

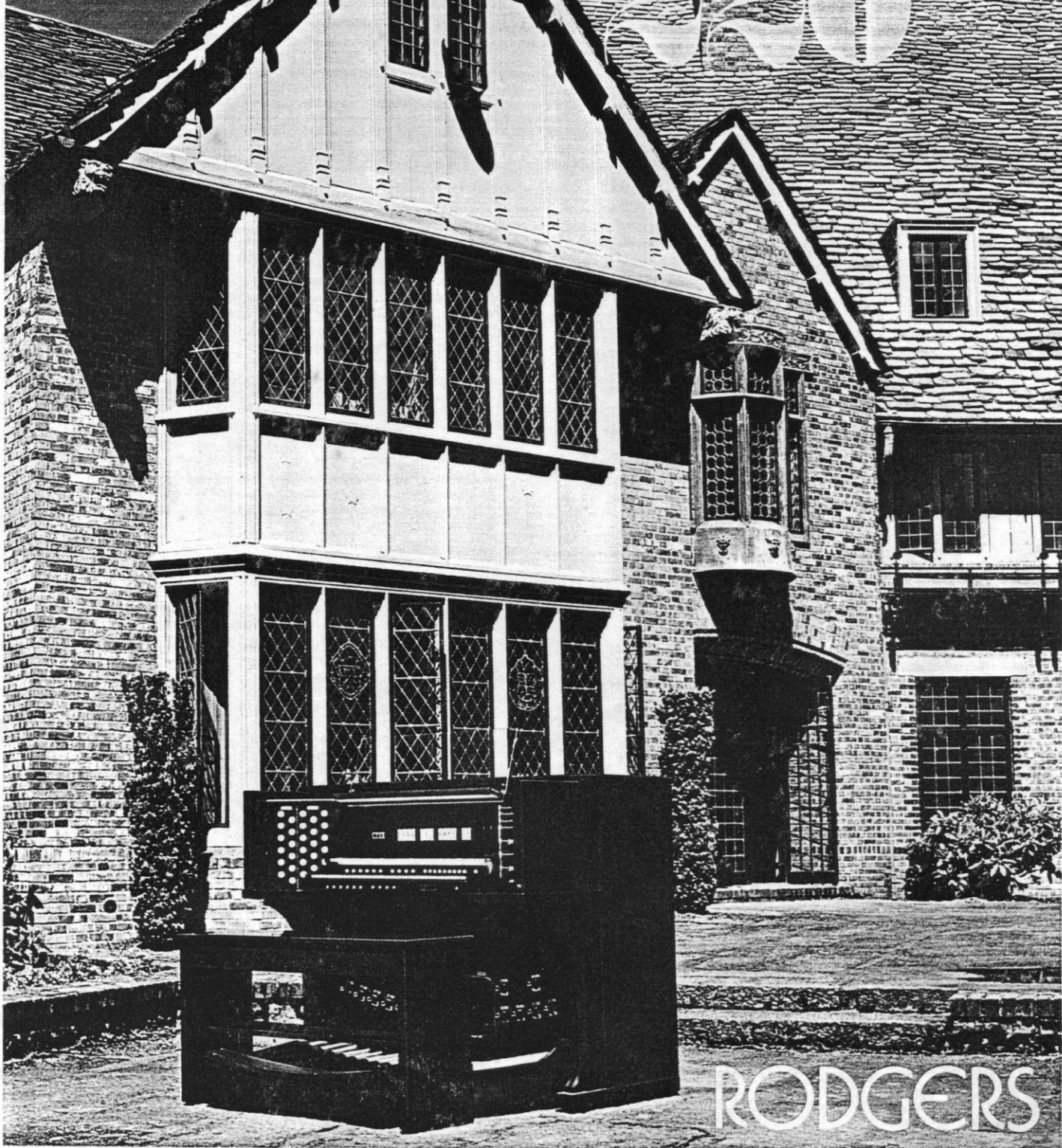
B35

**Technical Manual
and
Service Information
for**

**RODGERS
Cambridge
220-II**

RODGERS INSTRUMENT CORPORATION, HILLSBORO, OREGON U.S.A.

Cambridge 220



RODGERS

PHOTOGRAPHED AT LEWIS AND CLARK COLLEGE PORTLAND, OREGON

Cambridge 220 SPECIFICATIONS

GREAT ORGAN

A complete Foundation Chorus crowned with a three-rank mixture; a Flute Chorus beginning at 16' pitch, including a mutation; a String and two-rank Flute Celeste to accompany Swell solo voices; a color Reed; Harp and Carillon for percussive and special effects; complete Swell to Great couplers; a super coupler for maximum brilliance.

16'	Flûte Conique	1 1/3'	Larigot
8'	Principal		Fourniture III
8'	Bourdon	8'	Krummhorn
8'	Gambe		Harp
8'	Flute Celeste II		Carillon
4'	Octave		Great to Great 4'
4'	Spillflöte		Swell to Great 16'
2'	Fifteenth		Swell to Great 8'
2'	Blockflöte		Swell to Great 4'

SWELL ORGAN

A secondary Foundation Chorus brightened by its own three-rank mixture; a secondary Flute Chorus ranging from 8' to 1', with two mutations (used together, they form a Sesquialtera); a warm, broad String and String Celeste; a complete, rich and fiery Reed Chorus; independently adjustable Swell Tremulant; complete intramanual couplers for brilliance and versatility.

8'	Viola Pomposa		Plein Jeu III
8'	Viola Celeste	16'	Contre Trompette
8'	Hohlflöte	8'	Trompette
4'	Octave	4'	Claïron
4'	Flûte Harmonique		Tremulant
2 3/4'	Nazard		Flute Chiff
2'	Piccolo		Swell to Swell 16'
1 3/4'	Tierce		Swell Unison Off
1'	Fife		Swell to Swell 4'

PEDAL ORGAN

An independent 32' stop for proper grandeur in a complete two-manual organ; four independent 16' Flue stops of varying tone qualities and volume levels; appropriate upperwork completed by a three-rank mixture; an independent Reed at 16' pitch; complete Manual to Pedal couplers.

32'	Contra Violone		Mixture III
16'	Principal	16'	Bombarde
16'	Bourdon	8'	Trompette (SW)
16'	Violone	4'	Claïron (SW)
16'	Lieblich Gedeckt		Great to Pedal 8'
8'	Octave		Great to Pedal 4'
8'	Flute		Swell to Pedal 8'
4'	Choralbass		Swell to Pedal 4'

TREMULANTS

Main Tremulant
Diapason/Flute Chorus (Leslie)
Flute Tremulant Full (Leslie)

ECHO

Main Off
Echo On

COMBINATION ACTION

PRESET ACTION—Six preset pistons arranged in ascending order of dynamic level (available on stop tablet consoles only).

SETTERBOARD ACTION—Four adjustable pistons for each division; four collective general pistons; adjustment of pistons by switches in a drawer beneath the Great Manual.

COMPUTER CAPTURE ACTION—Four adjustable pistons for each division; six independently adjustable general pistons; adjustment of pistons by a Set Button under the Great Manual.

EXTERNAL SPEAKER SYSTEMS

The Cambridge 220 has six outputs for connecting speaker cabinets. Five outputs are for connecting Rodgers speaker cabinets, each of which contains 100 watts of amplification. The channels are: Great Diapason, Great Flute, Swell Flues, Swell Reeds and Celeste, and Pedal. The sixth output accommodates a Rodgers L2-100 Leslie, or a Leslie 147 used with an adaptor. An Echo adaptor is available for connecting Echo speakers. Each Rodgers speaker cabinet has controls to adjust the speakers to the acoustics of the room.

STANDARD FEATURES

- Two 61-note keyboards, with gold-on-gold single contact diode keying
- 32-note concave and radiating pedalboard, with magnetic reed-switch keying
- "Time-Sharing" circuitry for greater versatility and dependability
- Transposer with pistons and indicator lights; choice of nine pitch positions: normal, four semi-tones up, and four semi-tones down; transposer automatically returns to normal pitch when the organ is turned off
- Individual leveling control on each speaking stop (including Harp and Carillon)
- Adjustable voicing formants on all Reed stops for contoured scaling and tonal flexibility
- Adjustable Swell Flute Chiff for natural classic speech characteristics and greater clarity in contrapuntal music
- Natural decay characteristics on Harp and Carillon (rate of decay is adjustable)
- Natural harmonic activity
- Natural air sound on Flue stops, adjustable by division; Flutes and Diapasons adjust separately in each division
- Air sound ON/OFF switch under the Great Manual
- Tremulants adjustable for speed and depth (Swell Tremulant separately adjustable)
- Two expression pedals, correctly divided by division: Swell expression; Great and Pedal expression
- Two illuminated expression position indicators
- Crescendo pedal, with illuminated position indicator
- ON/OFF switch with indicator light
- Engraved stop controls, couplers and indicators
- Tutti piston and toe stud, with indicator light
- Handcrafted console available in a variety of woods and finishes, with matching bench and locking roll-top
- Lighted plexiglas music rack folds down and stores under roll-top
- Digital clock
- All components are solid-state, and contained within the console
- Five-year written guarantee

ALL RODGERS CLASSIC ORGANS COMPLY WITH AMERICAN GUILD OF ORGANISTS STANDARDS AND HAVE DISCRETE COMPONENT VOICING AND SCALING CAPACITY

OPTIONAL FEATURES

- The Cambridge 220 is available in three console styles: stop tablets on a straight stop rail; traditional drawknobs; Rodgers lighted drawknobs and couplers (Computer Capture Action only—shown overleaf)
- The console bench is available in two styles: a conventional, straight-sided bench containing storage space for music (shown overleaf); a professional "dog-leg" bench for minimal obstruction of pedalboard sight lines
- Tracker-touch manual keyboards
- Practice panel with adjustable reverberation, headphone output, and tape recorder inputs and outputs

DIMENSIONS

Height (music rack folded down): 130 cm (50 1/4")
Width: 155 cm (61 1/8")
Depth without pedalboard: 92 cm (36 1/8")
Depth with pedalboard: 138 cm (53 3/4")
Console Weight: 835 pounds

RODGERS
ORGAN COMPANY

HILLSBORO, OREGON 97123

TECHNICAL MANUAL
FOR

CAMBRIDGE 220-II

THIS MANUAL APPLIES TO ORGAN SERIAL NUMBER:

In addition to studying this manual, we suggest that you attend a Rodgers Service Seminar conducted by factory personnel. At these seminars you will have an opportunity to learn more about this and other Rodgers organs, and to exchange ideas with other service technicians.

For information write to: SERVICE SEMINARS
RODGERS ORGAN COMPANY
1300 N. E. 25th Avenue
Hillsboro, Oregon 97124

April, 1974

Copyright © 1973
BY
RODGERS ORGAN COMPANY
Hillsboro, Oregon

Printed in the United States of America

All rights reserved

Contents of this publication may not be reproduced
in any form without permission of copyright owner.

RODGERS ORGAN COMPANY

1300 N. E. 25th Avenue
Hillsboro, Oregon 97123
Telephone: (503) 648-4181

TABLE OF CONTENTS

Cambridge 220-II

	<u>PAGE</u>
SECTION 1 - INSTALLATION (Pink Pages)	
Disassembly Procedures - - - - -	1 - 4
Installation Notes - - - - -	5 - 9
Check-Out Procedure - - - - -	10 - 22
SECTION 2 - VOICING (Yellow Pages)	
A Word About Voicing - - - - -	23
Some General Tips on Voicing - - - - -	23
Preliminary Procedure - - - - -	24
Voicing Procedure - - - - -	24 - 36
SECTION 3 - TUNING (Green Pages)	
Tuning Controls - - - - -	37 - 39
Tuning Methods - - - - -	40
Main Oscillator Tuning - - - - -	40
Ensemble Oscillator Tuning - - - - -	41
Celeste Oscillator Tuning - - - - -	41 - 42
SECTION 4 - GENERAL TERMINOLOGY (Salmon Pages) - 43 - 48	
SECTION 5 - REFERENCE INFORMATION (Gold Pages)	
Cambridge 220-II Stop List - - - - -	49
Crescendo Sequence - - - - -	50
Stops Operated by Tutti - - - - -	51
Preset Stop List of Preset Combination Action Models - -	52
Capture System Location Guide - - - - -	53
List of Output Channels with Associated Stops - - - - -	54 - 56
Devices Operated by Each Stop - - - - -	57 - 63

TABLE OF CONTENTS, Cont'd.

	<u>PAGE</u>
SECTION 6 - TECHNICAL DESCRIPTION (Blue Pages)	
General - - - - -	64 - 65
Audio - - - - -	66 - 76
Combos - - - - -	77 - 84
Power Supplies and Air Sound - - - - -	84 - 85
Accessories - - - - -	86 - 89
Amplifiers and Speakers - - - - -	90 - 91
SECTION 7 - SCHEMATICS (White Pages)	
Index to Schematics - - - - -	92 - 93

INSTALLATION OF THE CAMBRIDGE 220-II

DISASSEMBLY PROCEDURES

To gain access to the internal components of this organ for installation or service, use the following procedures.

I. REMOVING THE CONSOLE BACK: (Refer to Figure 1-1).

- A. Remove the five screws holding on the back.
- B. Tilt the back away from the organ and lift it out.

III. OPENING THE RACKS: (Refer to Figure 1-2).

- A. Remove the console back using the procedure given in the previous step.
- B. Loosen the screws at the top of racks 1 and 2, and swing the catch plate out of the way.
- C. Remove the screws from the bracket at the top right end of racks 2 and 3.
- D. To open rack 1, remove the screw at the bottom right side of the rack. Racks 2 and 3 can be opened in the same manner.
- E. Replace all screws when closing the racks.

III. REMOVING THE LID:

- A. Remove the three screws on the back, located just below the lid. (See Figure 1-1).
- B. Slide the lid forward and lift it off.

IV. REMOVING THE ROLL TOP:

- A. Remove the lid using the procedure given in the previous step.

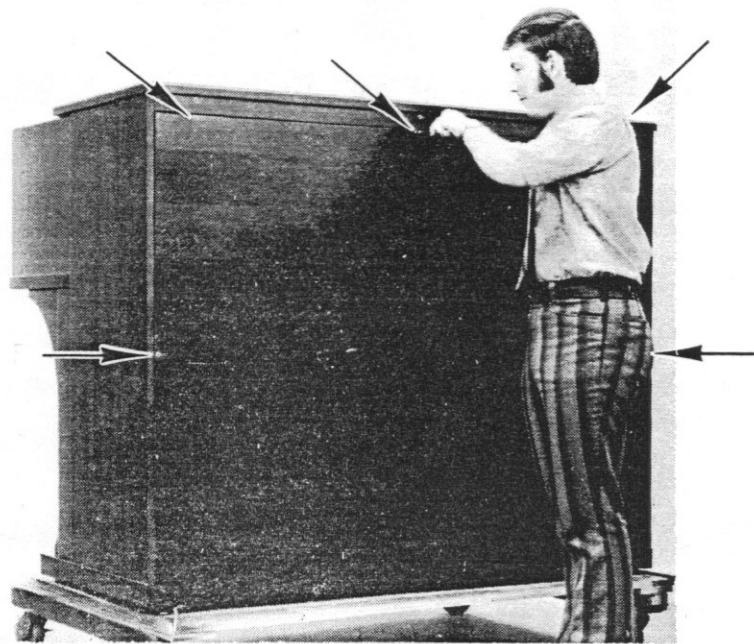


Fig. 1-1.

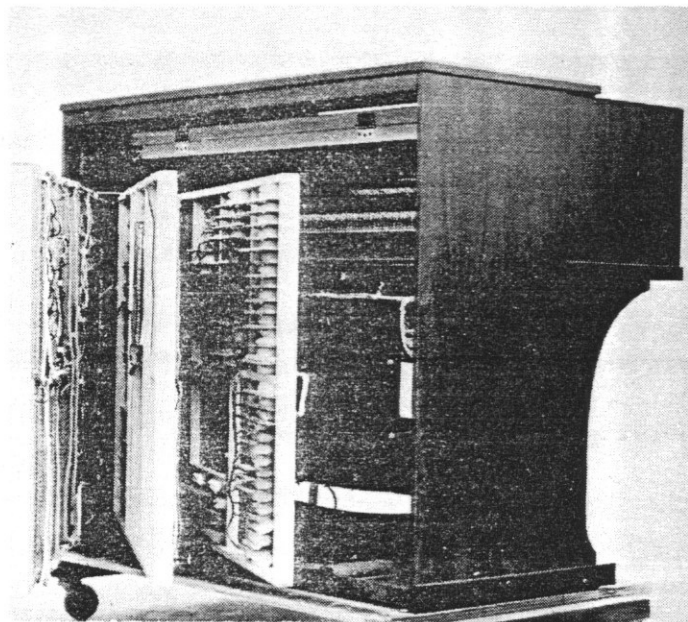


Fig. 1-2.

