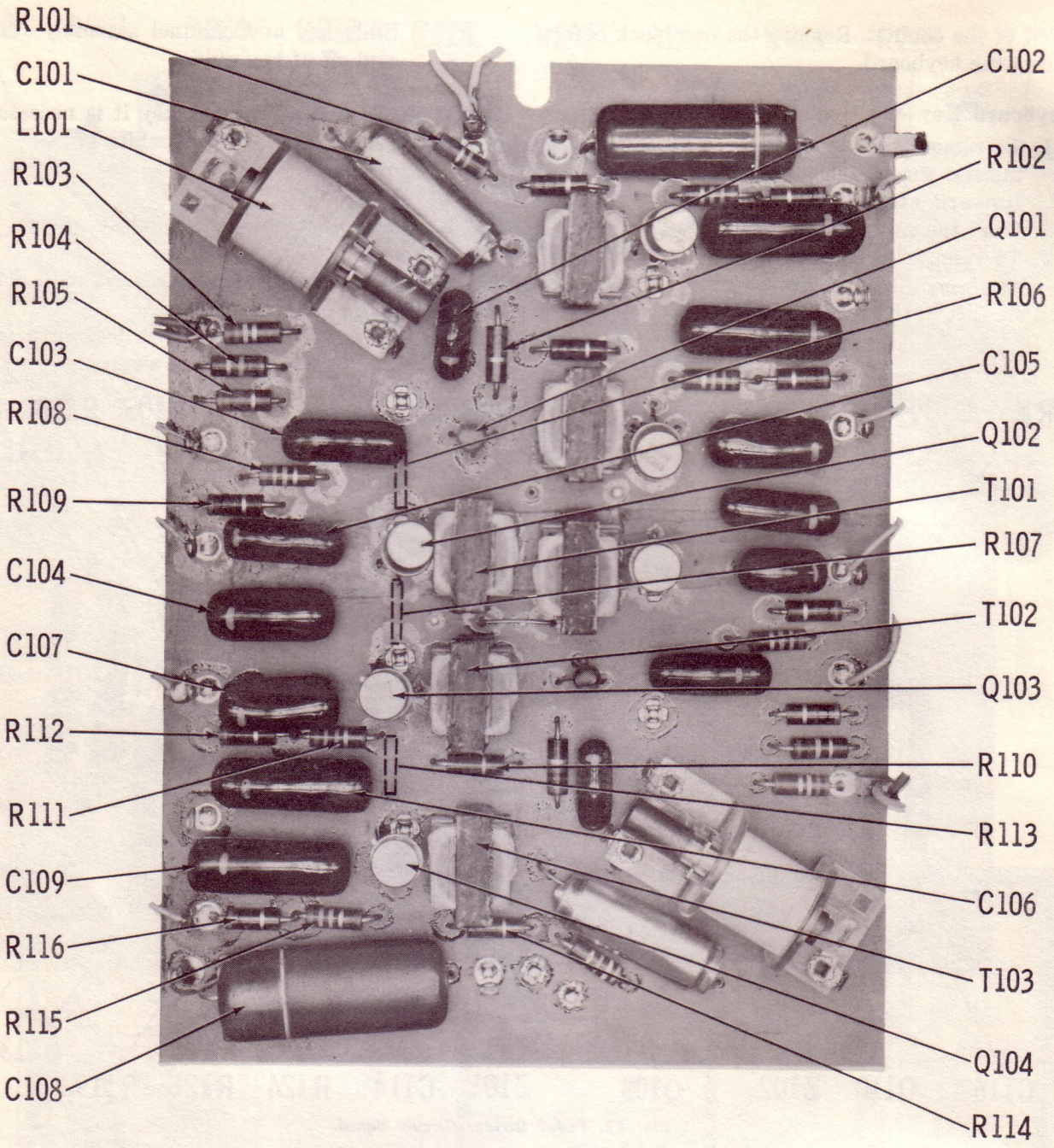


Fig. 18. Tone Generator Circuit Board—Components on Left Side.

c. Check for worn expression control (R501).
d. Check −12 volt adjustment. (See "Adjustments").

3. No vibrato.
   a. Clean VIBRATO CANCEL switch contacts. (See "Maintenance").
   b. Check vibrato oscillator (V302) circuitry.
4. No reverberation.
   a. Check reverberation amplifier (V303) circuitry.
   b. Check reverberation unit for defective components.
5. No sound, or distorted sound, from one keyboard note, using either 8′ or 16′ (not both) voice control tablets.
   a. Clean keyboard busbar contact. (See "Maintenance").
6. No sound, or distorted sound, from one keyboard note using both 8′ and 16′ voice control tablets.
   a. Check appropriate generator (Q101, Q102, Q103, Q104) circuitry.
7. No sound, or distorted sound, from keyboard using a particular voice control tablet.
   a. Clean tablet contacts. (See "Maintenance").
   b. Check tablet circuitry.
8. Chord buttons produce no sound, or weak distorted sound.
   a. Clean CHORD SUSTAIN CANCEL contacts. (See "Maintenance").