- B. Close the roll top completely.
- C. Raise the back edge of the roll top so it clears the top of the track.
- D. Pull the roll top toward the rear of the console and out of the track.

V. ACCESS TO THE KEYBOARDS: (Refer to Figure 1-3).

- A. Remove the lid and roll top using the procedure given in the previous two steps.
- B. Lift up the stopboard. It will support itself when completely raised.
- C. Raise the Swell keyboard. It will also support itself when completely raised.
- D. To raise the Great keyboard, remove the two screws located on each end at the bottom of the keyboard.

VI. ACCESS TO THE PEDALBOARD CONTACTS:

The pedalboard contacts can be reached without opening the organ.

- A. Remove the pedalboard by lifting it slightly next to the console and pulling it straight out.
- B. Remove the three screws along the bottom, front edge of the now exposed contact board. Lay the contact board flat on the floor.

VII. ACCESS TO EXPRESSION AND CRESCENDO PEDALS:

- A. Open all three racks as described previously.
- B. Remove the four screws that secure the pedal guard to the back side of the kneeboard.

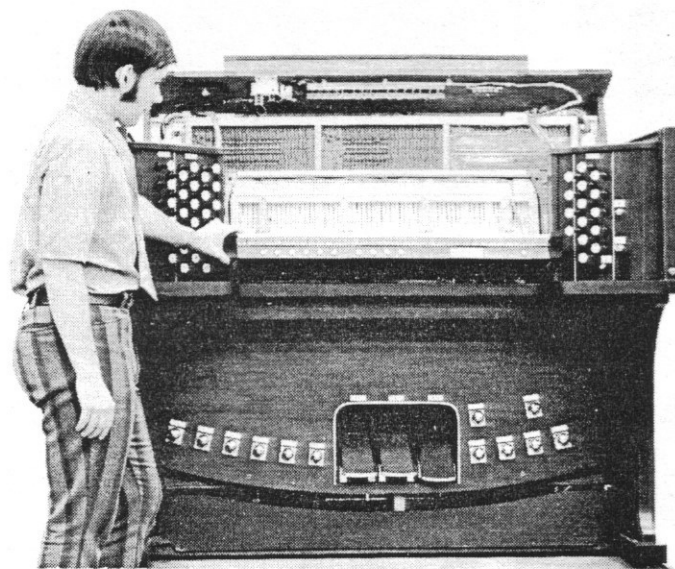


Fig. 1-3.

INSTALLATION NOTES

CAUTION: Do not connect the organ to power until after all steps under "Installation Notes" are complete.

ELECTRICAL REQUIREMENTS:

Voltage	117 Volts AC*
Frequency	60 Hertz*
Maximum Power Consumption (console only)	
Preset Models	100 Watts
Setterboard and Computer Capture Models.	600 Watts
(With piston depressed)	
Power Output for each External Tone Cabinet	
with S-100 Power Amplifier	100 Watts RMS

*Except European Models.

ELECTRICAL CIRCUITS REQUIRED:

A separate 15-Amp circuit at 117 Volts AC is recommended to avoid possible interference from nearby electrical equipment. When possible, a second 15-Amp circuit should be provided for the External Tone Cabinets.

Where local codes require it, conduit should be provided for the External Tone Cabinet cables which carry 15 Volts DC. DO NOT PULL TONE CABINET CABLES THROUGH THE SAME CONDUIT THAT CARRIES THE AC POWER CABLES.

The conduit size will be determined by the total number of cables that must pass through it and/or local building codes. Do not use conduit smaller than 3/4 inch (19 mm) thin wall.

LEVELING THE CONSOLE:

To assure best performance and longest life of the moving parts in the console, this organ should be leveled so it is "square" when first installed or when moved. Uneven floors tend to distort the cabinet over a period of time, and extreme stresses will damage the cabinet as well as the electrical and mechanical components.

Leveling glides, mounted under each corner of the console and bench, can be adjusted to compensate for any irregularities in the floor. A simple spirit level can be used to indicate correct adjustment.

After the console is correctly positioned and leveled, check to see that the pedalboard is at right angles to the console and properly positioned against the console.

CONNECTING SPEAKERS:

To connect speakers to the Model 220-II, first remove the back of the console following the procedure given under "Disassembly Instructions".

The Model 220-II has five independent output channels (six including output for a Leslie Speaker) with provisions for mixing down to a minimum of two channels. Refer to Figure 1-4 for speaker connection and channel mixing information.

I. When Two Speakers Are Used.

- A. Plug speaker number one into the Swell REEDS-CELESTE socket and set Mixing Switch No. 1 to the Mixed position. M13-100U. *
- B. Plug speaker number two into the Great FLUTE-KRUMMHORN socket and set Mixing Switches No. 2 and No. 3 to the Mixed positions. W6-100U. *

II. When Three Speakers Are Used.

- A. Plug speaker number one into the Swell REEDS-CELESTE socket and set Mixing Switch No. 1 to the Mixed position. M13-100U. *
- B. Plug speaker number two into the Great DIAPASONS-CELESTE socket and set Mixing Switch No. 2 to the Unmixed position. M13-100U. *
- C. Plug speaker number three into the Great FLUTE-KRUMMHORN socket and set Mixing Switch. W6-100U. *

III. When Four Speakers Are Used.

- A. Plug speaker number one into the Swell REEDS-CELESTE socket and set Mixing Switch No. 1 to the Mixed position. M13-100U. *
- B. Plug speaker number two into the Great DIAPASONS-CELESTE socket and set Mixing Switch No. 2 to the Unmixed position. M13-100U. *
- C. Plug speaker number three into the Great FLUTE-KRUMMHORN socket. W6-100U. *

FIG. 1 - 4.

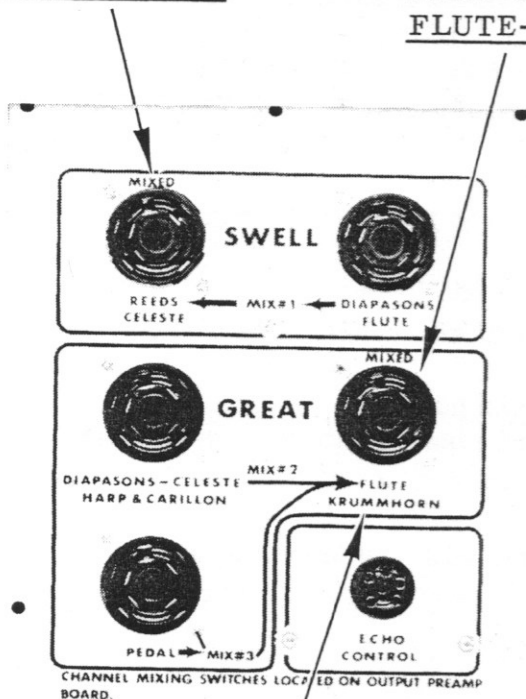
SWELL MIXED OUTPUT

Mixing Switch #1 mixes
DIAPASONS-FLUTE with
REEDS-CELESTE.

GREAT MIXED OUTPUT

Mixing Switch #2 mixes
DIAPASONS-CELESTE
HARP-CARILLON with
FLUTE-KRUMMHORN.

Mixing Switches located on
Output Preamp Board Loc. 1-I.



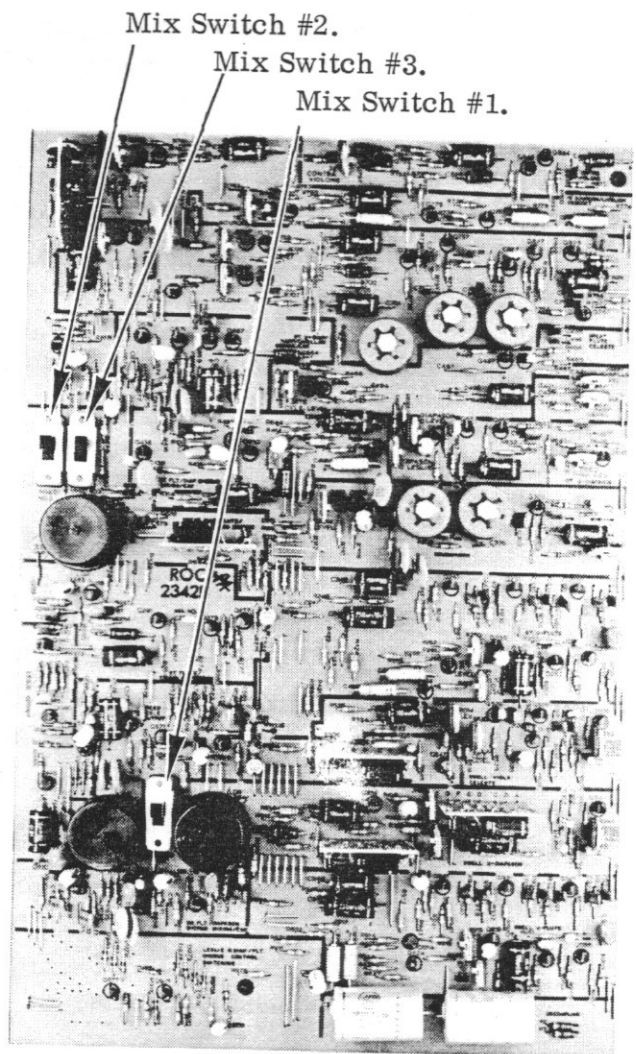
MAINT BY _____
TESTED BY _____
INSPE BY _____
BATCH NO _____

220-II
OUTPUT PANEL

SPEAKER FUSE
BEHIND PANEL
ASSEMBLY: 6551-162
PANEL: 4351-162
SCREEN: 30648



Mixing Switch #3 mixes
PEDAL with FLUTE-KRUMMHORN.



- D. Plug speaker number four into the PEDAL socket and set Mixing Switch No. 3 to the Unmixed position. P2-100U.*

IV. When Five Speakers Are Used.

- A. Plug speaker number one into the Swell REEDS-CELESTE socket. M13-100U.*
- B. Plug speaker number two into the Swell DIAPASONS-FLUTE socket. M13-100U or W6-100U.*
- C. Plug speaker number three into the Great DIAPASONS-CELESTE socket. M13-100U.*
- D. Plug speaker number four into the Great FLUTE-KRUMMHORN socket. W6-100U.*
- E. Plug speaker number five into the PEDAL socket. P2-100U.*
- F. Set all Mixing switches to the Unmixed position.

V. Leslie Speaker.

The following Leslie Speakers can be used with the Model 220-II.

Rodgers L-2-100
Leslie 145
Leslie 147

The Leslie Speaker is plugged into the LESLIE socket, and can be used with any combination of speakers.

VI. Echo Speakers.

Echo Speakers can be added to the Model 220-II through the use of the optional EC IIB Echo Adapter or the EC VI Multichannel Echo Adapter. Stop control for the Echo Speakers are "Main Off", "Echo On" provided on the stopboard of the organ.

The EC IIB Echo Adapter provides output for a single echo channel from any of the main output channels. Several adapters can be used together to provide additional echo channels. The EC VI Multichannel Echo Adapter provides output from all five main output channels to the echo speakers. While two Echo output sockets are provided on this adapter, the same signal is connected to both connectors.

*Suggested Speakers.

To use the Echo Adapters:

- A. Disconnect the Main Speakers from the Speaker Output Panel (if only a single EC IIB Echo Adapter is to be used, select which channel is to be routed through the Echo Speaker and disconnect only this speaker).
- B. Connect the Echo Adapter to the sockets on the Speaker Output Channel.
- C. Plug the Echo Control cable into the ECHO CONTROL socket.
- D. Connect the Main Speakers to the sockets on the Echo Adapter. Be sure to reconnect the Main Speakers to the sockets which correspond to the ones to which they were originally connected.
- E. Connect the Echo Speaker to the ECHO socket.
- F. To activate the Echo speaker, turn on the ECHO ON stop on the organ. The Main Speakers can be silenced so the sound is heard only through the Echo Speakers by pressing the MAIN OFF stop.

After the speaker cables have been connected to the output connectors, replace the back of the console, routing the speaker cables through the cutout.

CHECK-OUT PROCEDURE

CAMBRIDGE 220-II

After the new instrument is installed, give it a complete check-out using the following procedure. After the check-out is completed, fill out the pink card which is included in the package of materials supplied with this organ. Should a problem be encountered during the check-out procedure, note this on the card also, whether you fix it or not.

WHEN COMPLETED, PLEASE RETURN THE CARD TO THE FACTORY FOR EVALUATION.

This check-out procedure can also be used to check the operation of the instrument after it has been moved to a new location, or after an extended period of disuse.

I. BEFORE CONNECTING ORGAN TO POWER:

- A. Check that the organ and the speakers are wired for the proper line voltage.
- B. Turn the organ POWER key switch to the OFF position.
- C. Set all stop tabs to their OFF position (not necessary on lighted drawknob models).
- D. Check that the console is level and the pedalboard is properly positioned. Leveling instructions are given under "Installation Notes".
- E. Connect the speakers as described under "Installation Notes".

IMPORTANT NOTE: Do not make any adjustments during this check-out procedure. If voicing is required, it should be done according to the "Voicing Instructions" (Section 2) after the Check-Out Procedure is completed.

II. AFTER CONNECTING THE ORGAN AND SPEAKERS TO POWER:

- A. Turn the organ POWER key switch to the ON position.
- B. If the organ has the optional Practice Panel, push in the REVERB control knob and turn it fully counterclockwise.

- C. Please read each step completely, along with any accompanying notes, before each check. After completion of each step, TURN OFF ALL OF THE STOPS.
- D. On lighted drawknob models, check for a light in the knob when the stop is on.
- E. The "Reference" section of this manual provides information which may aid you in this Check-Out Procedure.
- F. If a question arises as to the correct operation of any portion of the organ, refer to the Owner's Guide for further information.
- G. This procedure includes checks for all options which could be included on the 220-II. If the organ you are checking does not include the listed option, skip the step and start with the next applicable check.

III. CHECK ORGAN VOICES:

A. Swell Manual Division.

1. Check Swell Voices

NOTE: The 16' SWELL TO SWELL, 4' SWELL TO SWELL, and SWELL UNISON OFF couplers and the SWELL TREMULANT are not speaking stops. They will be checked later.

Turn ON one of the Swell stops and the MAIN TREMULANT. Press the Swell expression pedal about half way down. Play each of the 61 keys on the Swell (upper) keyboard and listen for the selected voice. Repeat for each Swell stop. The following Swell stops have unique characteristics:

4' CLAIRON - Top Octave (keys 50 through 61) key the Swell Unit Diapason signal keyer.

8' VIOLA CELESTE - Starts at Key 13.

PLEIN JEU III - This stop operates three diode gates, generating a tone with three component parts. Play all 61 Swell keys and listen for the three components on each note.

2. Check Swell Intra-Manual Couplers

- a). Turn on the 8' TROMPETTE, 4' SWELL TO SWELL coupler,

and SWELL UNISON OFF (Swell voices). Play keys 1 through 49 and listen for the Trompette at the 4' pitch only. There should be no sound on keys 50 through 61.

- b). Turn ON the 8' TROMPETTE, 16' SWELL TO SWELL coupler, and SWELL UNISON OFF (Swell voices). Play keys 13 through 61 and listen for the Trompette at the 16' pitch only. There should be no sound on keys 1 through 12.

3. Check Swell Tremulant

Turn OFF the MAIN TREMULANT and turn ON the 8' VIOLA POMPOSA and the Swell TREMULANT. Play any note on the Swell manual and listen for tremulant. Turn OFF the 8' VIOLA POMPOSA and turn ON the 8' TROMPETTE. Play any note on the Swell manual and listen for tremulant.

B. Great Manual Division.

1. Check Great Voices

NOTE: The 4' GREAT TO GREAT, 4' SWELL TO GREAT, 8' SWELL TO GREAT, and 16' SWELL TO GREAT couplers are not speaking stops. They will be checked later.

Turn ON one of the Great stops and the MAIN TREMULANT. Press the Great expression pedal about half way down. Play each of the 61 keys on the Great (lower) keyboard and listen for the selected voice. Repeat for each Great stop. The following Great stops have unique characteristics:

1-1/3' LARIGOT - Keys 1 through 54 only.

HARP - Keys 13 through 61 only.

CARILLON - Keys 13 through 49 only.

FOURNITURE III - This stop operates three diode gates, generating a tone with three component parts. Play all 61 Great keys and listen carefully for the three components on each note.

2. Check Great Celeste II

Turn ON the 8' FLUTE CELESTE II and turn OFF the MAIN TREMULANT. This voice is derived from the Celeste oscillators which are tuned slightly sharp from the Main Oscillators.

The 8' FLUTE CELESTE II stop also turns on a soft 8' Flute from the Main oscillator and when heard against the Celeste oscillator produces a slow undulating beat. The Celeste portion of this stop sounds on keys 13 through 61 only.

3. Check Great Intra-Manual Coupler

Turn ON the 8' KRUMMHORN and the 4' GREAT TO GREAT coupler. Play keys 1 through 49 and listen for the KRUMMHORN at both the 4' and 8' pitches. If in question as to whether both voices are present, turn OFF the 4' GREAT TO GREAT coupler momentarily and listen for the difference. On keys 50 through 61, only the 8' pitch will be heard.

4. Check Swell to Great Inter-Manual Couplers

- a). Turn ON the 8' TROMPETTE (Swell voice) and the 8' SWELL TO GREAT coupler (check that all other Great stops are OFF). Play keys 1 through 61 on the Great manual and listen for the Trompette voice.
- b). Turn ON the 8' TROMPETTE (Swell voice) and the 4' SWELL TO GREAT coupler (check that all other Great stops are OFF). Play keys 1 through 49 on the Great manual and listen for the Trompette voice.
- c). Turn ON the 8' TROMPETTE (Swell voice) and the 16' SWELL TO GREAT coupler (check that all other Great stops are OFF). Play keys 13 through 61 and listen for the Trompette voice.

C. Pedal Division.

1. Check Pedal Voices

NOTE: The 4' SWELL TO PEDAL, 8' SWELL TO PEDAL, 4' GREAT TO PEDAL, and 8' GREAT TO PEDAL couplers are not speaking stops. They will be checked later.

Turn ON one of the Pedal stops and the MAIN TREMULANT (there is no tremulant on Pedal keys 001 - 012; bottom 24 notes on 32' stops and bottom 12 notes on 16' stops). Play each of the 32' Pedal keys and listen for the selected voice. Repeat for each Pedal stop. The following Pedal stop has unique characteristics:

MIXTURE III - This stop operates three diode gates, generating a tone with three component parts. Play all 32 Pedal keys and listen carefully for the three components on each note.

2. Check Swell to Pedal Inter-Manual Couplers

- a). Turn ON the 8' VIOLA POMPOSA (Swell voice) and the 4' SWELL TO PEDAL coupler (check that all other Pedal stops are OFF). Play all 32 Pedal keys and listen for the Trompette voice.
- b). Turn ON the 8' VIOLA POMPOSA (Swell voice) and the 8' SWELL TO PEDAL coupler (check that all other Pedal stops are OFF). Play all 32 Pedal keys and listen for the Viola Pomposa voice.

3. Check Great to Pedal Inter-Manual Couplers

- a). Turn ON the 8' KRUMMHORN (Great voice) and the 4' GREAT TO GREAT coupler (check that all other Pedal stops are OFF). Play all 32 Pedal keys and listen for the Krummhorn voice.
- b). Turn ON the 8' KRUMMHORN (Great voice) and the 8' PEDAL TO PEDAL coupler (check that all other Pedal stops are OFF). Play all 32 Pedal keys and listen for the Krummhorn voice.

IV. CHECK EXPRESSION PEDALS:

To check each of the separate channels for proper expression, turn ON the indicated stop and turn OFF all other stops. Hold any key down and operate the indicated expression pedal. Listen for variation in loudness.

A. Check Great Flute Channel Expression.

Turn ON the 8' BOURDON (Great voice) and operate the Great expression pedal.

B. Check Great Diapason Channel Expression.

Turn ON the 8' PRINCIPAL (Great voice) and operate the Great expression pedal.

C. Check Pedal Channel Expression.

Turn ON the 16' BOMBARDE (Pedal voice) and operate the Great

expression pedal. The loudness variation for the Pedal is slightly less than for the Swell and Great manuals.

D. Check Swell Flute Channel Expression.

Turn ON the 8' HOHLFLÖTE (Swell voice) and operate the Swell expression pedal.

E. Check Swell Diapason Channel Expression.

Turn ON the 8' VIOLA POMPOSA (Swell voice) and operate the Swell expression pedal.

F. Check Swell Reeds/Celeste Channel Expression.

Turn ON the 8' TROMPETTE (Swell voice) and operate the Swell expression pedal.

V. CHECK CRESCENDO PEDAL:

The Crescendo pedal adds stops in a predetermined order, building a crescendo sound as it is depressed. Indicator lights on the stopboard indicate the degree of crescendo as the pedal is depressed.

NOTE: If it is suspected that the increase in organ stops is "weak" (suggesting the possibility that a voice, or voices is not being added), consult the Crescendo Sequence chart in the "Reference" section to see which voices should be added. Then, manually add those that are called for before the pedal is depressed to that position. Check the voices. Then remove all of the voices and press the pedal to the next position. Listen for the addition of the same voices.

- A. Hold a chord on the Swell manual. Press the Crescendo pedal down slowly and listen for the addition of voices, one at a time. Also, check the indicator lights on the stopboard.
- B. Hold a chord on the Great manual and repeat the check of the Crescendo pedal.
- C. Hold a note on the Pedal and repeat the check of the Crescendo pedal.

VI. CHECK COMBINATION ACTION:

- A. Preset Type.

The stops for the Preset type of Combination Action are determined at the factory. A list of the stops turned on by each piston is found in the "Reference" section of this manual.

The Preset Pistons are of the "double touch" variety. When pressed lightly (first touch), the piston operates the set of predetermined stops. If any other voices are already on, the voices called up by the Preset piston are added to them. Pushing in more firmly on the piston (second touch) calls up the same set of predetermined stops, but it cancels any other voices that might be on.

The Stop Rail is always on when the organ is first turned on. The Stop Rail can be cancelled by pressing any of the Preset pistons to the "second touch" position. The Stop Rail piston is also of the "double touch" variety, and its voices (hand selected) can be added to those called up by any of the five Preset pistons by pressing the Stop Rail piston to the first touch position. The second touch position of the Stop Rail cancels all other Preset pistons.

NOTE: The Couplers, Tremulants, Echo Controls, and Chiff remain in operation regardless of the position of the Stop Rail piston.

1. Press Preset Piston #1. Check that the indicator light comes on.
2. Play a note on each of the keyboards. Check for the correct voices. If in doubt as to the correct voices for any of the Preset pistons, check the Preset Stop List in the "Reference" section and manually add the listed stops by pressing the Stop Rail piston to the first touch position. Then, compare the voices with that selected by the piston.
3. Repeat the check for Preset pistons #2 through #5.

B. Setterboard Type (Optional).

The Combination Action Setterboard is located in a drawer beneath the Great manual. The stops and controls of the organ can be "programmed" on the Setterboard by moving the individual switch to the right (ON). The programmed stops can be called-up by pressing pistons located beneath the keyboards.

To check the Combination Action Setterboard:

1. Pull out the Setterboard drawer.
2. Notice that there are four groups of switches for each stop of the Swell, Great, and Pedal divisions.

3. In the Swell division of the Setterboard, set a single stop switch to ON in each of the four groups (e.g., #1 - 8' TROMPETTE, #2 - 4' CLAIRON, #3 - 8' HOHLFLÖTE, #4 - 2' PICCOLO. In a similar way, program the Great and Pedal divisions.
4. With all Swell stops off, press Swell piston #1 (located beneath the center of the Swell manual). The preselected Swell stop should move to the ON position. Repeat for Swell pistons #2, #3, and #4.
5. With all Great and Pedal stops off, press Great piston #1 (located beneath the center of the Great manual). This piston also selects the programmed stops for the Pedal. The preselected Great and Pedal stops should move to the ON position. Repeat for Great pistons #2, #3, and #4.
6. Press the "O" piston located beneath the right side of the Great manual. This piston cancels all called-up stops but does not affect the setting of the switches on the Setterboard. Check that all stops move to the OFF position.
7. Press Master piston #1 (located beneath the left side of the Swell manual). This piston calls-up the Swell, Great, and Pedal stops programmed in Group 1. Check that the preselected stops move to the ON position. Repeat for Master pistons #2, #3, and #4, and Master toe studs #1 through #4.

C. Computer Capture Type (Optional).

With the Computer Capture Combination Action, the stops and controls of the organ can be "programmed" from the keyboard. The preselected stops can be called-up by pressing pistons located on the rails beneath the keyboards.

To check the Computer Capture Combination Action:

1. Set the COMBONS key switch to the ON position.
2. Turn ON one Swell stop. Then, press the SET piston (located beneath the left side of the Great manual), and while holding it depressed, push in Swell piston #1 (located beneath the center of the Swell manual). This stores the selected stop for Swell piston #1. Select different Swell stops and repeat this procedure for Swell pistons #2, #3, and #4.
3. Turn ON one Great stop. Then, press the SET piston, and while holding it depressed, push in Great Piston #1 (located beneath the center of the Great manual). Select different Great stops and repeat

This procedure for Great pistons #2, #3, and #4.

4. Turn ON one Pedal stop. Then press the SET piston, and while holding it depressed, push in Pedal piston #1 (located beneath the left side of the Great keyboard). Select a different Pedal stop and repeat this procedure for Pedal pistons #2, #3, and #4.
5. Turn ON one Swell, Great, and Pedal stop. Then, press the SET piston, and while holding it depressed, push in General piston #1 (located beneath the left side of the Swell manual). Select different Swell, Great, and Pedal voices and repeat this procedure for General pistons #2, through #6.
6. With all Swell stops OFF, press Swell piston #1. While holding the piston depressed, check to see that the programmed Swell stop moves to the ON position and "cycles". "Cycling" refers to the slight movement of the stop as the computer action goes through its cycle.
7. With all Great stops OFF, press Great piston #1. While holding the piston depressed, check to see that the programmed Great stop moves to the ON position and "cycles". Repeat for Great pistons #2, #3, and #4.
8. With all Pedal stops OFF, press Pedal piston #1. While holding the piston depressed, check to see that the programmed Pedal stop moves to the ON position and "cycles". Repeat for Pedal piston #2, #3, and #4, and Pedal toe studs #1 through #4.
9. With all Swell, Great, and Pedal stops OFF, press General piston #1. While holding the piston depressed, check to see that the programmed Swell, Great, and Pedal stops move to the ON position and "cycle". Repeat for General pistons #2 through #6 and General toe stud #1 through #6.
10. Press the "O" piston located beneath the right side of the Great manual. This piston cancels all called-up stops but does not affect the stored program. Check that all stops have been cancelled.

VII. CHECK SWELL CHIFF:

- A. Turn ON the 8' HOHLFLÖTE (Swell voice) and play a note on the Swell keyboard. Listen for the absence of chiff. Turn ON the SWELL FLUTE CHIFF (General voice) and strike a key on the Swell keyboard several times. Each time the key is played, the note should begin with the characteristic pipe organ chiffing sound. Check all notes on the Swell keyboard.

- B. With all other stops off, turn ON the 4' FLUTE HARMONIQUE (Swell voice) and the SWELL FLUTE CHIFF (General voice). Check keys 49 through 54 for chiff.

VIII. CHECK TUTTI:

- A. Turn ON the TUTTI by pressing the TUTTI piston beneath the right side of the Swell manual.
- B. Check that the TUTTI indicator light on the stopboard is illuminated when the TUTTI is ON.
- C. The TUTTI stop turns on most of the stops and couplers (see Reference section for list). Play a chord on each manual and check for a full organ sound.
- D. Repeat this check using the TUTTI toe stud on the kneeboard to the right of the CRESCENDO expression pedal.

IX. CHECK AIR SOUND:

- A. Turn ON the AIR SOUND switch located either beneath the Great manual or on the Setterboard.
- B. The following stops have no Air Sound:

Swell Manual

4' CLAIRON
8' TROMPETTE
16' CONTRE TROMPETTE

Great Manual

8' KRUMMHORN
CARILLON
HARP

Pedal

4' CLAIRON (SW)
8' TROMPETTE (SW)
16' BOMBARDE

- C. Turn on an appropriate Swell stop. Press one Swell key and listen for Air Sound. Depress additional keys, one at a time, and notice that the

Air Sound builds up until about five keys are pressed. Repeat this check for all appropriate Swell stops. Also, check to see that the AIR SOUND switch turns off the Air Sound.

- D. Turn on an appropriate Great stop and repeat the Air Sound check for the Great manual.
- E. Turn on an appropriate Pedal stop and repeat the Air Sound check for the Pedal.

X. ACTIVITY:

No check is required for the Activity.

XI. CHECK GREAT TO PEDAL REVERSIBLE (Optional):

- A. Press the GT. TO PED. piston beneath the center of the Great manual.
- B. Check that the 8' GREAT TO PEDAL coupler stop changes position (on lighted drawknob models, check that light comes on or goes off each time the piston is pressed).

NOTE: This piston will cancel the 4' GREAT TO PEDAL coupler if it is on, but it will not turn it back on.

- C. Repeat this check using the GT. TO PED. toe stud on the kneeboard to the right of the Crescendo pedal.

XII. CHECK TRANSPOSER

- A. Turn ON the 8' PRINCIPAL (Great voice).
- B. Check that the "O" light of the transposer indicator is on. If not, press the "O" piston.
- C. Hold Key 25 (Middle C) depressed. Then, press the '1#' piston and check that the pitch of the note moves one semitone sharp. Also check that the '1#' light of the transposer indicator is on.
- D. Continue the check for the '2#' through '4#' transposer pistons.

- E. Press the "O" piston and repeat this check for the '1_b' through '4_b' transposer pistons.

XIII. CHECK LESLIE SPEAKER (Optional):

- A. Set the FLUTE/DIAPASON CHORUS (General stop to ON.)
- B. Turn ON the 8' PRINCIPAL (Great voice).
- C. Play a chord on the Great manual. Turn the FLUTE/DIAPASON CHORUS stop from ON to OFF several times while carefully listening for the characteristic undulating beat produced by the Leslie speaker. Output is heard through both the Main and Leslie speakers.
- D. Turn the FLUTE TREMULANT FULL (General stop) to ON.
- E. While playing a chord on the Great manual, listen for a faster beat heard only through the Leslie speaker.

XIV. CHECK ECHO SPEAKERS (Optional):

- A. Turn ON the 8' PRINCIPAL (Great voice).

NOTE: If only a single Echo speaker is used and it is connected to the Swell division, select a corresponding voice from this division.

- B. Play a chord on the Great manual. Turn ON the ECHO ON (General stop) and listen for output through both the Main speakers and the Echo speakers.
- C. Press the MAIN OFF (General stop) down. While playing the chord, listen for output only through the Echo speakers.
- D. Turn OFF the ECHO ON stop. Notice that both the Main and Echo speakers are silent when a chord is played. Return the MAIN OFF stop to the up position (Main speakers on).

XV. CHECK PRACTICE PANEL (Optional):

- A. While repeating a chord on either keyboard, turn the REVERB control clockwise and listen for an increase in reverberation as the control is turned.

This completes the Check-Out Procedure for the CAMBRIDGE 220-II.
If this is a new organ, please fill out the pink card and return it to the factory.

VOICING THE CAMBRIDGE 220-II

A Word About Voicing:

There are two major steps in setting up an organ: tuning and voicing. Whereas tuning refers to the process of setting the oscillators to play the correct notes or frequencies, voicing involves setting the individual stops or voices so they are properly balanced for correct tonal quality.

Each new Rodgers Organ is voiced first at the factory, again at the Dealer's Showroom, and finally at the installation site. Each time the organ is moved to a new location, the voicing should be checked since physical size and characteristics of the room may change the performance of the organ.