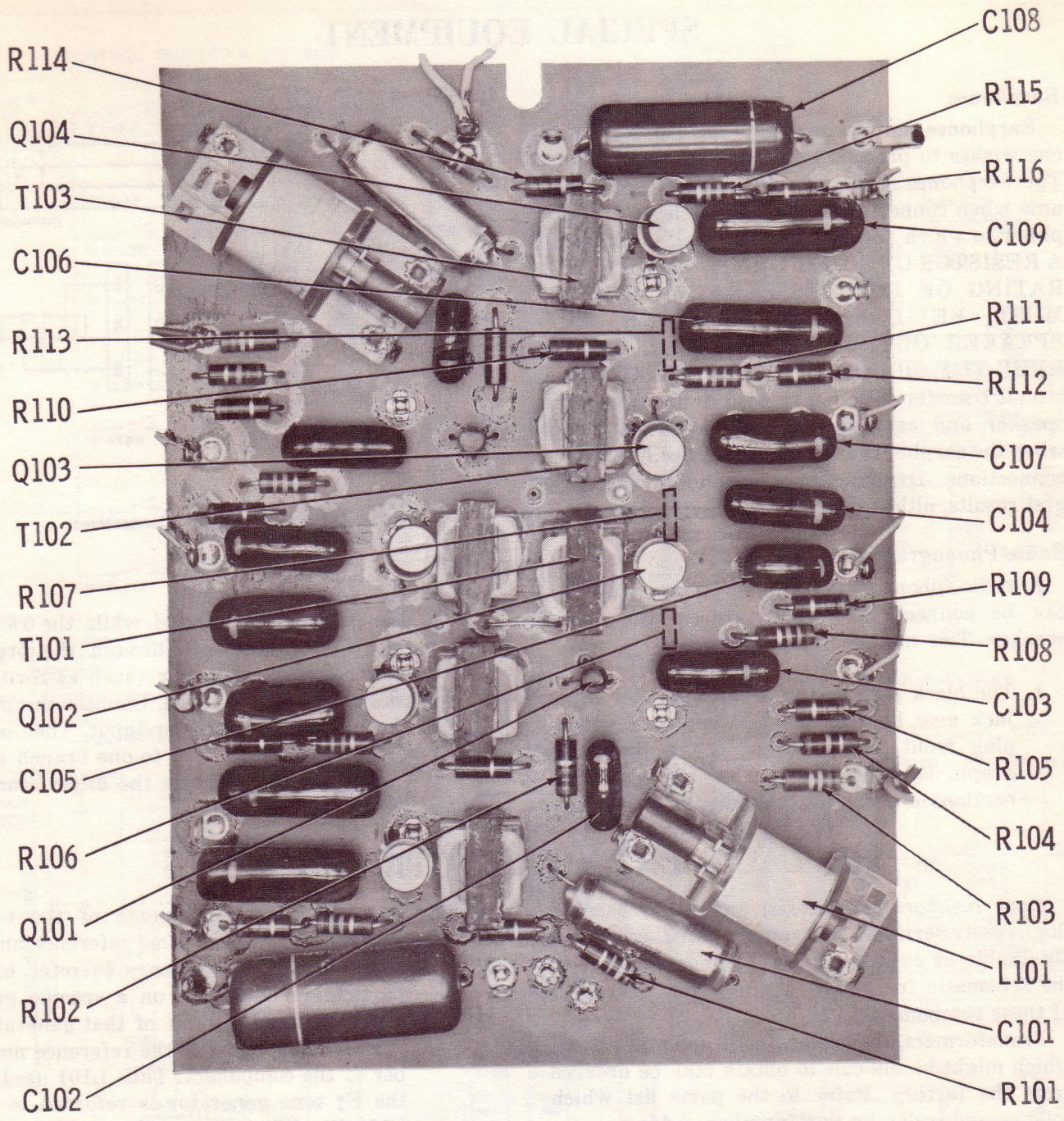


Fig. 19. Tone Generator Circuit Board—Components on Right Side.

b. Clean rhythm bar contacts. (See "Maintenance").
c. Check chord tablet circuitry.

9. Notes missing when chord buttons are played.
   a. Clean chord contact springs and chord busbars. (See "Maintenance").
   b. Check tone generator circuitry.
10. Either pedal note fails to sound (but not both).
    a. Clean pedal switch contacts. (See "Maintenance").
    b. Clean chord contact springs and chord busbars. (See "Maintenance").
11. Both pedal notes do not sound, or are weak or distorted.
    a. Check pedal preamp (Q105), driver (Q106) and divider (Q107, Q108, Q109, Q110) circuitry.
    b. Check −16 volt source on power supply.
12. Octaves out of tune.
    a. Check −12 volt adjustment. (See "Adjustments").
    b. Check tone generator circuitry, especially R106, R107, R113.
13. Organ out of tune.
    a. Check −12 volt adjustment. (See "Adjustments").
    b. Retune the organ. (See "Adjustments").

SPECIAL EQUIPMENT

Earphones

Earphones can be attached to the organ if someone wishes to practice without disturbing others. The earphones will generally give adequate volume when connected to the receptacle on the amplifier to which the speaker voice coil is attached. A RESISTOR OF 6 TO 10 OHMS, WITH POWER RATING OF NOT LESS THAN 10 WATTS, MUST BE CONNECTED ACROSS THE SPEAKER OUTPUT RECEPTACLE WHENEVER THE SPEAKER IS DISCONNECTED. A circuit transfer jack can be used to disconnect the speaker and connect the resistor automatically when the earphones are plugged in. See Fig. 20 for connections. Dynamic type earphones will give best results, although other types can be used.

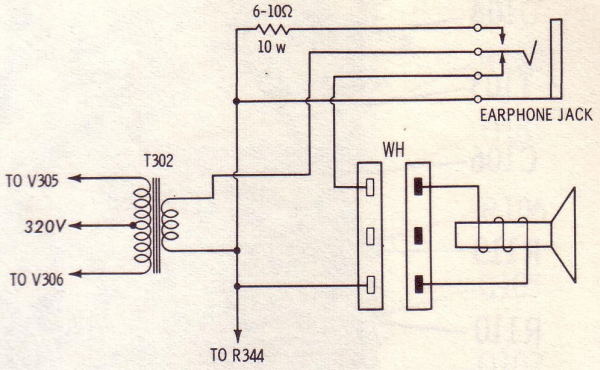


Fig. 20. Earphone Jack Connections.

Radio-Phonograph Connection

A radio, phonograph, or microphone amplifier can be connected to play through the organ speaker. Two methods may be used.

1. The black plug in the organ amplifier input jack may be removed and replaced with a plug from the output of the radio-phonograph. The organ cannot be used while connections are made in this manner.
2. If the organ is to be used while the radio-phonograph is playing through the organ amplifier, a "Y" connector (such as Switchcraft #330F1) is required. Connect the plug of the "Y" to the amplifier input. Then connect the black organ plug to one branch and the radio-phono output to the other branch of the "Y" connector.

REPLACEMENT OF ELECTRICAL PARTS

Most resistors, capacitors, and tubes used in the Everett Series 2000 organ are standard values, obtainable at electronics supply houses. Refer to the schematic for values, ratings and tolerances of these components.