The voicing of any organ requires a great deal of musical and practical experience. While many aspects of voicing involve individual taste and preference, particularly on the part of the organist, there are certain conventions and limits to be observed.

This voicing procedure combines both convention on organ voicing as accepted by the American Guild of Organists (AGO) and philosophy as developed by Rodgers Organ Company and its service technicians.

Some General Tips on Voicing:

CAUTION: Do not change any of the voicing controls unless specifically requested to do so by the owner of the organ or the organist responsible for it, except when performing a troubleshooting procedure. In the latter case, check the voicing of any portions of the instrument which may have been disturbed after the trouble has been fixed.

1. When making adjustments, be sure the Crescendo pedal is fully closed (all Crescendo indicator lights off), the TUTTI is OFF, the AIR SOUND switch (located either under the right side of the Great manual or on the Setterboard) is OFF, and the Swell and Great expression pedals are fully open (maximum).
2. Always use two people. One to play the organ (preferably the normal organist), and the other to adjust the voicing controls.
3. Change settings only while playing a continuous note or chord. Never change settings with the instrument silent.

4. A good chord to use in making the comparisons is the Middle C Major Triad of C - E - G (keys 25 - 29 - 32).
5. The speaker cabinets should all be placed in approximately the location that they will permanently occupy. The tweeter adjustment on the M13-100 and W6-100 units should be set to about 1/2 to 2/3 of its full range setting. The Mid-range adjustment on the W6-100 should be at about the midpoint while the Bass switch should be set to High. The Tweeter/Mid-range Phasing switch should be set to taste as there is no rule of thumb. All amplifier Bass Boost (if equipped) switches should initially be in the OFF (down) position.

Preliminary Procedure:

1. Remove the console back and open the racks as described under "Disassembly Procedures".
2. Turn the organ POWER key switch to the ON position.
3. If this organ has the optional Practice Panel, push in the REVERB control knob and turn it full counterclockwise.
4. Please read each step completely, along with any accompanying notes, before performing the adjustment.
5. The "Reference" section of this manual provides information which may help you in this voicing procedure.
6. Location of adjustments is shown on a pullout page at the end of this section.

NOTE: All voicing controls in this procedure are indicated in parenthesis.

Voicing Procedure:

The voice leveling adjustments are made in two stages:

1. By Unit Voice. These adjustments affect more than one stop.

Unit Voice Leveling (adjustments located on output circuit board)

Great Unit Diapason	(R660)
Great Unit Flute	(R260)
Swell Unit Diapason	(R360)
Swell Unit Flute	(R915)
Swell Unit Reed	(R548)

2. By Individual Stop. These adjustments affect only one stop. They can be further grouped into two categories:

Individual Stop Leveling (adjustments located on output circuit board).

SWELL:

8' Viola Celeste (Celeste part only) (R530)

GREAT:

8' Flute Celeste II (Celeste part only) (R490)

8' Krummhorn (R311)

Harp (R482)

Carillon (R480)

PEDAL:

32' Contra Violone (R798)

16' Principal (R728)

16' Bourdon (R768)

16' Lieblich Gedeckt (R788)

16' Violone (R708)

16' Bombarde (R748)

Individual Stop Leveling (adjustments located on the diode keying rack, at the end of each diode gate that they affect). They do not have individual adjustment numbers.

SWELL:

8' Viola Pomposa

8' Hohlflöte

2-2/3' Nazard

2' Piccolo

1-3/5' Tierce

1' Fife

Plein Jeu III (3 adjustments)

GREAT:

16' Flute Conique

8' Principal (affects 8' Gambe only)

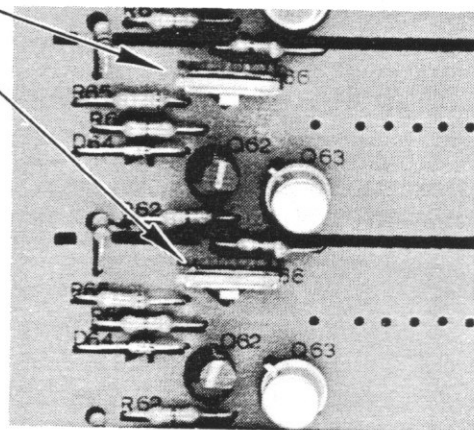
8' Bourdon (affects unison portion of 8' Flute Celeste II)

2' Fifteenth

2' Blockflöte

1-1/3' Larigot

Fourniture III (3 adjustments)



PEDAL:

- 8' Octave
- 8' Flute
- Choralbass
- Mixture III (3 adjustments)

I. SET GREAT DIAPASON LEVEL:

- A. Turn ON the following Great voices: 8' PRINCIPAL, 4' OCTAVE, and 2' FIFTEENTH.
- B. Play a chord on the Great Manual.
- C. Set the Great Unit Diapason level (R660) at a comfortable full volume (F). This step is a very important step in the voicing process since it sets the level of the Great Diapasons for making subsequent comparisons. You may find that your first impulse is to set the Great Unit Diapason loud. However, adopt a conservative attitude initially. Then, if the organ seems too soft during the worship service, the leveling can always be reviewed.

II. SET SWELL UNIT DIAPASON LEVEL:

- A. Cancel all stops.
- B. Turn ON the 4' OCTAVE (Great voice) and 4' OCTAVE (Swell voice).
- C. Alternately play the same chord on the Great and Swell Manuals.
- D. Adjust the Swell Unit Diapason level (R360) so that the apparent loudness of the Swell is just slightly softer than that of the Great.

III. SET GREAT UNIT FLUTE LEVEL:

- A. Cancel all stops.
- B. Turn ON the 4' SPILLFLÖTE (Great voice).
- C. Play a chord on the Great Manual and while holding it, add the 4' OCTAVE (Great voice). The sound should be about 30% louder than with the 4' SPILLFLÖTE alone. As mentioned before, the particular denomination may desire a different relationship between the Flutes and the Diapasons.

- D. Adjust the Great Unit Flute level (R260) for the desired balance.
- E. To further check the Unit Diapason level.
 - 1. Cancel all stops (press the "O" piston on organs so equipped).
 - 2. Hold a chord on the Great Manual and add the following Great stops in the listed order.

The sound should build up smoothly, with no large or sudden bursts of loudness as each stop is added.

8' GAMBE
8' BOURDON
8' PRINCIPAL
4' SPILLFLÖTE
4' OCTAVE
2' BLOCKFLÖTE
2' FIFTEENTH
FOURNITURE III

- 3. Remove the FOURNITURE III from the above combination. The sound should remain full and still brilliant, with the Principal tone predominating. The balance of the Principals and Flutes may vary somewhat, depending on the tastes of a given denomination. In general, the more Liturgical churches tend toward bolder Principal tones and fairly modest Flutes. With the more Evangelical churches the opposite is often true.

IV. SET SWELL UNIT FLUTE LEVEL:

- A. Cancel all stops.
- B. Turn ON the 4' SPILLFLÖTE (Great voice) and 4' FLUTE HARMONIQUE (Swell voice).
- C. Alternately play the same chord on the Great and Swell Manuals.
- D. Adjust the Swell Unit Flute level (R915) so that the apparent loudness of the Swell is the same level or just perceptibly louder than the Great.

V. SET THE SWELL UNIT REED LEVEL:

- A. Cancel all stops.
- B. Turn ON the 8' PRINCIPAL and 4' OCTAVE (Great voices) and the 8' TROMPETTE (Swell voice).
- C. Alternately play the same chord on the Great and Swell Manuals.
- D. Adjust the Swell Unit Reed level (R548) so that the apparent loudness of the Swell is the same or slightly louder than the Great.
- E. Further check this adjustment by adding the 2' FIFTEENTH, 8' BOURDON, 4' SPILLFLÖTE, and 2' BLOCKFLÖTE to the Great. Now while holding a chord on the Great Manual, turn ON the 8' SWELL TO GREAT coupler. The 8' TROMPETTE from the Swell should add "fire" to the Great sound, but should never completely dominate it.

NOTE: Steps VI and VII set the proper relationship between the Celeste voices and their unison partners.

VI. SET SWELL VIOLA CELESTE LEVEL:

- A. Cancel all stops.
- B. Turn ON the 8' VIOLA POMPOSA and 8' VIOLA CELESTE (Swell voices).
- C. While holding a chord on the Swell Manual, turn the Viola Celeste level (R530) all the way down.
- D. While continuing to hold the chord, add the 4' OCTAVE (Swell voice). The 4' OCTAVE should be somewhat louder than the Viola Pomposa level; however, the difference should be quite subtle. If the Viola Pomposa level is either too loud or too soft, adjust the Viola Pomposa level on the Viola Pomposa diode slide until a noticeable difference between the two stops is achieved.
- E. As a check of correct level, play each stop separately. Play the chord for 4' OCTAVE one octave lower than the position used for 8' VIOLA POMPOSA. Thus, it is somewhat easier to compare levels when the identical pitches are heard.
- F. Continue to hold a chord with only the 8' VIOLA POMPOSA and 8' VIOLA CELESTE stops ON. Gradually increase the setting of the Viola Celeste level (R530) until a pleasant undulating sound is achieved.

VII. SET GREAT FLUTE CELESTE LEVEL:

- A. Cancel all stops.
- B. Turn ON the 8' FLUTE CELESTE II (Great voice).
- C. While holding a chord on the Great Manual, turn the Flute Celeste level (R490) all the way down.
- D. Still holding the chord, momentarily add the Great 8' BOURDON stop. The Bourdon should be considerably louder than the Flute Celeste Unison. If the Bourdon level is either too loud or too soft, adjust the flute Celeste Unison level on the Bourdon diode slide until a noticeable difference between the two stops is achieved.
- E. Holding the chord, bring up the Flute Celeste level (R490) until a pleasant undulating sound is achieved.

VIII. SET GREAT KRUMMHORN LEVEL:

- A. Cancel all stops.
- B. Turn ON the 8' TROMPETTE (Swell voice) and the 8' KRUMMHORN (Great voice).
- C. While alternately playing the same chord on the Swell and Great Manuals, adjust the Great Krummhorn level (R311) so that the apparent loudness of the Great is somewhat less than the Swell.

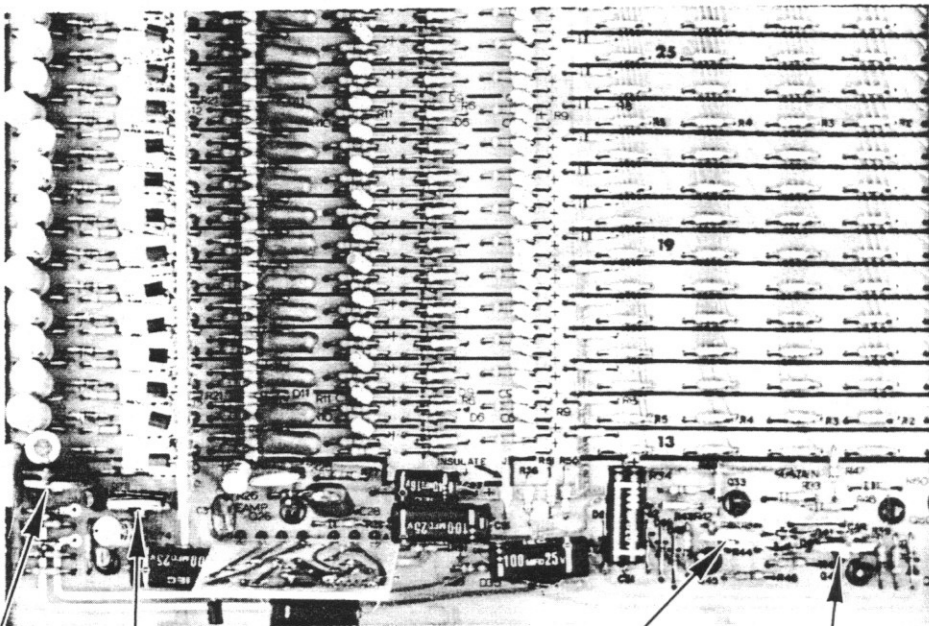
IX. SET GREAT HARP LEVEL:

- A. Cancel all stops.
- B. Turn ON the HARP and 8' FLUTE CELESTE II (Great voices).
- C. Play a series of chords on the Great Manual. There should be a slight percussive attack heard against the Flute Celeste sound each time the chord is played. The Harp should be slightly louder than the Flute Celeste.
- D. Adjust the Harp level (R482) until the attack is heard clearly.

HARP-CARILLON SUSTAIN POTS

Located on Harp-Carillon

Keyer, Loc. 2-G



R679
Carillon
Level
Adjust

R674
Harp Level
Adjust

R644
Harp Sustain
Length

R640
Carillon Sustain
Length

X. SET GREAT CARILLON LEVEL:

Adjustment of the Carillon level is a matter of personal taste. However, a good suggestion to follow is to balance the Carillon against the foundations of the Swell division in the following manner:

- A. Cancel all stops.
- B. Turn ON the 8' VIOLA POMPOSA, 8' HOHLFLÖTE, and 4' FLUTE HARMONIQUE (Swell voices) and the CARILLON (Great voice).
- C. Play the Carillon on the Great Manual (only one note at a time) and accompany it on the Swell Manual. The Carillon should be plainly heard above the Swell combinations.
- D. Adjust Great Carillon level (R481) until a good relationship is achieved.

XI. SET HARP AND CARILLON SUSTAIN:

The length of the sustain on the Harp and Carillon is purely a matter of personal taste and should be set as desired by the individual organist using the following procedure:

- A. Cancel all stops.
- B. Turn ON the HARP and 8' FLUTE CELESTE II (Great voices).
- C. Play a chord on the Great Manual.
- D. Adjust the Harp Sustain Length (R644) for the desired amount of sustain each time the chord is played.
- E. Turn OFF the HARP and turn ON the CARILLON (Great voices).
- F. Play a note on the Great Manual.
- G. Adjust the Carillon Sustain Length (R640) for the desired amount of sustain each time the note is played. Generally, the Carillon sustain should be slightly longer than the Harp sustain.

XII. SET PEDAL 16' and 32' LEVELS:

- A. Cancel all stops.
- B. Turn ON the TUTTI (use TUTTI piston or toe stud).
- C. Play a C chord on the Great Manual and low CCC on the Pedal (lowest C on Pedal).
- D. The Pedal sound should compliment the Great Manual chord, adding a good amount of bass and weight while not producing a "boomy" effect. If the Pedal seems to be overpowering or is not loud enough, adjust Pedal level (R794) to produce a good balance.

XIII. SET INDIVIDUAL PEDAL STOPS LEVELS:

The relative level of the Pedal stops is set at the factory, and should not require further adjustment. However, the Pedal stops should be checked to insure that the present setting is appropriate for the installation.