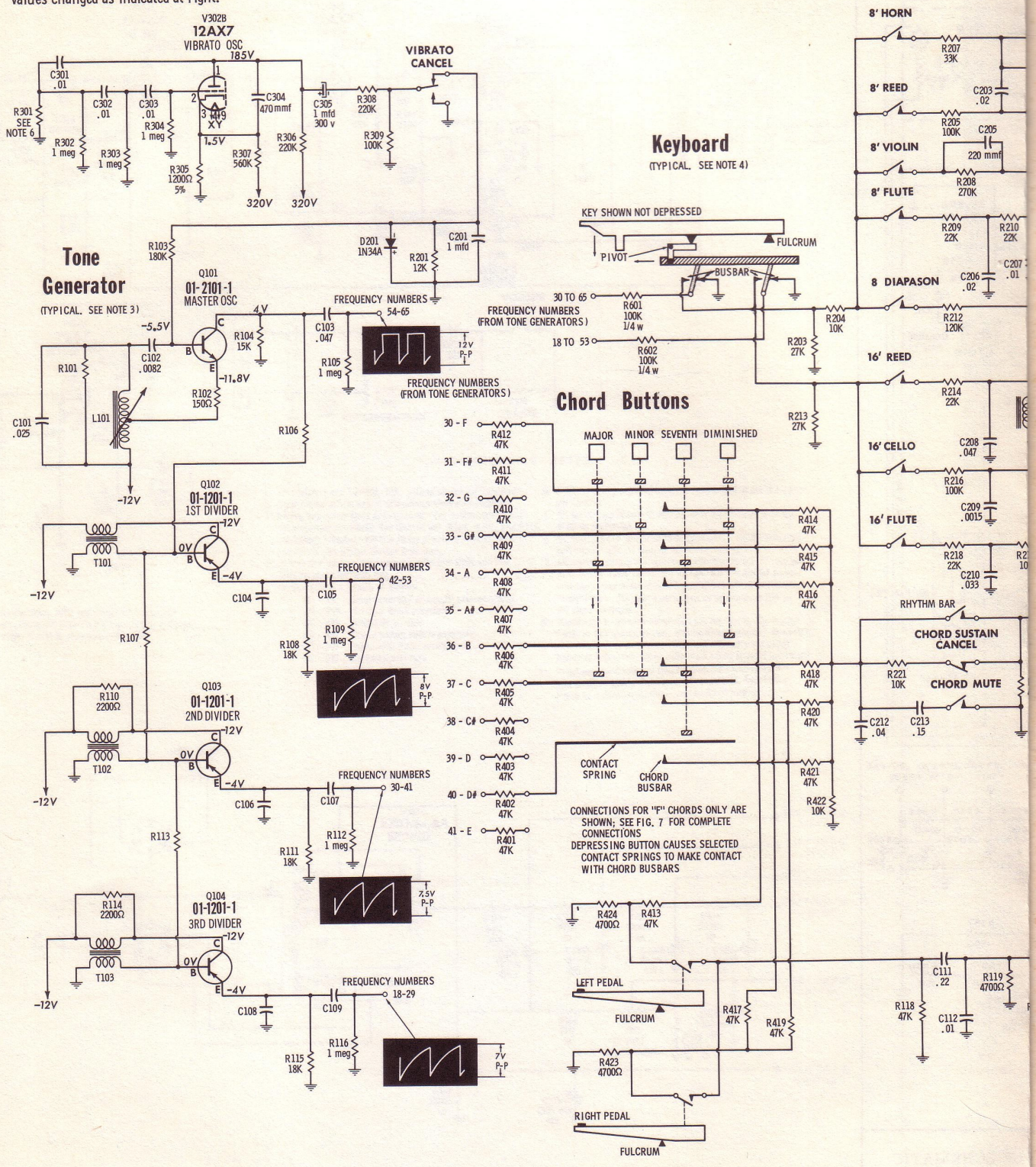
Transformers, transistors, coils and other items which might be difficult to obtain may be ordered from the factory. Refer to the parts list which follows and order by part number. Address:

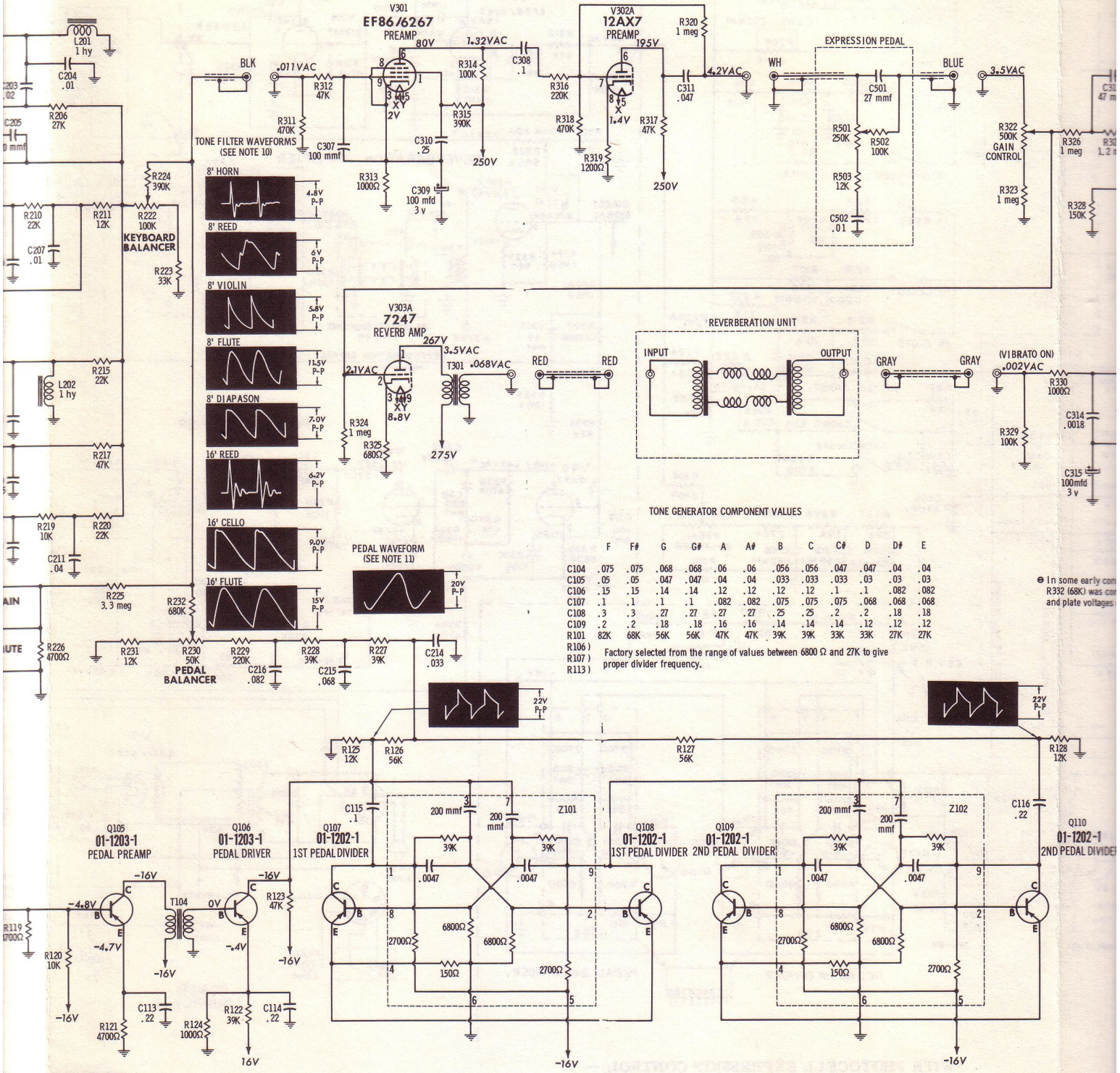
Service Department
Everett Organ Company
4045 North Rockwell Street
Chicago, Illinois 60618

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 tone generators.

CHANGES IN KEYBOARD BALANCER CIRCUIT:
Affecting (Mod. 2022-Ser. #3346 & Up)
(Mod. 2044-Ser. #2875 & Up)
Wire between R225 & R232 removed at tie point & rerouted to positive side of R223. R222A added between R211 & R222. Resistor values changed as indicated at right.