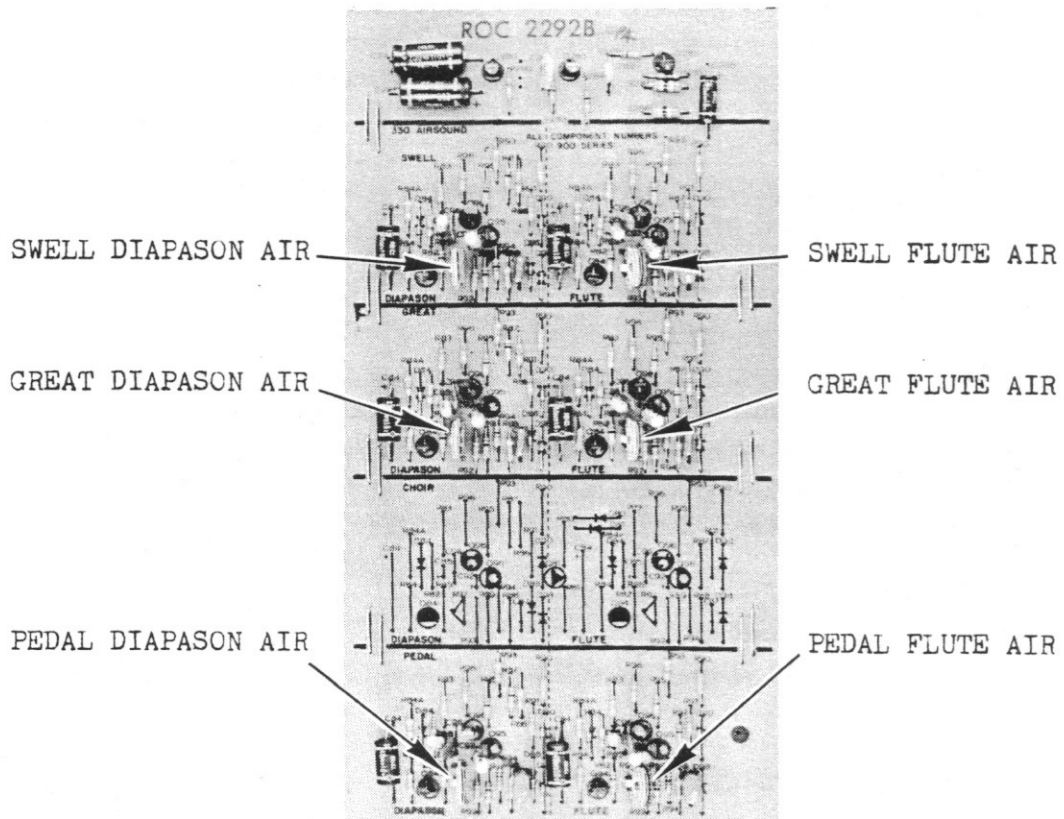
- A. Cancel the TUTTI.
- B. Turn ON the 16' LIEBLICH GEDECKT (Pedal voice). While playing low CCC on the Pedal, close the Great expression pedal (set to minimum). The sound should be barely audible. Adjust the 16' Lieblich Gedeckt level (R788) for the correct volume.
- C. With the 16' LIEBLICH GEDECKT stop on, add the following stops in sequence. Turn OFF the previous stop as the next one is added. The dynamic level as each succeeding stop is added should be greater than the previous stop. If the level is not correct for any of the stops, adjust the listed control.

16' VIOLONE	(R708)
16' BOURDON	(R768)
16' PRINCIPAL	(R728)
16' BOMBARDE	(R748)

- D. Turn ON all Pedal stops except the 32' CONTRA VIOLONE.
- E. While playing a note on the Pedal, turn the 32' CONTRA VIOLONE stop ON and OFF several times. Adjust the 32' Contra Violone level (R798) until this stop adds the proper amount of "weight" to the Pedal. Be careful not to get this stop too loud as it is also very valuable under Celestes and other soft combinations.

AIR SOUND LEVELING

Air Sound Board Loc. 1-E.



XIV. SET AIR SOUND LEVELS (Optional):

The Air Sound levels were set at the factory and may not need further adjustment. However, since tweeter settings can radically affect the apparent amount of air sound in a given voice, it should be checked at the installation.

- A. Turn ON the AIR SOUND switch (located either under the right side of the Great manual or on the Setterboard).
- B. Turn ON the 8' PRINCIPAL (Great voice).
- C. Play a chord on the Great manual and listen for air sound. The air sound should be kept at a conservative level; it should be more conspicuous by its absence than by its presence. If adjustment is necessary, set the Great Diapason Air level (R997) for an appropriate amount of air sound.
- D. Repeat this procedure for each of the Air Sound level adjustments using the following stops (only one stop on at a time).

8' BOURDON	Great Flute Air
8' VIOLA POMPOSA	Swell Diapason Air
8' HOHLFLÖTE	Swell Flute Air
16' PRINCIPAL	Pedal Diapason Air
16' BOURDON	Pedal Flute Air

XV. SET LESLIE LEVEL (Optional):

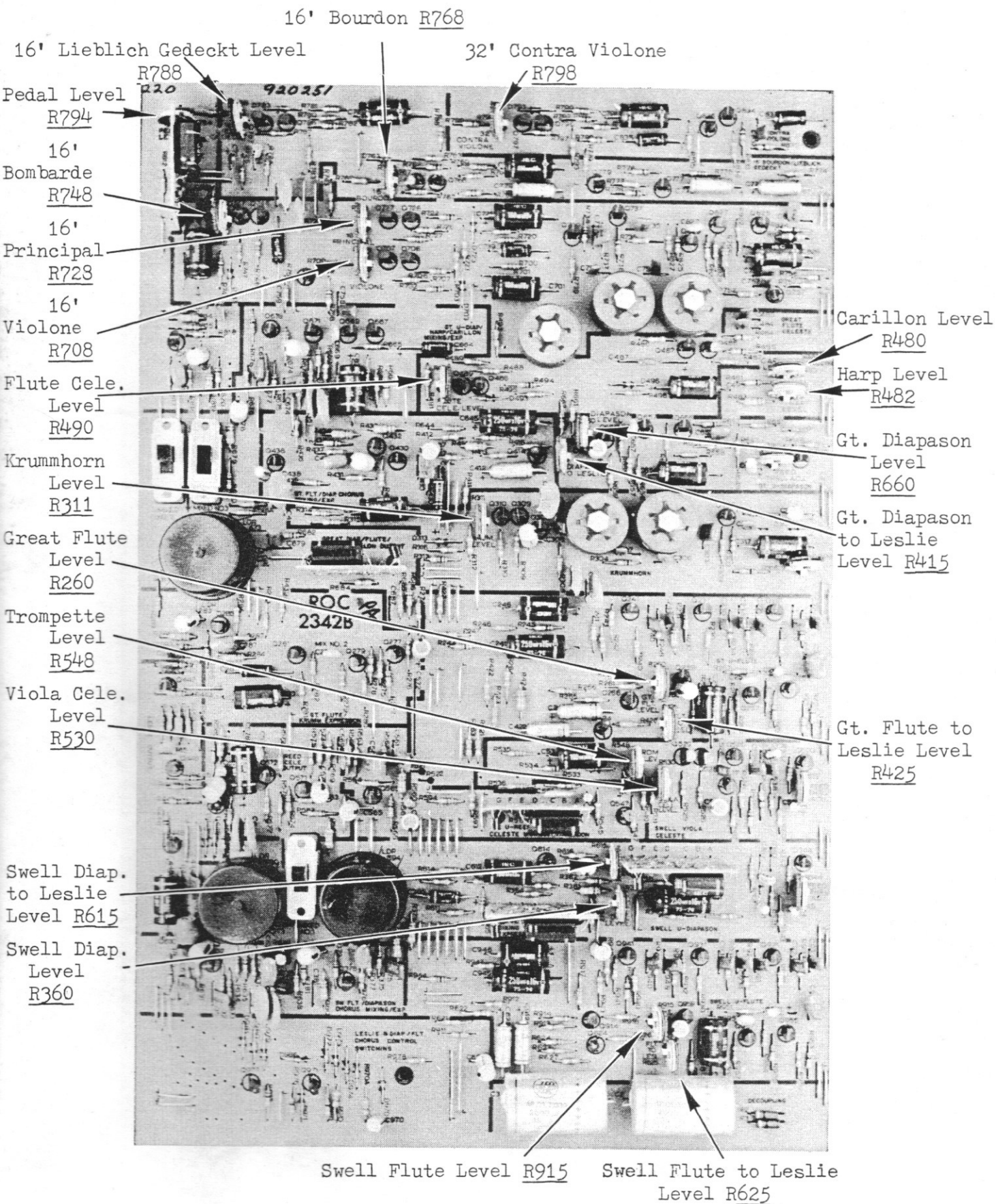
- A. To activate the Leslie Speaker, set the FLUTE/DIAPASON CHORUS (General voice) to ON.
- B. Turn ON the 8' PRINCIPAL (Great voice).
- C. Play a chord on the Great manual. Turn the FLUTE/DIAPASON CHORUS stop from ON to OFF several times while carefully listening for a change in volume. It is recommended that the Diapason voices have minimum level through the Leslie. The Swell Flute voices should have the most volume through the Leslie. This is relative

to personal taste and, of course, should be set to the level desired by the organist.

- D. Set the Great Diapason Leslie level (R415) for the desired volume through the Leslie Speaker.
- E. Repeat this procedure for each of the Leslie level adjustments using the following stops (only one stop on at a time).

8'	BOURDON	Great Flute Leslie	(R425)
8'	VIOLA POMPOSA	Swell Diapason Leslie	(R615)
8'	HOHLFLÖTE	Swell Flute Leslie	(R625)

Level Adjustment Locations



TUNING

GENERAL:

The Cambridge 220-II contains a total of 206 signal generating oscillators, each of which can be individually tuned. The oscillators are grouped into three sets:

Name	Number of Oscillators	Notes	Location in Organ (See Schematic 1)
Main Oscillators	109	001 - 85	1-A, 1-B, 1-C, 1-D
Ensemble Oscillators	48	13 - 60	2-A, 2-B
Celeste Oscillators	49	13 - 61	2-B, 2-C

For easier identification, the notes, keys, and oscillators of Rodgers Organs are numbered. This numbering system is such that middle C (261 Hertz) is note number 25. The oscillators are numbered so they correspond to the note that they produce. For 8' stops, the key numbers and the note numbers also correspond. The 32' octave is identified by notes 001 - 0012, and the 16' octave by numbers 01 - 012. To determine the note number and oscillator for any stop on any key, refer to the Keying Chart (Schematic 2). Guide numbers have also been stamped on the racks near the oscillators to help in locating them for tuning.

Example: Figure 3-1 shows the Main Oscillators, Notes 13 - 48.

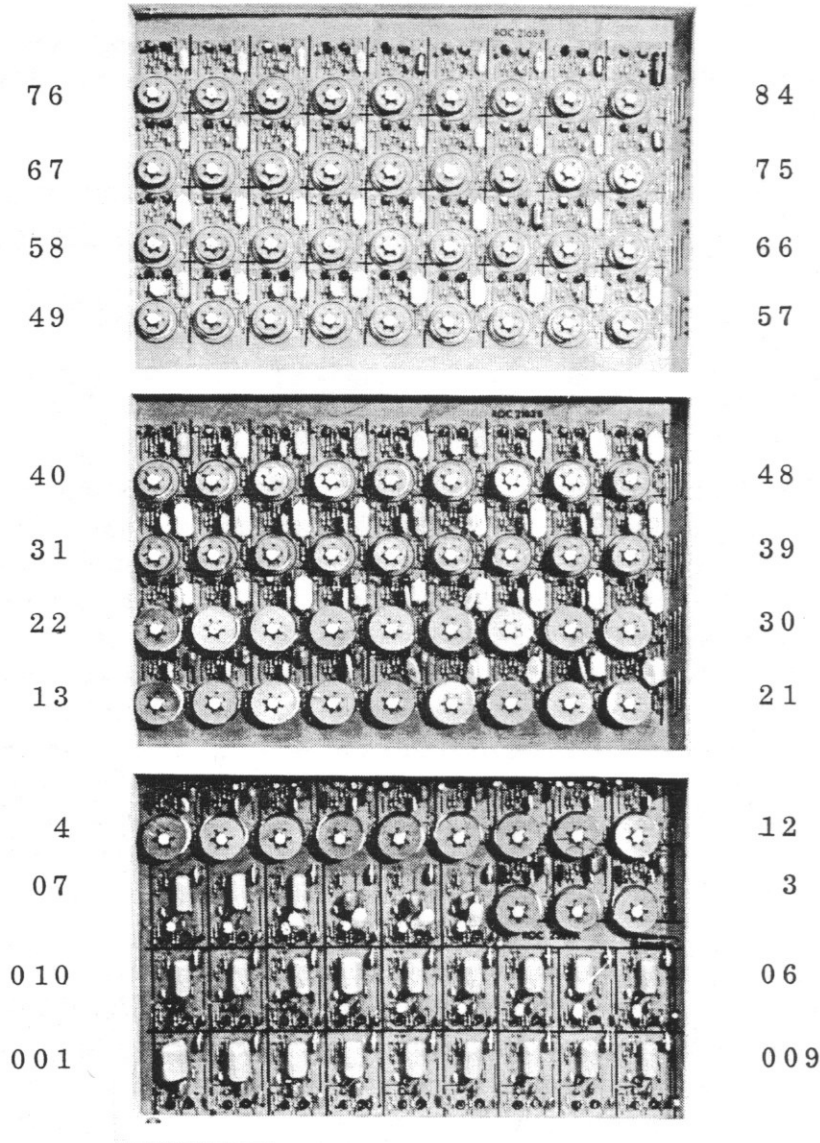
TUNING CONTROLS:

All oscillators in this organ are of the LC type with the exception of Main Oscillator notes 001 - 012 and the Tremulant Oscillator. To make tuning adjustments on the LC type oscillator, turn the cap of the ferrite core counter-clockwise (ccw) to raise the pitch and clockwise (cw) to lower it.

CAUTION: Do not loosen the nut on the holding spring on top of the ferrite core when making tuning adjustments.

The RC type of oscillator used for notes 001 - 012 is adjusted by the potentiometer located in each oscillator circuit.

FIG. 3-1
Main Oscillators
Notes 001 - 84
Loc. 1A, 1B & 1C

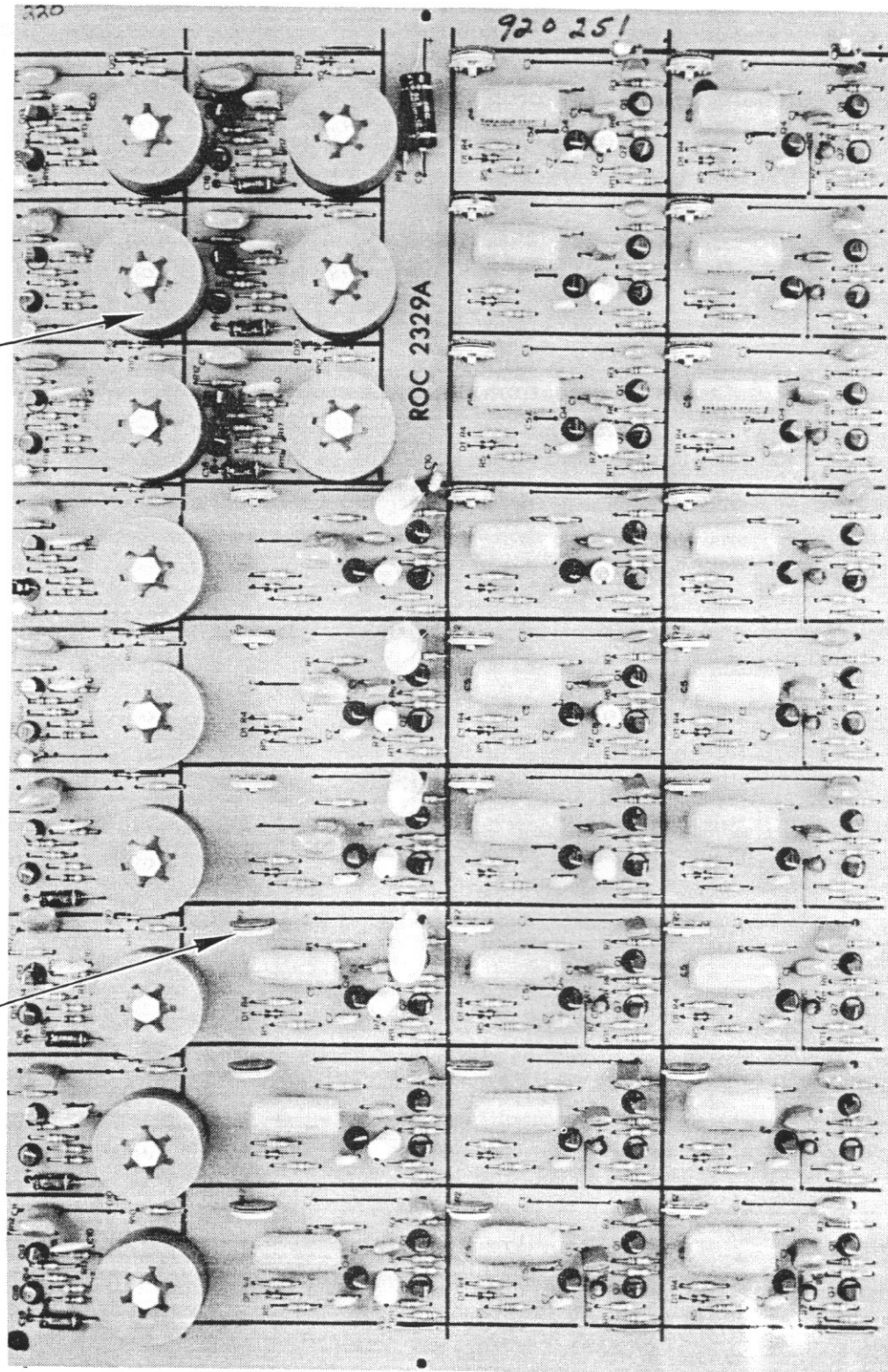


LC/RC OSCILLATORS

Frequency Adjustments

RC Type. Adjust Potentiometer.