	WAS	NOW
R222A	(Added)	47K
R223	33K	100K
R224	390K	220K
R225	3.3Meg.	270K
R232	680K	560K



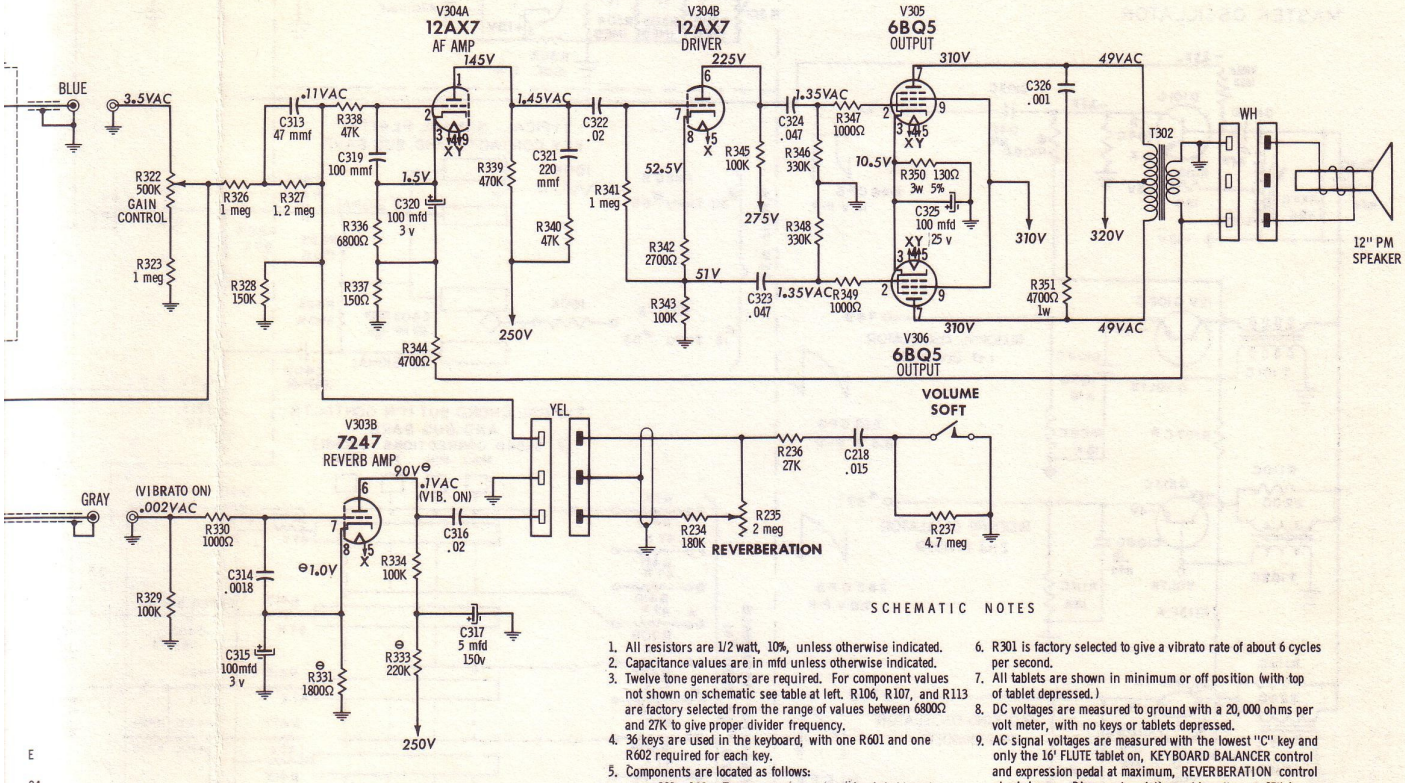


TONE GENERATOR COMPONENT VALUES

	F	F#	G	G#	A	A#	B	C	C#	D	D#	E
C104	.075	.075	.068	.068	.06	.06	.056	.056	.047	.047	.04	.04
C105	.05	.05	.047	.047	.04	.04	.033	.033	.033	.03	.03	.03
C106	.15	.15	.14	.14	.12	.12	.12	.12	.1	.1	.082	.082
C107	.1	.1	.1	.1	.082	.082	.075	.075	.075	.068	.068	.068
C108	.3	.3	.27	.27	.27	.27	.25	.25	.2	.2	.18	.18
C109	.2	.2	.18	.18	.16	.16	.14	.14	.14	.12	.12	.12
R101	82K	68K	56K	56K	47K	47K	39K	39K	33K	33K	27K	27K
R106) R107) R113)	Factory selected from the range of values between 6800 Ω and 27K to give proper divider frequency.											

⊖ In some early con... R332 (68K) was co... and plate voltages

Fig. 21. Schematic.