LC Type. Adjust Ferrite Cap.



TUNING METHODS:

A variety of tuning methods can be used to tune the oscillators in this organ. Any one of these procedures can provide tuning; the accuracy depends in large part on the competence and care on the part of the technician.

A. Beating Octaves.

This tuning method works best when the majority of the oscillators are known to be correctly tuned and only a few oscillators are out of tune.

1. Play the note to be tuned and the note one octave higher or lower.
2. Adjust the core or potentiometer for zero beat.

NOTE: To prevent accidental detuning of oscillators, double check that you have located the correct component before adjusting.

B. Strobococonn or Peterson Tuner.

Either of these instruments facilitates a very accurate adjustment of the oscillators. For best results, follow the directions provided with the unit.

NOTE: In the following procedure, turn ON only the given stops and be sure all other stops remain off. Set the expression pedals for the desired loudness or for adequate operation of the tuning instruments. Play only one note at a time. The Keying Chart shown on Schematic 2 can be used as a reference.

I. MAIN OSCILLATOR TUNING:

- A. Turn ON the 8' PRINCIPAL (Great voice).
- B. Tune Main Oscillators 1 to 61 starting with Key 1 on the Great Manual and continuing through Key 61.
- C. Turn OFF the 8' PRINCIPAL and turn ON the 2' FIFTEENTH (Great voice).
- D. Play keys 38 through 61. With this stop selected, you can tune Main Oscillators 62 (when playing Key 38) through 85 (when playing Key 61).
- E. Turn ON the 32' CONTRA VIOLONE (Pedal voice).
- F. Play keys 001 to 012 (bottom 24 keys on Pedal), and tune Main Oscillators 001 to 0012 and 01 to 012.

II. ENSEMBLE OSCILLATOR TUNING:

- A. Turn ON the 8' VIOLA POMPOSA (Swell Voice).
- B. Play keys 13 to 60 on the Swell Manual and tune Ensemble Oscillators 13 to 60.

NOTE: The Main and Ensemble Oscillators should be correctly tuned before beginning this step. Then the Celeste Oscillators can be tuned by beating them against the Ensemble Oscillators.

III. CELESTE OSCILLATOR TUNING:

- A. Turn ON the 8' FLUTE CELESTE II (Great voice).
- B. Play keys 13 to 61 on the Great Manual, one at a time, and tune Celeste Oscillators 13 to 61 using the procedure given in the following steps.
- C. As each note is played, you will simultaneously hear a signal from the Celeste Oscillator via the Flute Celeste signal keyer, and a signal from the Ensemble Oscillator via the Great Unit Flute signal keyer. The resulting Celeste (beat) sound is due to the difference in frequency between these two oscillators.
- D. Tune each Celeste Oscillator for zero beat and then rotate the cap of the core counterclockwise (tuned sharp) until the proper number of beats are heard as follows:

NOTES	BEATS PER SECOND
13 - 24	1 beat at Note 13, graduated to 2 beats at Note 24.
25 - 36	2 beats at Note 25, graduated to 3 beats at Note 36.
37 - 61	3 beats at Note 37, graduated to 4 beats at Note 61.

- E. As a final check of correct Celeste Oscillator tuning, turn down the Great Unit Flute level control, R260, located on the Output Preamp Board, Location 1-I.
- F. Only the Celeste portion of the voice is now heard. Play keys 13 through 61 in progression and listen for a smooth chromatic scale. If any notes seem to be out of tune, check and adjust them by beating them against the note one octave higher or lower.
- G. Return R260 to its correct setting by playing a note on the Great Manual. Adjust R260 for a pleasant, undulating sound.

- H. If desired, the Celeste Oscillators can be tuned with either a Strobocoann or a Peterson Tuner. Be sure to set the Celeste Oscillators on the sharp side of the Ensemble Oscillators. Adjust the relationship between the Celeste Oscillators and the Main Oscillators as follows:

<u>NOTES</u>	<u>SET CELESTE OSCILLATORS SHARP BY:</u>
--------------	--

13 - 20	14 cents ¹
21 - 32	12 cents
33 - 44	9-1/2 cents
45 - 56	7-1/2 cents
57 - 61	5 cents

¹One cent equals 1/100th of a semitone.

This completes the tuning procedure for the Cambridge 220-II.

GENERAL TERMINOLOGY

The definitions given here for each term are those that are generally accepted and understood by organists. However, in some cases the terms are unique to the Rodgers Organ Company.

ACTIVITY - An effect which, in pipe organs, causes a slight random change, or fluttering, of the pure tone. In Rodgers Organs, an electronic circuit causes both an AM and FM random variation of the voices, imparting this pipe organ characteristic.

A. G. O. - An organization of organists, the American Guild of Organists. Membership obtained through nomination by two active members. A. G. O. grants the following proficiency degrees on the basis of annual examinations: Associate (A. A. G. O.) and Fellow (F. A. G. O.). The A. G. O. publishes a monthly magazine, "Music/A. G. O."

ANTIPHONAL - A division of the organ which is usually placed at the opposite end of the room from the main organ. It is used for echo effects, alternating choruses, or for augmenting the main organ in congregational singing. Generally includes most divisions of a Rodgers organ.

AIR SOUND - Describes the "breathy" component of a pipe organ sound which is caused by eddy currents in the air around the mouth of the pipe. In Rodgers Organs, this sound is duplicated electronically.

A. M. TREMULANT - Amplitude modulation tremulant, a type of tremulant characterized by a periodic change in the amplitude (volume level) of the sound.

BALANCING - The final act of the Voicing process, consisting of adjustment of each stop and channel on the organ so that a homogenous and full, but not overly loud, sound results. This can only be successfully done in the actual environment or installation where the organ is to be used.

CELESTE - An organ voice produced by tone generators of like quality, one tuned to unison pitch, and the other tuned slightly sharp. The resulting gentle undulations are said to resemble "celestial" voices.

CHIFF - The transient harmonic component that precedes the tone in a pipe voiced in the Baroque manner. This type of articulation is useful in playing contrapuntal music. In the Rodgers Organ, it is produced by an electronic circuit.

CIPHER - A malfunction of the organ consisting of a note that sounds continuously without the key being pressed, and often without a stop being on.

COMBINATION ACTION - Any device on an organ by which previously selected groups of stops can be brought on at will by pressing a button or piston, on the keyboard or a toe stud on the kneeboard. Several types of combination action are available on Rodgers Organs:

1. Pre-Set: These combinations are selected and permanently wired into the organ at the factory.
2. Setterboard: The stop combinations are selected by means of switches located in a drawer beneath the Great Manual of the organ.
3. Capture: Selected combinations can be set by pressing a SET piston and then pressing the piston on which the combination is to be stored.

COMPUTER CAPTURE - An application of computer magnetic memory technology to capture combinations in Rodgers Organs. This results in an action with no moving parts, and one that can be conveniently contained in the organ console.

COUPLERS - A feature which allows an entire division to be played in a special manner. There are two types of couplers:

1. Inter-Manual: Enables an entire division to be played on another keyboard, usually at several different pitch levels (i. e. , 16' SWELL TO GREAT, 8' SWELL TO GREAT, 4' SWELL TO GREAT).
2. Intra-Manual: Enables an entire division to be played against itself an octave higher or lower (i. e. , 4' GREAT TO GREAT, 16' SWELL TO SWELL), or silenced altogether (i. e. , SWELL UNISON OFF).

CRESCENDO - The crescendo pedal gradually adds a pre-selected succession of stops as it is depressed. When fully depressed, a Forte or full organ sound results.

DIAPASON - Generally referred to by the name "Principal", denoting the Principal foundation voice of the organ. Principal tone is the natural sound produced by wind-blown open metal pipes, and is the oldest organ sound, and the most important.

DRAWKNOB - Probably the oldest and most traditional manner of operating the stops of the organ. A knob, with the name of the stop on it, is drawn out to turn on the stop and pushed in to turn it off.

- ECHO ORGAN - Similar to the Antiphonal Organ except that the Echo Organ often includes only one division.
- ENSEMBLE - The single most important (and generally most subtle) factor in determining the success of an organ. It is the sound of many different tone sources acting together, with all of the slight uncertainties of pitch giving warmth and vitality to the music. It is the difference between an entire string section playing a single note, and a single amplified violin playing the same note at the same volume.
- FILTERS - Electronic circuits that shape and alter the basic sound of a given tone generator.
- FLUE STOPS - Non-reed stops, namely the Foundation, Flute, and String families. In pipe organs, Flues generate their tones by the action of a sheet of wind against a sharp lip. This sets a column of air in motion within the walls of the pipe in the manner of a toy whistle.
- F. M. TREMULANT/VIBRATO - This is the true Vibrato. This is the result of a regularly occurring change in the pitch of a sustained tone. The human voice has a certain amount of natural vibrato.
- FOOTAGE - The general term used to designate pitch in an organ. In a pipe organ, a rank of open pipes, the longest of which is 8 feet, will produce the standard concert pitch on an organ keyboard; consequently, such a stop is called an 8' stop. A 16' stop speaks one octave lower while a 4' stop speaks an octave higher.
- FORMANT - A type of filter employing tuned resonant circuits which is used to impose a specific harmonic structure on a sound. This type of circuit is most effective with reed stops. In Rodgers Organs, the formants can be adjusted to provide voicing.
- FRACTIONAL PITCHES - Organ stops that speak other than unison or octave pitches (i. e., $5-1/3'$, $2-2/3'$, $1-3/5'$, $1-1/3'$). These are also called mutations and are useful in building up synthetic solo combinations or adding color to ensembles.
- FUNDAMENTAL - The portion of a musical tone that defines the pitch of the tone to the ear, usually the lowest pitched harmonic of the tone.
- GATE - An electronic circuit which, in conjunction with a mechanical or electronic switch, opens or closes a DC or power circuit and permits the switch to control several other circuits. May be a Diode Gate or a Transistor Gate.

GREAT ORGAN - The most important division of the organ. Other divisions usually couple to it. It is characterized by complete development of the Diapason Chorus, the sound which separates the organ from any other instrument.

HARMONIC - Any one of the many pitch partials that give a musical tone its primary quality. The relative intensity of these harmonics determines the tone quality of a given sound.

KEYING - The process by which a pipe or tone generator is made to speak and cut off. In Rodgers Organs, the keying circuit controls the attack and release characteristics to produce an action similar to pipe organs.

KEYER - Electronic circuit which blocks or passes an audio signal corresponding to one note of a scale. A Keyer circuit may modify the input waveform and impart certain attack and decay characteristics. A Keyer may be identified by the type of waveform it transmits, or by actual voice. It also can be identified as to the type of active element (i. e., diode keyer or transistor keyer).

MAIN ORGAN - The body of the instrument, usually containing the Great, Swell, and Pedal divisions. Echo divisions are installed elsewhere in the auditorium.

MIXTURE - A compound stop consisting of two or more ranks of high-pitched unison and fifth-sounding mutations. These stops are used to reinforce the natural upper harmonics of a full ensemble and to add brilliance and definition.

MUTATION - See "Fractional Pitches".

OSCILLATOR - An electronic circuit that produces a sustained alternating impulse of electricity at a fixed pitch.

PRESETS - See "Combination Action No. 1".

RANDOM MOTION - A term used by the electronic organ industry to describe the random variations in pitch, intensity, and harmonic structure that occur in a pipe tone

REED - One of two classes of organ stops. In a pipe organ, a reed pipe generates its tone by the vibration of a brass tongue against a rectangular opening. The resulting tone is given security of pitch and timbre by a resonator placed on the reed assembly.

REED SWITCH - Consists of a pair of overlapping flat contacts, hermetically sealed in a glass tube. The contacts are operated magnetically.

- REED RELAY - Consists of a Reed Switch with a coil of wire wound around it. When a current is applied to the coil, the reed switch closes.
- REGISTRATION - The art of knowing what stops to use in playing a given piece of music artistically and authentically.
- REVERBERATION - The ability of a room to sustain a sound. This quality is to be distinguished from echoing, which is an undersirable repeated 'bounce' between two parallel surfaces. Reverberation is generally measured in terms of the number of seconds required for a loud sound to die away completely.
- REVERSIBLE ACTION - An action applied to certain critical couplers or stops on an organ that allows them to be individually turned on or off through the operation of a piston or toe stud. Pressing the piston once turns on the device; pressing the piston again reverses the action.
- SEMITONE - Refers to the spacing between two adjacent notes. For example: C-sharp is one semitone higher, or sharp, than C. Likewise, B-natural is one semitone lower, or flat, than C.
- SET PISTON - The piston that is pressed before pressing the piston on which a combination is to be stored. This applies only to the Computer Capture Combination Action.
- SETTERBOARD - See "Combination Action No. 2".
- SFORZANDO - See "Tutti".
- SWITCH - An electronic circuit which, in conjunction with a mechanical switch, opens or closes a DC or power circuit. It may, at the same time, invert or modify the action of the mechanical switch. The circuit may be identified by the signal switched or by the type of active element (i.e., transistor switch).
- STOP - Strictly speaking, a stop is a chromatic series of tones of like tone quality, one tone for each key on the keyboard. In practice, a distinction is made between Speaking Stops (stops which actuate a voice) and Non-Speaking stops (couplers, tremulants, echo controls, expression couplers, etc.).
- SUSTAIN - A device that permits a more gradual decay of the signal level by allowing the keying voltage to decrease gradually. This applied to the Harp/Carillon Signal Keyer in the Cambridge 220-II.
- SWELL ORGAN - The more romantic division of the organ, named for the fact that in the pipe organ, it is enclosed in a box with shutters on the front, giving it the ability to 'swell' in volume. The Swell contains the Solo and Major Chorus Reeds, as well as the soft Strings and Celeste stops.

TRACKER TOUCH - A mechanism applied to the keyboards of Rodgers Organs to simulate the top-resistant type of touch characteristic of tracker-action pipe organs. Available as an option, this keyboard touch promotes clean, articulate playing.

TUTTI - A Full Organ sound which is selected by pressing a single piston. This piston is of the reversible type in that it selects the Full Organ the first time it is pressed and then reverts to the original registration when pressed again.

UNIFICATION - The switching process whereby a set of tone generators of the same tone quality can be played at any pitch level (16', 8', 4', 2-2/3', etc.), and on any division of the organ (but subject to just one expression pedal and tremulant).

VOICING - The complex process following the testing of an organ, in which every stop in the instrument is carefully scaled and graded for correct tone quality. This also involves making sure that each stop adds into the ensemble, without asserting itself unduly. A good deal of this is done at the factory, but it culminates in the finishing process at the installation site.