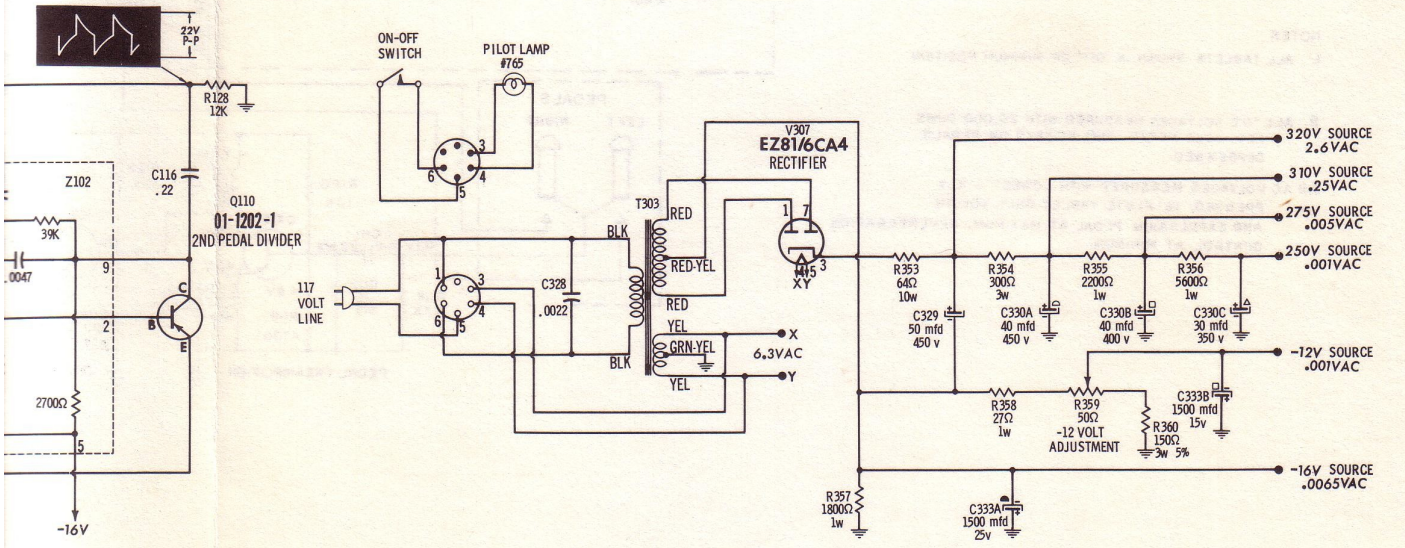


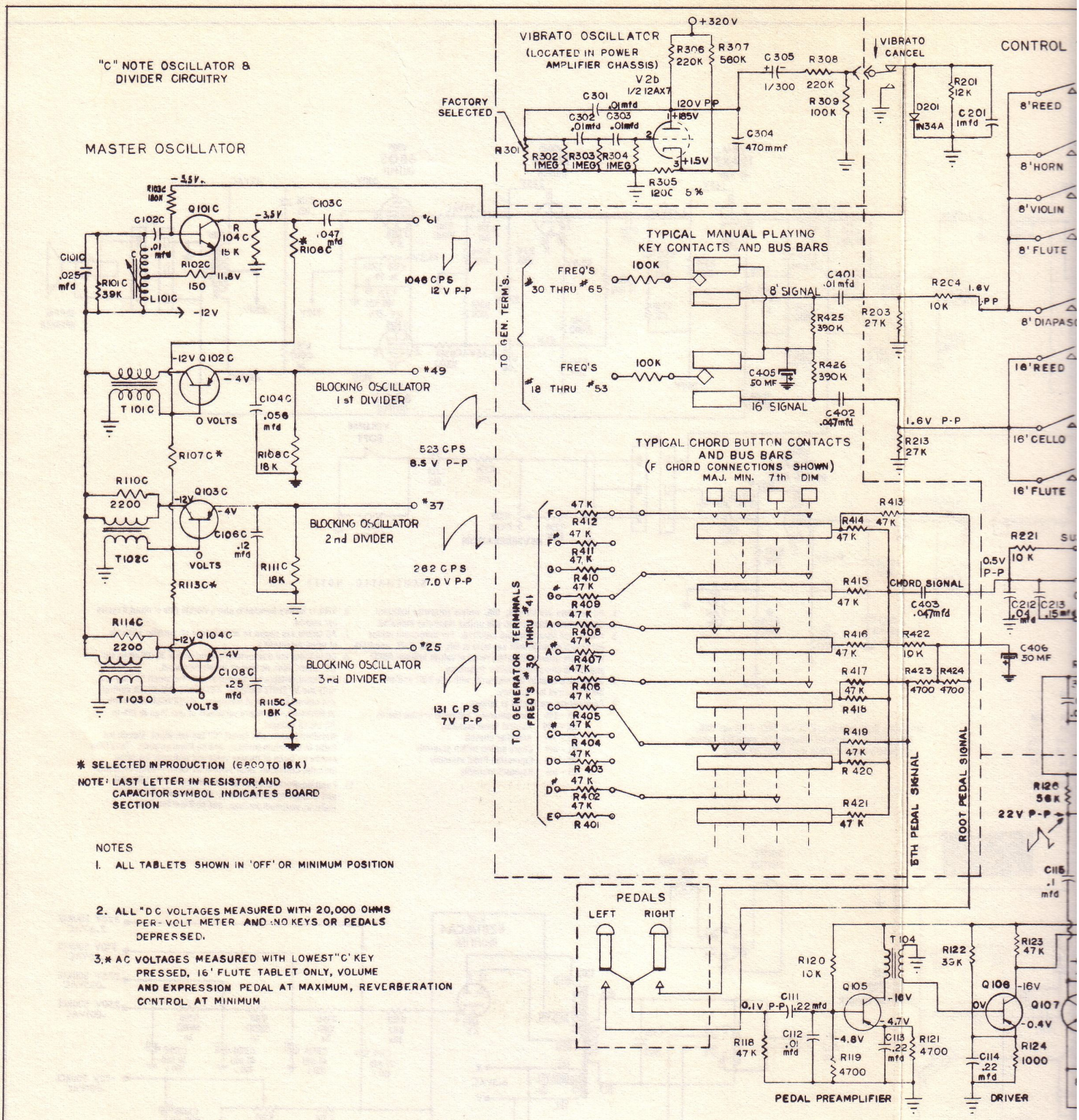
⊖ In some early consoles, R331 was 390Ω; R333 was 100K; R332 (68K) was connected between R331 and R333; cathode and plate voltages of V303B were about 30% lower.

E
.04
.03
.082
.068
.18
.12
27K

SCHEMATIC NOTES

1. All resistors are 1/2 watt, 10%, unless otherwise indicated.
2. Capacitance values are in mfd unless otherwise indicated.
3. Twelve tone generators are required. For component values not shown on schematic see table at left. R106, R107, and R113 are factory selected from the range of values between 6800Ω and 27K to give proper divider frequency.
4. 36 keys are used in the keyboard, with one R601 and one R602 required for each key.
5. Components are located as follows:
   - 101 - 199 Tone generator and pedal printed boards
   - 201 - 299 Control tablet assembly
   - 301 - 399 Amplifier chassis
   - 401 - 499 Chord button switch assembly
   - 501 - 599 Expression Pedal assembly
   - 601 - 645 Keyboard assembly
6. R301 is factory selected to give a vibrato rate of about 6 cycles per second.
7. All tablets are shown in minimum or off position (with top of tablet depressed.)
8. DC voltages are measured to ground with a 20,000 ohms per volt meter, with no keys or tablets depressed.
9. AC signal voltages are measured with the lowest "C" key and only the 16' FLUTE tablet on, KEYBOARD BALANCER control and expression pedal at maximum, REVERBERATION control at minimum. Disregard variations of less than ± 25% in AC signal voltages.
10. Waveforms taken with lowest "C" key depressed, Expression Pedal in maximum position, and no Reverberation. Tone filter waveforms taken at speaker voice coil with only the tablet indicated depressed; other waveforms taken at point indicated.
11. Pedal waveform taken at speaker voice coil with left pedal and C Major button depressed, all tablets off, Expression Pedal in maximum position, and no Reverberation.





* SELECTED IN PRODUCTION (6800 TO 18K)

NOTE: LAST LETTER IN RESISTOR AND CAPACITOR SYMBOL INDICATES BOARD SECTION

NOTES

1. ALL TABLETS SHOWN IN 'OFF' OR MINIMUM POSITION

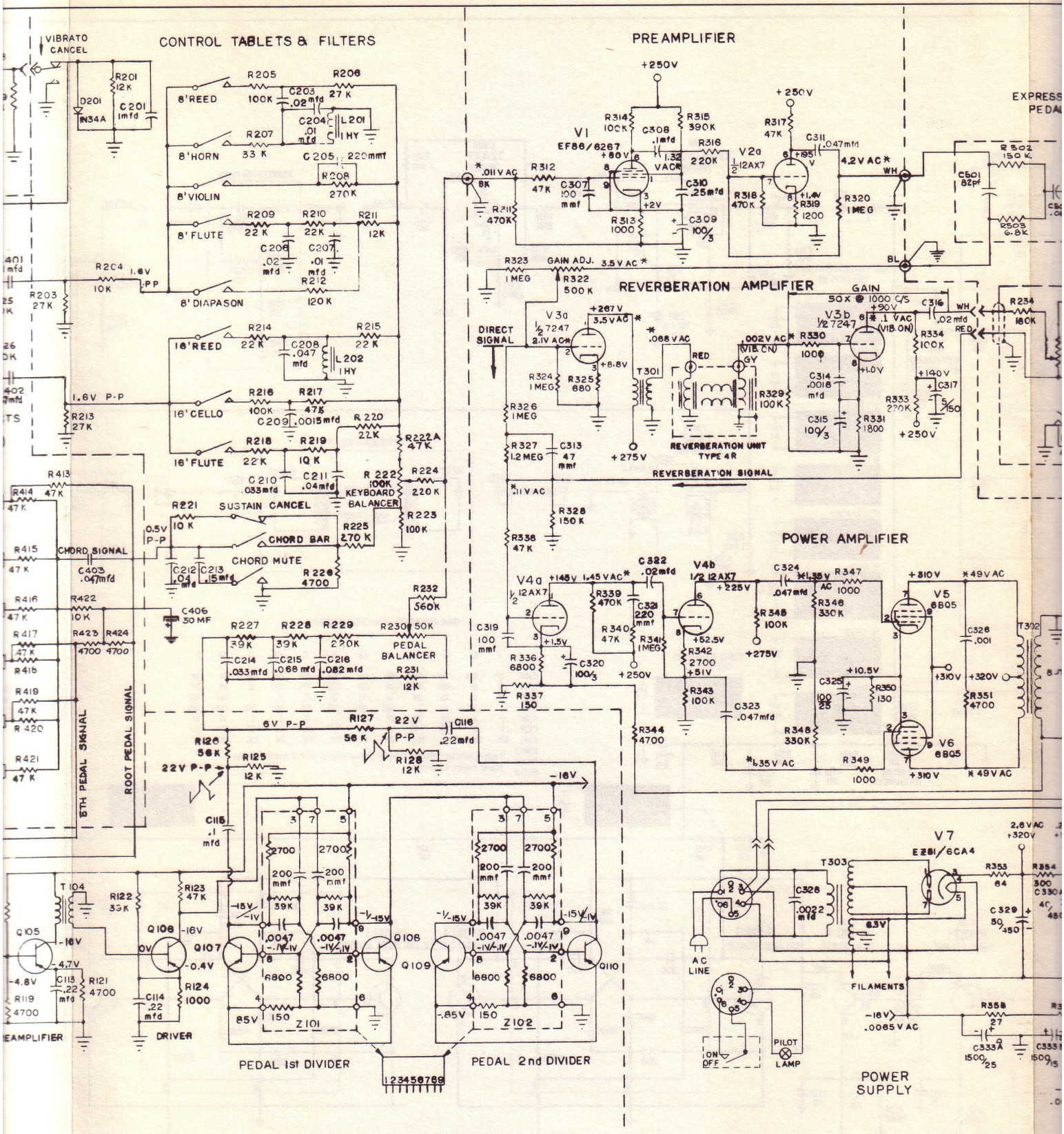
2. ALL "DC VOLTAGES MEASURED WITH 20,000 OHMS PER-VOLT METER AND NO KEYS OR PEDALS DEPRESSED.

3. * AC VOLTAGES MEASURED WITH LOWEST "C' KEY PRESSED, 16' FLUTE TABLET ONLY, VOLUME AND EXPRESSION PEDAL AT MAXIMUM, REVERBERATION CONTROL AT MINIMUM

WITH PH

MOI

MOI



WITH PHOTOCELL EXPRESSION CONTROL —

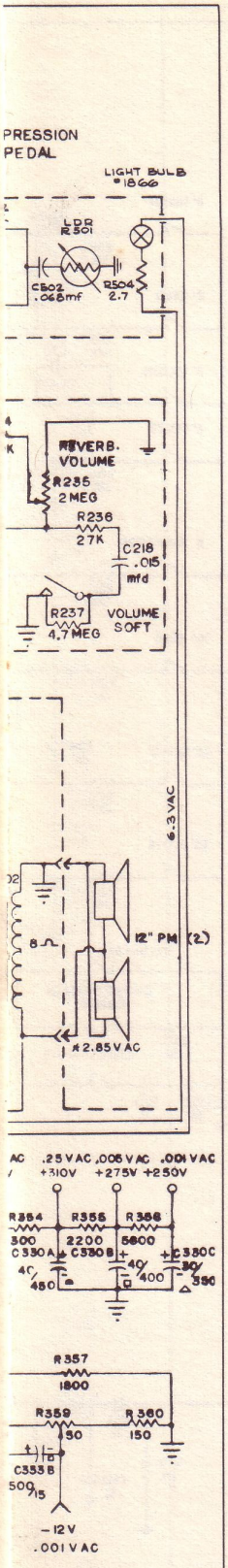
MODEL 2022, SERIAL NO. 5401 AND ABOVE.

MODEL 2044, SERIAL NO. 5501 AND ABOVE.