REFERENCE INFORMATION

I. CAMBRIDGE 220-II STOP LIST:

GREAT STOPS

16' Flute Conique
8' Principal
8' Bourdon
8' Gambe
8' Flute Celeste II
4' Octave
4' Spillflöte
2' Fifteenth
2' Blockflöte
1-1/3' Larigot
Fourniture III
8' Krummhorn
Harp
Carillon
4' Great to Great
16' Swell to Great
8' Swell to Great
4' Swell to Great

PEDAL STOPS

32' Contra Violone
16' Principal
16' Bourdon
16' Violone
16' Lieblich Gedeckt
8' Octave
8' Flute
4' Choralbass
Mixture III
16' Bombarde
8' Trompette (SW)
4' Clairon (SW)
8' Great to Pedal
4' Great to Pedal
8' Swell to Pedal
4' Swell to Pedal

SWELL STOPS

8' Viola Pomposa
8' Viola Celeste
8' Hohlflöte
4' Octave
4' Flute Harmonique
2-2/3' Nazard
2' Piccolo
1-3/5' Tierce
1' Fife
Plein Jeu III
16' Contre Trompette
8' Trompette
4' Clairon
Tremulant
16' Swell to Swell
Swell Unison Off
4' Swell to Swell

GENERAL STOPS

Main Tremulant
Flute/Diapason Chorus
Flute Tremulant Full
Swell Flute Chiff
Main Off
Echo On

II. CRESCENDO SEQUENCE:

Position of CRESCENDO Expression Pedal	Indicator Light				
	Standard Indicator	Optional Custom Indicator	SWELL STOPS	GREAT STOPS	PEDAL STOPS
0	Off	Off	Stops selected by Stopboard or by Combination Action		
1	P	#1	8' Viola Pomposa	8' Bourdon	16' Lieblich Gedeckt
2			4' Flute Harmonique	8' Swell to Great	8' Great to Pedal
3		#2	4' Octave	4' Spillflöte	16' Violone
4	MP	#3	8' Hohlflöte	8' Principal	16' Bourdon
5		#4	2' Piccolo	4' Octave	
6	MF	#5	Plein Jeu III	2' Fifteenth	16' Principal
7		#6	8' Trompette	2' Blockflöte	8' Swell to Pedal
8	F	#7	1' Fife	Fourniture III	

III. STOPS OPERATED BY TUTTI:

The TUTTI piston or toe stud turns on all of the following stops:

GREAT STOPS

16' Flute Conique
8' Principal
8' Bourdon
8' Gambe
4' Octave
4' Spillflöte
2' Fifteenth
2' Blockflöte
1-1/3' Larigot
Fourniture III
8' Krummhorn
4' Great to Great
8' Swell to Great
4' Swell to Great

SWELL STOPS

8' Viola Pomposa
8' Hohlflöte
4' Octave
4' Flute Harmonique
2' Piccolo
1' Fife
Plein Jeu III
16' Contre Trompette
8' Trompette
4' Clairon
4' Swell to Swell

PEDAL STOPS

32' Contra Violone
16' Principal
16' Bourdon
16' Violone
16' Lieblich Gedeckt
8' Octave
8' Flute
4' Choralbass
Mixture III
16' Bombarde
8' Trompette (SW)
4' Clairon (SW)
8' Great to Pedal
8' Swell to Pedal
4' Swell to Pedal

GENERAL STOPS

FLUTE/DIAPASON CHORUS
FLUTE TREMULANT FULL

IV. PRESET STOP LIST FOR PRESET COMBINATION ACTION MODELS:

PRESET PISTON	SWELL STOP	GREAT STOP	PEDAL STOP
1	8' Viola Pomposa 8' Viola Celeste	8' Flute Celeste II 4' Great to Great	16' Violone 16' Lieblich Gedeckt
2	8' Viola Pomposa 8' Hohlflöte 4' Flute Harmonique 2' Piccolo	8' Principal 8' Bourdon 4' Spillflöte	16' Bourdon 8' Flute
3	8' Viola Pomposa 8' Hohlflöte 4' Octave 2' Piccolo	8' Principal 4' Octave 4' Spillflöte 2' Blockflöte	16' Bourdon 16' Violone 8' Flute
4	8' Viola Pomposa 8' Hohlflöte 4' Octave 4' Flute Harmonique 2' Piccolo 1' Fife	8' Principal 4' Octave 4' Spillflöte 2' Fifteenth 2' Blockflöte	16' Bourdon 16' Violone 8' Octave 4' Choralbass
5	8' Viola Pomposa 4' Octave 4' Flute Harmonique 2' Piccolo Plein Jeu III 16' Contre Trompette	16' Flute Conique 8' Principal 8' Bourdon 4' Octave 4' Spillflöte 2' Fifteenth Fourniture III	32' Contra Violone 16' Principal 16' Lieblich Gedeckt 8' Octave 4' Choralbass Mixture III

CAPTURE SYSTEM LOCATION GUIDE

This chart shows the relationship of Stops to Core numbers on Capture System:

SWELL DIVISION

1. SPARE CORES
2. 8' Viola Pomposa
3. 8' Viola Celeste
4. 8' Hohlflöte
5. 4' Octave
6. 8' Flute Harmonique
7. 2-2/3' Nazard
8. 2' Piccolo
9. 1-3/5' Tierce
10. 1' Fife
11. Plein Jeu III
12. 16' Contre Trompette
13. 8' Trompette
14. 4' Clarion
15. Tremulant
16. 16' Swell to Swell
17. Swell Unison Off
18. 4' Swell to Swell
19. Swell Flute Chiff
20. SPARE CORES
21. SPARE CORES

GREAT DIVISION

1. SPARE CORES
2. 16' Flute Conique
3. 8' Principal
4. 8' Bourdon
5. 8' Gambe
6. 8' Flute Celeste II
7. 4' Octave
8. 4' Spillflöte
9. 2' Fifteenth
10. 2' Blockflöte
11. 1-1/3' Larigot
12. Fourniture III
13. 8' Krummhorn
14. Harp
15. Carillon
16. 4' Great to Great
17. SPARE CORES
18. SPARE CORES

PEDAL DIVISION

1. SPARE CORES
2. 32' Contra Violone
3. 16' Principal
4. 16' Bourdon
5. 16' Violone
6. 16' Lieblich Gedeckt
7. 8' Octave
8. 8' Flute
9. 4' Choralbass
10. Mixture III
11. 16' Bombarde
12. 8' Trompette
13. 4' Clarion
14. SPARE CORES
15. SPARE CORES

COUPLERS

1. SPARE CORES
2. 8' Great to Pedal
3. 4' Great to Pedal
4. 8' Swell to Pedal
5. 4' Swell to Pedal
6. 16' Swell to Great
7. 8' Swell to Great
8. 4' Swell to Great
9. Main Tremulant
10. Flute Diapason Chorus
11. Flute Tremulant Full
12. Main Off
13. Echo On
14. SPARE CORES
15. SPARE CORES

V. LIST OF OUTPUT CHANNELS WITH ASSOCIATED STOPS:

There are five independent output channels on the 220-II with an additional output channel for a Leslie Speaker. The five output channels can be mixed down to a minimum of two channels.

SWELL REEDS/CELESTE

Swell Stops

16' Contre Trompette
8' Trompette
4' Clairon
8' Viola Celeste

Pedal Stops

8' Trompette
4' Clairon

SWELL DIAPASONS/FLUTE ¹

8' Viola Pomposa
4' Octave
Plein Jeu III
8' Hohlflöte
4' Flute Harmonique
2-2/3' Nazard
2' Piccolo
1-3/5' Tierce
1' Fife

GREAT FLUTE/KRUMMHORN

Great Stops

16' Flute Conique
8' Bourdon
8' Flute Celeste II (Unison)
4' Spillflöte
2' Blockflöte
1-1/3' Larigot
8' Krummhorn

Pedal Stop

8' Flute

GREAT DIAPASONS/CELESTE ²

Great Stops

8' Principal
8' Gambe
4' Octave
2' Fifteenth
Fourniture III
Harp
Carillon
8' Flute Celeste II (Celeste)

Pedal Stops

8' Octave
4' Choralbass
Mixture III

PEDAL ²

Pedal Stops (Note: See Great Diapasons, Great Flute, Swell Reeds)

32' Contra Violone
16' Principal
16' Bourdon
16' Violone
16' Lieblich Gedeckt
16' Bombarde

LESLIE

Flute/Diapason Chorus

All Swell Unit Flute, Swell Unit Diapason, Great Unit Flute, and Great Unit Diapason stops. Leslie operates at low speed.

Flute Tremulant Full

All Swell Unit Flute and Great Unit Flute stops. Leslie operates at high speed.

1. Can be mixed with Swell REEDS/CELESTE.
2. Can be mixed with Great FLUTE/KRUMMHORN.

VI. DEVICES OPERATED BY EACH STOP:

A. GREAT STOPS

STOP	KEYS	STOP LEVEL ADJUST	OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED BY STOP TAB
8' Principal		No	MAIN OSC.	Great Unit Diapason	Loc. 3-D
8' Gambe		Yes 1	Notes: 1 - 85	Loc. 1-G, H, J	Schematics 5 and 8
4' Octave	1 - 61	No		Schematic 8	Each stop is keyed through a
2' Fifteenth		Yes 1		Level Control: R660	Diode Gate which is controlled
Fourniture III				Loc. 1-I	by a Transistor Switch
A		Yes 1			
B		Yes 1			
C		Yes 1			
16' Flute Conique		Yes 1	MAIN OSC.	Great Unit Flute	Loc. 3-D
8' Bourdon		No	Notes: 01 - 12	Loc. 1-G, H, J	Schematics 5 and 9
8' Flute Celeste II ²	1 - 61	Yes 1	61 - 85	Schematic 9	Each stop is keyed through a
4' Spillflöte		No	ENSEMBLE OSC.	Level Control: R260	Diode Gate which is controlled
2' Blockflöte		Yes 1	Notes: 13 - 61		by a Transistor Switch
1-1/3' Larigot	1 - 54	Yes 1			
8' Krummhorn	1 - 61	Yes, Loc. 1-I	MAIN OSC.	Great Krummhorn	Loc. 3-D
			Notes: 1 - 12 & 61	Loc. 2-G	Schematics 5 and 14
			ENSEMBLE OSC.	Schematic 14	Stop control is by means of an
			Notes: 13 - 60		Audio Transistor Switch, Q309
					and Q310, Loc. 1-I.
Harp	13 - 61	Yes, Loc. 1-I	MAIN OSC.	Harp/Carillon	Stop control is by means of
Carillon	13 - 49		Notes: 13 - 73	Loc. 2-G	Audio Transistor Switches and
				Schematic 15	Diode Gates, all located on the
				Level Control:	Harp/Carillon Keyer board,
				Harp, R482	Loc. 2-G.
				Carillon, R480	
				Loc. 1-I	

A. GREAT STOPS, Cont'd.

STOP	KEYS	STOP LEVEL ADJUST	OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED BY STOP TAB
8' Flute Celeste II ²	13 - 61	Yes	Celeste	Flute Celeste Loc. 2-J	This stop activates two signal keyers. The Flute Celeste is stop controlled by means of an Audio Transistor Switch Loc. 1-I
		Celeste Portion, R490, Loc. 1-I		Schematic 13	The Unison portion of this stop is controlled by a Diode Gate, Loc. 3-D. This Diode Gate is also used for the 8' Bourdon.
		Unison Portion, located on 8' Bourdon Diode Gate, Loc. 3-D		Level Control: R490	
4' Great to Great	1 - 49				Loc. 3-C
16' Swell to Great	13 - 61				Schematic 5
8' Swell to Great	1 - 61				Stop control is by means of the Coupler Sync Gate, Q92 (one per stop).
4' Swell to Great	1 - 49				

1 Stop level controls not individually numbered; located with the associated Transistor Switch and Diode Gate.

2 The 8' Flute Celeste II stop control activates both the Flute Celeste Signal Keyer by means of an Audio Transistor Switch and the 8' Bourdon Diode Gate.

B. SWELL STOPS

8' Viola Pomposa	Yes ³	Yes ³	MAIN OSC.	Swell Unit Diapason	Loc. 3-F, G
4' Octave		No	Notes: 1 - 12	Loc. 1-G, H, J	Schematics 5 and 10
Plein Jeu III			61 - 85		Each stop is keyed through a Diode Gate which is controlled by a Transistor Switch.
A	1 - 61	Yes ³	ENSEMBLE OSC.	Schematic 10	
B		Yes ³	Notes: 13 - 60	Level Control:	
C		Yes ³		R360, Loc. 1-I	
4' Clairon	50 - 61	No			
(top 12 notes)					

B. SWELL STOPS, Cont'd.

STOP	KEYS	STOP LEVEL ADJUST	OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED BY STOP TAB
8' Hohlflöte		Yes ³	MAIN OSC.	Swell Unit Flute	Loc. 3-F, G
4' Flute Harmonique		No	Notes: 1 - 85	Loc. 1-G, H, J	Schematics 5 and 11
2-2/3' Nazard	1 - 61	Yes ³			Each stop is keyed through
2' Piccolo		Yes ³		Schematic 11	Diode Gate and Chiff circuit.
1-3/5' Tierce	1 - 57	Yes ³		Level Control: R915	The Diode Gate is controlled
1' Fife	1 - 49	Yes ³		Loc. 1-I	by a Transistor Switch

16' Contre Trompette	1 - 61	No	MAIN OSC.	Swell Unit Reed	The Chiff level and switching
8' Trompette		No	Notes: 01 - 61	Loc. 2-I	is provided by a Transistor
4' Clairon ⁴	1 - 49	No		Level Control: R548	Switch Q204, Loc. 3-H
				Loc. 1-I	

8' Viola Celeste	13 - 61	Yes	CELESTE OSC.	Viola Celeste	Loc. 1-I
				Loc. 2-J	Schematics 13 and 19
				Schematic 13	This stop activates an Audio
				Level Control: R530	Transistor Switch, Q528 and
				Loc. 1-I	Q529

Tremulant		Yes	TREMULANT OSC.		Loc. 1-D
		Loc. 1-D			Schematic 7
		Tremulant			Stop control is by Transistor
		Frequency,			Switch Q213
		R138			
		Tremulant			
		Level R212 ⁵			

B. SWELL STOPS, Cont'd.

STOP	KEYS	STOP LEVEL		OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED	
		ADJUST				BY STOP	TAB
16'	Swell to Swell	13 - 61				Loc. 3-C	
	Swell Univison Off	1 - 61				Schematic 5	
4'	Swell to Swell	1 - 49				Stop control is by means of the	
						Coupler Sync Gate, Q92 (one	
						per stop)	

3	Stop level controls not individually numbered; located with the associated Transistor Switch and Diode Gate.						
4	The top 12 notes of the 4' Clairon stop are derived from the Swell Unit Diapason Signal Keyer.						
5	The Tremulant Frequency adjustment R138 affects both the Swell Tremulant and the Main Tremulant.						

C. PEDAL STOPS

32' Contra Violone ⁷	001 - 8	Yes, R798, Loc. 1-I	MAIN OSC. Notes: 001 - 8	32' Pedal Keyer, Loc. 1-L	Loc. 1-I	Schematics 18 and 20
16' Principal ⁷		Yes, R728	MAIN OSC.	16' Pedal Keyer, Loc. 1-K	Level control for this entire group of stops is R794 located on the Output Preamp Board.	
16' Bourdon ⁷	01 - 20	Yes, R768 Loc. 1-I	Notes: 01 - 20	Schematic 17	Loc. 1-I	
16' Violone ⁷		Yes, R708 Loc. 1-I			Stop control is by means of an Audio Transistor Switch for each stop.	
16' Lieblich Gedeckt ⁷		Yes, R788 Loc. 1-I				
16' Bombarde ⁷		Yes, R748 Loc. 1-I				

8' Octave ⁸	1 - 32	Yes ⁶	MAIN OSC.	Great Unit Diapason Loc. 1-G, H	Loc. 3-G	Schematic 8
4' Choralbass ⁸	13 - 44	Yes ⁶		Schematic 8	Each stop is keyed through a Diode Gate which is controlled by a Transistor Switch.	
Mixture III ⁸						
A		Yes ⁶				
B	1 - 32	Yes ⁶				
C		Yes ⁶				

C. PEDAL STOPS, Cont'd.

STOP	KEYS	STOP LEVEL		OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED	
		ADJUST	YES ⁶			BY STOP TAB	
8' Flute	1 - 32	Yes ⁶		MAIN OSC. Notes: 1 - 12 ENSEMBLE OSC. Notes: 13 - 32	Great Unit Flute Loc. 1-G, H Schematic 9	Loc. 3-G Schematic 9 This stop is keyed through a Diode Gate which is controlled by a Transistor Switch.	
8' Trompette (SW)	1 - 32	No		MAIN OSC. Notes: 1 - 44	Swell Unit Reed Loc. 2-I Schematic 12 Level Control: R548 Loc. 1-I	Loc. 3-G Schematic 12 Each stop is keyed through a Diode Gate which is controlled by a Transistor Switch	
4' Clairon (SW)		No					
8' Great to Great	1 - 32					Loc. 3-C Schematic 5 Stop control is by means of the Coupler Sync Gate, Q92 (one per stop).	
4' Great to Pedal							
8' Swell to Pedal							
4' Swell to Pedal							
Stop level controls not individually numbered; located with the associated Transistor Switch and Diode Gate.							
Voicing networks for these stops are located on the Output Preamp Board, Loc. 1-I. A single level control for all of these voices, R794, is also at this location.							
A Signal Keyer level control will affect all voices derived from that keyer. For example, the Great Unit Diapason Signal Keyer is used for stops in both the Great Division and the Pedal Division.							