CONSOLE

2000

FIGU



OLE SCHEMATIC

000 SERIES

IGURE 21A

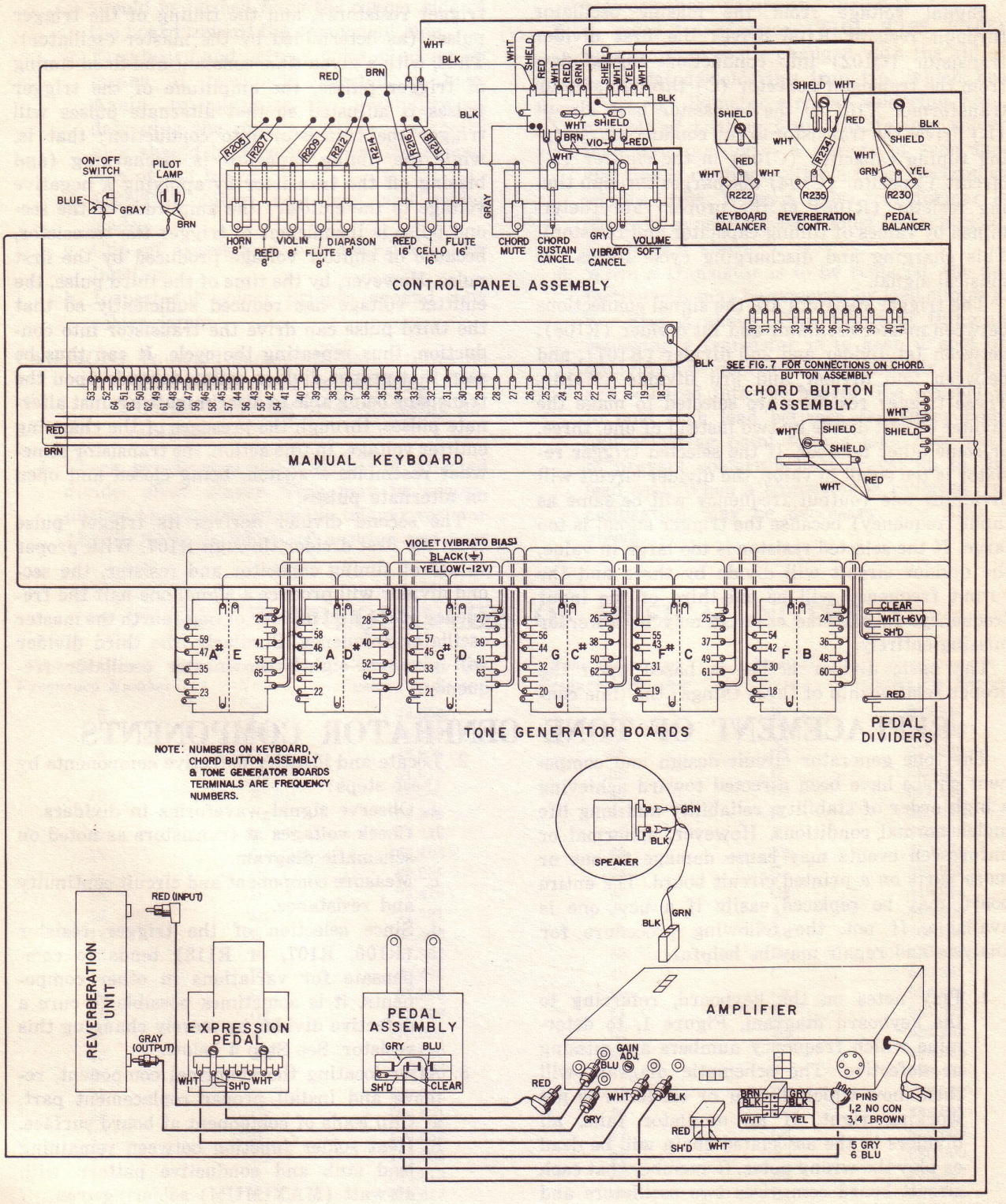


Fig. 22. Wiring Diagram.

TECHNICAL DESCRIPTION OF TONE GENERATOR FREQUENCY DIVIDERS

This divider circuit supplies an output signal only when an input signal voltage is applied.

Signal voltage from the master oscillator through resistor R106 drives the first divider transistor (Q102) into conduction. Signal flow from the transistor collector (C) through step-up transformer T101 to the transistor base circuit (B) drives the transistor to full conduction, charging timing capacitor (C104) in the emitter (E) circuit. Capacitor (C104) discharges through timing resistor (R108) at the proper rate (determined by values of timing capacitor and resistor). This charging and discharging cycle forms the musical signal.

The trigger resistors are the signal connections between master oscillator and 1st divider (R106), between 1st divider and 2nd divider (R107), and between 2nd divider and 3rd divider (R113). These trigger resistors are selected to make the divider circuit divide by two instead of one, three, or some other number. If the selected trigger resistor is too small in value, the divider circuit will divide by one (output frequency will be same as input frequency) because the trigger signal is too large. If the selected resistor is too large in value, the divider circuit will divide by three and the output frequency will be one-third of the input frequency. In extreme cases it may be lower or missing entirely.

The basic divider action is based upon the proper relationship of three things: the time constant of the timing capacitor and resistor, the amplitude of the trigger pulses (as set by the trigger resistors), and the timing of the trigger pulses (as determined by the master oscillator). Thus, with a given time constant and fixed timing of trigger pulses, the amplitude of the trigger pulses is adjusted so that alternate pulses will trigger the transistor into conduction; that is, while the timing capacitor is discharging (and biasing off the transistor by applying a negative voltage to the emitter) the amplitude of the second pulse is insufficient to trigger the transistor, because of emitter voltage produced by the first pulse. However, by the time of the third pulse, the emitter voltage has reduced sufficiently so that the third pulse can drive the transistor into conduction, thus repeating the cycle. It can thus be seen that proper divider action depends upon the transistor being able to discriminate against alternate pulses, through the presence of the changing emitter voltage. In this action, the transistor somewhat resembles a switch, being closed and open on alternate pulses.

The second divider derives its trigger pulse from the first divider through R107. With proper values of timing capacitor and resistor, the second divider will produce a signal one-half the frequency of the first divider or one-fourth the master oscillator frequency. Similarly, the third divider will give one-eighth the master oscillator frequency.

REPLACEMENT OF TONE GENERATOR COMPONENTS

The tone generator circuit design and component choice have been directed toward achieving a high order of stability, reliability and long life under normal conditions. However, abnormal or unforeseen events may cause damage to one or more parts on a printed circuit board. The entire board may be replaced easily if a new one is available. If not, the following procedure for analysis and repair may be helpful:

1. Play notes on the keyboard, referring to the keyboard diagram, Figure 1, to determine which frequency numbers are missing or defective. The schematic diagram will then show which divider or oscillator is not working right. If an oscillator fails, all dividers in the associated chain will be dead or play the wrong notes. Remember that each circuit board comprises two oscillators and their divider chains; the left half includes all octaves of one musical note and the right half includes all octaves of another note, as marked on the tuning coil L101.
2. Locate and identify defective components by these steps:
   a. Observe signal waveforms in dividers.
   b. Check voltages at transistors as noted on schematic diagram.
   c. Measure component and circuit continuity and resistance.
   d. Since selection of the trigger resistor (R106, R107, or R113) tends to compensate for variations in other components, it is sometimes possible to cure a defective divider by merely changing this resistor. See Step 4 below.
3. After locating the abnormal component, remove and install proper replacement part.
   a. Clip leads of component at board surface.
   b. Heat solder junction between remaining lead stub and conductive pattern with 40-watt (MAXIMUM) soldering iron.
   c. Brush excess of solder from joint area with small, stiff bristle brush or other suitable tool.

d. **GENTLY** push component lead stubs through holes in board and pattern, using pointed tool or wooden toothpick. To minimize the possibility of damaging the conductive copper pattern, the lead stubs should be pushed *from* the copper side of the board toward the component side.

e. Free board and pattern holes of solder by means of toothpick inserted in hole. Again, to minimize the possibility of damaging the copper pattern, the toothpick should be inserted *from* the copper side of the board.

f. **GENTLY** insert new part and solder leads.

g. Clip off excess lead wire near the solder junction.

h. Inspect for solder bridges around new solder joints.

CAUTION: To avoid damage to pattern, use no mechanical force on copper pattern during soldering or de-soldering operation.

4. Check synchronization stability of affected divider chain stages. This may be accomplished by disconnecting the trigger resistor (R106, R107 or R113) of a stage and connecting a 50,000 ohm variable resistor in its place. Adjust resistor to highest and lowest positions where divider plays proper pitch, measuring resistance value at each of these positions. Select a resistor midway between these values and install it.

5. A pulse transformer (T101, T102, T103) may be more easily changed with the aid of a special de-soldering iron tip, which has 1″ or ¾″ diameter circular soldering area, capable of heating four transformer solder lugs simultaneously. A variety of such special tips is readily available from electronics supply firms. When a pulse transformer is changed, synchronization must be rechecked. See Step 4 above.

6. When a transistor is to be replaced, the defective unit may be removed by lead clipping. See Step 3 above. The important thing in replacing a transistor is to keep it cool by applying adequate heat sinks on leads as they are soldered into the board. One method is to hold each lead between transistor body and soldering point with a long nose plier to prevent soldering heat travel up to the lead seal. When a transistor is replaced, recalibration may be necessary. See Step 4 above.

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*
6	F	43.653	36	B	246.941
7	F♯	46.249	37	C	261.625
8	G	48.999	38	C♯	277.182
9	G♯	51.913	39	D	293.664
10	A	55.000	40	D♯	311.126
11	A♯	58.270	41	E	329.627
12	B	61.735	42	F	349.228
13	C	65.406	43	F♯	369.994
14	C♯	69.295	44	G	391.995
15	D	73.416	45	G♯	415.304
16	D♯	77.781	46	A	440.000
17	E	82.406	47	A♯	466.163
18	F	87.307	48	B	493.883
19	F♯	92.498	49	C	523.251
20	G	97.998	50	C♯	554.365
21	G♯	103.826	51	D	587.329
22	A	110.000	52	D♯	622.253
23	A♯	116.540	53	E	659.255
24	B	123.470	54	F	698.456
25	C	130.812	55	F♯	739.988
26	C♯	138.591	56	G	783.991
27	D	146.832	57	G♯	830.609
28	D♯	155.563	58	A	880.000
29	E	164.813	59	A♯	932.327
30	F	174.614	60	B	987.766
31	F♯	184.997	61	C	1046.502
32	G	195.997	62	C♯	1108.730
33	G♯	207.652	63	D	1174.659
34	A	220.000	64	D♯	1244.507
35	A♯	233.081	65	E	1318.510

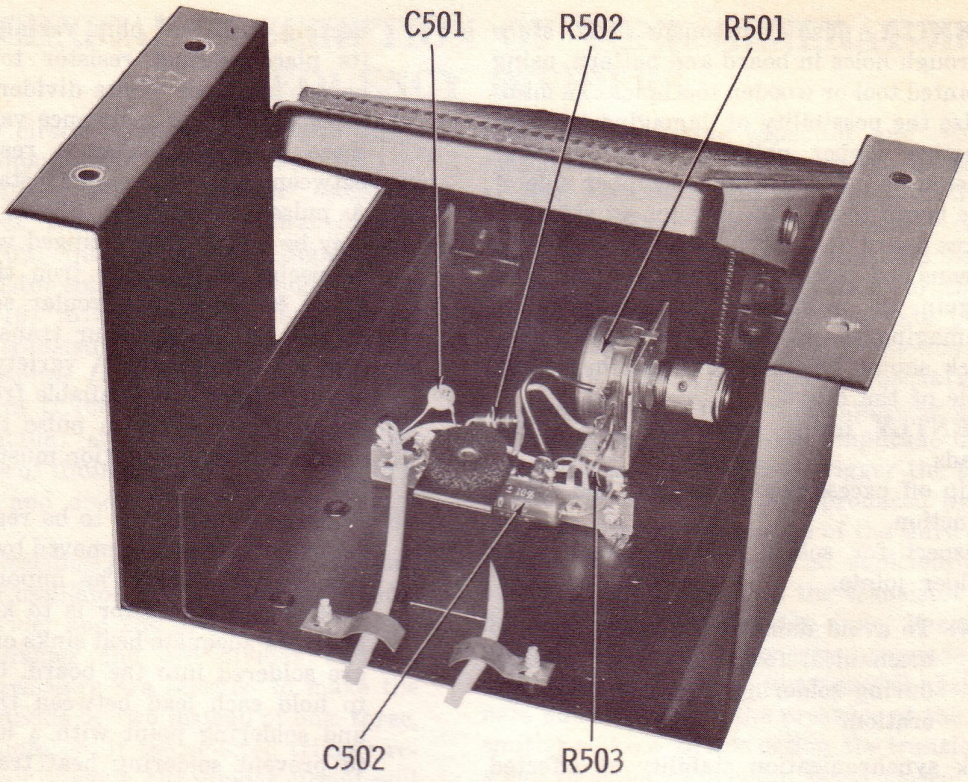


Fig. 23. Expression Pedal.

REPLACEMENT PARTS LIST

Ref. No.	*Part No.*	*Description*
		TRANSISTORS
Q101	01-2101-1	Master Oscillator, similar to 2N2712 but with slightly higher voltage ratings. 2N697 is a premium type which can be substituted.
Q102, Q103, Q104	01-1201-1	Frequency Divider, 2N1303 is a satisfactory substitute.
Q105, Q106	01-1203-1	Pedal Preamp, Pedal Driver. 2N1307 is a satisfactory substitute.
Q107, Q108, Q109, Q110	01-1202-1	Pedal Divider. 2N1307 is a satisfactory substitute.
		DIODE
D201	01-1501-0	1N34A, Signal Diode
		CAPACITORS
C101	A0-514-12	0.25 mfd, ±5%, Polystyrene
C329	A0-20996-0	50 mfd @ 450V, Electrolytic
C330A	A0-22001-0	40 mfd @ 450V, Electrolytic
B		40 mfd @ 400V, Electrolytic
C		30 mfd @ 350V, Electrolytic
C333A	A0-27320-0	1500 mfd @ 25V, Electrolytic
B		1500 mfd @ 15V, Electrolytic
		RESISTORS, VARIABLE
R222	A0-20293-50	100K, KEYBOARD BALANCER Control
R230	A0-20293-49	50K, PEDAL BALANCER Control
R235	A0-20293-54	2 meg, REVERBERATION Volume Control
R322	A0-20293-52	500K, Gain Adjustment
R359	A0-27314-0	50Ω, —12V Adjustment
R501	A0-24286-0	250K, Expression Pedal
		TRANSFORMERS
T101, T102, T103, T104	A0-27318-0	Coupling
T301	A0-27311-0	Reverberation
T302	A0-24158-0	Output
T303	A0-27312-1	Power, for 117 volt, 60 cycle
T303	A0-27312-2	Power, for 117 volt, 50 cycle
T303	A0-27312-3	Power, for 234 volt, 50 or 60 cycle
		COILS
L101-E	A0-27319-1	Tuning Coil for E generator
L101-D#	A0-27319-2	Tuning Coil for D♯ generator
L101-D	A0-27319-3	Tuning Coil for D generator
L101-C#	A0-27319-4	Tuning Coil for C♯ generator
L101-C	A0-27319-5	Tuning Coil for C generator
L101-B	A0-27319-6	Tuning Coil for B generator
L101-A#	A0-27319-7	Tuning Coil for A♯ generator
L101-A	A0-27319-8	Tuning Coil for A generator
L101-G#	A0-27319-9	Tuning Coil for G♯ generator
L101-G	A0-27319-10	Tuning Coil for G generator
L101-F#	A0-27319-11	Tuning Coil for F♯ generator
L101-F	A0-27319-12	Tuning Coil for F generator
L201, L202	A0-27183-0	Tone Filter Choke
		SPEAKER
	A0-27293-0	12" PM
		COUPLATES
Z101, Z102	A0-27331-1	Pedal Divider