D. GENERAL STOPS

STOP	KEYS	STOP LEVEL ADJUST	OSCILLATORS	SIGNAL KEYS	DEVICES OPERATED BY STOP TAB
Main Tremulant			TREMULANT OSC.		Loc. 1-D Schematic 7 This stop activates Transistor Switch Q143 which applies a low-frequency tremulant signal to all oscillators except 001-012 Tremulant Level control is R142 Tremulant Frequency control is R138 (affects both AM and FM tremulant).
Flute/Diapason Chorus		Loc. 1-I Swell Flute to Leslie, R625 Swell Diapason to Leslie, R616 Great Flute to Leslie, R425 Great Diapason to Leslie, R415			Loc. 1-I Schematics 19 and 20 This stop activates Transistor Switch Q977 which in turn controls audio transistor switching of the Flute and Diapason voices. These voices are fed into the Leslie channel and the Leslie rotor is switched to slow.
Flute Tremulant Full					Loc. 1-I Schematics 19 and 20 This stop activates Transistor Switch Q971 which overrides the Flute/Diapason Chorus stop. Flute signals are switched out of the main channels and into the Leslie channel. The Leslie Rotor is switched to fast

D. GENERAL STOPS, Cont'd.

STOP	KEYS	STOP LEVEL ADJUST	OSCILLATORS	SIGNAL KEYERS	DEVICES OPERATED BY STOP TAB
Swell Flute Chiff				Swell Unit Flute Loc. 1-G, H, J Schematic 11	Loc. 3-H (3-E in early models) Schematic 11 This stop activates Transistor Switch Q204 which controls the Chiff Diode Gate.
Main Off					These stops activate a Transistor Switch, Loc. 3-A, which is connected to the Echo Control socket located on the Output Panel, Loc. 1-F.
Echo On					
Air Sound Switch (Located under Great Keyboard or on the Setterboard)		Loc. 1-E Two per keyboard, one for Diapasons and one for Flutes			Loc. 1-E Schematic 31 This switch controls the Air Sound generator by grounding the collector of Q283.

TECHNICAL DESCRIPTION

How To Use This Technical Description:

The following technical description explains the basic operation of the circuits in the Cambridge 220-II Organ. Diagrams of all the circuits in this organ are shown in the Schematics Section. Follow the circuits on these diagrams as you read the descriptions. For an explanation of the information to be found on the schematics, refer to the first few pages of the Schematics Section.

This technical description is provided to help you understand how this organ works in order that you might better service it if trouble develops. The location of each circuit in the organ is identified in this description so that it can be quickly located. As a further assist to service, special service notes are included to help identify typical problems which might occur.

If in doubt as to the meaning of any of the terms used to describe the operation of this organ, refer to the General Terminology given in Section 4. Reference information which lists the voices included in this organ, voices selected by special stops such as TUTTI, and similar information is given in Section 6.

Introduction:

Basically, the Model 220-II consists of five unified voices and seven 'straight' voices. All of the voices are signal keyed and distributed in a manner that allows the organ to be grouped by division, both with respect to expression and speaker systems. In addition, there are two sets of unison-tuned oscillators, Main and Ensemble, supplying signal to the voices in a manner that produces maximum ensemble at reasonable cost.

GENERAL

Coupler System/Time Sharing (Schematic No. 5)

There are two types of couplers used in the 220-II. An understanding of these couplers will be helpful in this discussion.

INTRA-MANUAL COUPLERS: The intra-manual couplers provide coupling within a division. For example: If the 8' VIOLA POMPOSA (Swell voice) is turned ON and Key 25 (Middle C) is played, Note 25 is heard. Now if the

4' SWELL TO SWELL coupler is turned ON, you will also hear Note 37 (4' voice one octave higher). If the 4' SWELL TO SWELL coupler is turned OFF and the 16' SWELL TO SWELL coupler is turned ON, you will hear both Note 25 and Note 13 (16' voice one octave lower).

The SWELL UNISON OFF stop is in the 'normally on' condition when not activated. If this stop is activated and both the 4' SWELL TO SWELL and 16' SWELL TO SWELL couplers are OFF (not activated), there will be no sound when any key is played on the Swell keyboard, regardless of what other Swell stops are on. As you can see, the SWELL UNISON OFF stop is only used in conjunction with either the 4' SWELL TO SWELL or 16' SWELL TO SWELL stops to silence the 8' voice.

INTER-MANUAL COUPLERS: The inter-manual couplers provide coupling of voices between the divisions of the organ (e.g., between the Swell and Great Manuals). This allows 8' Swell voices to be played on the Great Manual. For example: If the 8' SWELL TO GREAT coupler is activated or on the Pedal if the 8' SWELL TO PEDAL coupler is on.

TIME SHARING SYSTEM: Key to the operation of the Coupler System used in the 220-II is the time-sharing system. The Keying Block Diagram on Schematics 3 and 4 should be used along with Schematic 5 to understand this system.

When the organ is first turned ON, Clock Start Circuit Q155-Q156 provides a starting voltage to clock multivibrator Q158-Q163-Q181. The clock runs at a 120 kHz rate and its output is shaped and inverted by Q165 and Q167. The clock signal drives a three-stage ring counter. Each stage of this ring counter is referred to as a 'time slot'; one for each of the three divisions of the organ. With each output pulse from the clock, the ring counter shifts from one time slot to the next (NOTE: Only the Swell time-slot circuit is shown in detail; the other two are identical). Output from the Pedal time slot is coupled back to the Swell time slot to form a closed loop.

Since the clock puts out a pulse every 8 microseconds (120 kHz rate), the ring counter shifts between time slots at this rate. Assuming that the Swell time slot is activated, it will deliver an output for 6 microseconds. Then it shuts off and 2 microseconds later, the Great time slot is turned ON for 6 microseconds by the next clock pulse. This sequence repeats for the Pedal time slot, and then is coupled back to the Swell time slot. The waveforms shown on the left side of the Keying Block Diagram (Schematic 3) show the relationship between the time slots.

Referring to the schematic of the Swell time slot, the output from the collector of Q178 is connected to the Swell keys. (See page 88 for transposer information.)

To understand the operation of the couplers, let's follow the action of the Pedal circuit. The output from the Pedal time-slot is connected to the Pedal keyboard, and also to the input of the couplers associated with it (4' GREAT TO PEDAL, 8' GREAT TO PEDAL, 4' SWELL TO PEDAL, and 8' SWELL TO PEDAL). The circuitry shown for the 4' SWELL TO PEDAL coupler is also used for the other couplers. Notice that it is not activated, and therefore does not allow the time-slot signal to pass, unless the stop is on. When the stop is on and a Pedal key is played, the simultaneous application of a Pedal time-slot pulse at the junction of D197-D198 and the base of Q196, activates the Swell voice at the 4' pitch when the Pedal key is played. Action is similar for the other couplers.

The 16' Pedal Coupler Switch (located at top of schematic) is driven directly by the Pedal time-slot signal and the Pedal keying pulse since there are no couplers for this voice.

Output of the couplers from each of the three divisions is connected to a Pulse to DC Converter circuit. The capacitor at the input of this circuit is charged by the time-slot pulses applied to it and holds the associated transistor in conduction. When this pulse is absent, the capacitor discharges to end the keying output voltage.

AUDIO

Oscillators and Tremulant (Schematic No. 7)

The Model 220-II utilizes both LC (inductor-capacitor) and RC (resistor-capacitor) oscillators. The RC oscillators are used for the first two octaves of the Main Oscillators (Notes 001 - 012) and for the Tremulant Oscillators. The LC Oscillators are used for the remaining 182 oscillators in the Main, Ensemble, and Celeste Oscillators.

LC OSCILLATORS: The LC oscillators in this organ are somewhat unique in that the coil does not have a feedback winding. The feedback winding has been replaced by a transistor (Q16) that also acts as an emitter follower to drive the load presented by the signal keyers. The oscillator coil is bobbin wound and housed in a ferrite cup core. Oscillator tuning is controlled by rotating the cap of the cup core.

RC OSCILLATORS - NOTES 001 - 012: The RC Oscillators used for the bottom two octaves of the Main Oscillator are modified three-transistor phase-shift

oscillators incorporating a gain-regulating diode. Tuning for these oscillators is provided by R2 in the first leg of the phase-shift network.

Service Notes: Oscillator problems can be caused by a shorted load, usually a bridge across the circuit runs on the signal-keyer circuit boards. If a shorted load is suspected, disconnect the plastic-insulated signal wire from the oscillator circuit board which is connected to the negative side of C16 on LC Oscillators, and C8 on RC Oscillators. Disconnecting this wire will isolate the suspected short, allowing the oscillator to operate normally.

TREMULANT OSCILLATOR: The tremulant oscillator is a two-transistor phase-shift oscillator. Tuning for this oscillator is provided by R138 in the phase-shift network. The output of this oscillator drives two separate tremulant systems; the F.M. Tremulant and the Swell A.M. Tremulant.

F.M. TREMULANT: When the MAIN TREMULANT stop is OFF, transistor Q143 conducts to shunt the tremulant signal from the F.M. Tremulant circuit. With this stop ON, Q143 is off to allow the tremulant signal to pass to Q145. The amplified tremulant signal is applied to the junction of C10-D10. This signal varies the bias on D10. When it is forward biased, D10 connects C10 in parallel with C11. This changes the operating frequency of the LC Oscillator. As the tremulant signal goes negative, it reverse biases D10 to disconnect C10 from the oscillator circuit. This produces a slight variation in the frequency of each of the LC Oscillators at the rate determined by the Tremulant Oscillator. The F.M. Level Adjust R142 determines the amount that the oscillators will change.

ACTIVITY: Activity is the random variation of frequency and amplitude of the individual LC Oscillators. The amount of activity is determined by the source impedance of the bias network R18 - R19, that supplies the entire set of oscillators. The source impedance of the individual oscillators will vary at the frequency rate of which the oscillator was tuned. Since all of the oscillators are connected to a common bias source with a source impedance of 500 ohms at low frequencies (lower for higher frequencies), the combined load variations of all the oscillators will cause the bias voltage to increase and decrease at a random rate. The amount of activity is controlled by R330 in series with C380 which serves to reduce the source impedance of the bias network. Capacitor C381 serves to remove high frequency variations from the bias bus.

A.M. TREMULANT: The A.M. Tremulant is driven by the same signal as the F.M. Tremulant, but this circuit affects only the Swell voices. Transistor audio switch Q213 turns the circuit on or off as controlled by the SWELL TREMULANT stop. When this circuit is turned ON, Q214 amplifies the tremulant signal to drive the tremulant lamp. This lamp is mounted in a lamp housing with two light-dependent resistors (LDR) located on Schematic 19.

The LDR's are connected in the feedback path of the Swell Unit Reed Preamp and the Swell Unit Flute and Diapason Preamp. The lamp brightness will vary at the rate of the tremulant oscillator frequency thus causing the light dependent resistor (LDR) to vary in resistance. This variation in resistance will change the gain of the preamps to provide A. M. modulation.

Great Unit Diapason Signal Keyer (Schematic 8)

The various pitches of this diapason are keyed by diode gates from the Great division of the organ. The Great Diapason Signal Keyer is one of a group of four signal keyers called the Main Keyers. This signal keyer covers a compass of 85 notes (Notes 1 - 85). Oscillator signal is supplied by the Main Oscillators (Schematic 7). The signal keyer itself is of the single-diode type (D31) featuring a specially designed circuit layout that provides a canceling signal to reduce feed-thru (singing). This canceling signal is collected from a capacitor built into the etched-circuit board and supplied to the Great Unit Diapason Preamp (Output Preamp Board, Loc. 1-I). Feed-Thru adjust R648 can be set for the correct amount of canceling signal. The Diapason signal from the diode keyer is fed to this same preamp along with the output of the Air sound generator (Schematic 31).

The signal keying diodes (D31) are held reverse-biased to insure that they do not conduct until a keying voltage is supplied from the diode gates. This bias is provided by voltage divider R644-R645 on the Output Preamp Board.

Keying for some 4' and 8' Pedal voices is also provided by this signal keyer.

Service Notes: Excessive feed-thru (singing) can be caused by an incorrect setting of the Feed-Thru adjust R648 located on the Output Preamp Board (Loc. 1-I). This control should be set for minimum feed-thru with the Great Expression shoe open (maximum volume) with no keys depressed. Before making this adjustment, it is a good idea to check the oscillator cable on the back side of the Signal Keyer Board. This cable should be dressed away from the circuit board as much as possible.

Great Unit Flute Signal Keyer (Schematic 9).

The Great Unit Flute Signal Keyer covers a compass of 97 notes (Notes 01 - 85). Oscillator signal for Notes (01 - 12) (61 - 85) is supplied by the Main Oscillators (Schematic 7, Loc. 1-A, 1-B, 1-C, 1-D) and Notes 13 - 60 by the Ensemble Oscillators (Schematic 7, Loc. 2-A, 2-B). The signal keyer itself is of the double-diode type (D23-D24). Output from the signal keyer is divided into three ranges by note: Notes 01 - 36, 37 - 57, and 58 - 85. The signal on each of these busses is connected to a low-noise grounded-base summing amplifier located on the Output Preamp Board (Loc. 1-I). The outputs of these three stages are summed together and connected to the three-stage output amplifier.

Swell Unit Diapason Signal Keyer (Schematic 10)

The Swell Unit Diapason Signal Keyer is basically the same as the Great Unit Diapason Signal Keyer. It is of the single-diode type (D31) with a Feed-Thru adjust R344 (Loc. 1-D), to provide minimum feed-thru (singing).

Service Notes: Set Feed-Thru adjust R344 for minimum feed-thru with the Swell expression shoe open (maximum volume) with no keys depressed. Also check the cable dress as described under Great Unit Diapason Signal Keyer.

Swell Unit Flute and Chiff Signal Keyer (Schematic 11)

The Swell Unit Flute Signal Keyer is the fourth of the Main Keyers. The circuit is basically the same as the Great Unit Flute Signal Keyer except that it contains the chiffing system.

The chiff is obtained by simultaneously keying at the fundamental pitch and, momentarily keying a higher pitched note (31 semitones above the fundamental note). In the 220-II, the same Swell Unit Flute Signal Keyer is used for both the Swell flute and chiff voices. The Swell FLUTE CHIFF stop activates the Chiff Control Circuit Q204 (only one circuit). The Flute Chiff adjust R202 determines the amount of chiff signal added to the Swell Unit Flute. Output from the emitter of Q204 is connected to the Chiff Keyer diode gate through a special keying circuit C97 - D97 - D99 - R97 (65 separate circuits). When the FLUTE CHIFF stop is OFF, the cathode of D97 is referenced slightly negative from ground, thus shunting any keying voltage being supplied to the Chiff diode gate. When the FLUTE CHIFF stop is ON, the bus connected to D97 is referenced at the positive potential determined by R202. This level, in turn, determines the amount of chiff keying current that passes through the chiff keying circuit. The chiff keying voltage is applied to the Flute Signal Keyer only momentarily as determined by the charge time of C97.

The output signal from the Flute and Chiff Signal Keyers is divided into three ranges and connected into separate summing preamps. Output amplification is provided by a three-stage output amplifier.

Swell Unit Trompette/Reed Signal Keyer (Schematic 12)

This signal keyer contains formants which provide voicing through adjustable ferrite cup cores. Each of these formants affects a group of notes; usually three, but in some cases, six or twelve. The compass of this signal keyer is 73 notes (Notes 01 - 61). Oscillator signal is supplied by the Main Oscillators (Schematic 7).

Oscillator signal is connected to the base of transistor Q55. This transistor is the signal keying device for this voice and is keyed on when base current is supplied through R51. This allows the oscillator signal to pass to the Trompette voicing circuits. The output of the various voicing formants are connected to common-base amplifier Q545. Output from this circuit is through emitter follower Q547.

Service Notes: Voicing of the Swell Trompette normally varies over the compass of the keyboard. The voicing range of this keyer is very broad to satisfy the wide variation in personal taste associated with this voice of the organ. For this reason, it is advisable that no adjustments be made to the voicing formants (ferrite cup core caps) without proper consultation with the owner of the organ or the organist.

Some seemingly unrelated problems can upset the performance of this keyer. For example, the input amplitude from the oscillators can affect the voicing of this signal keyer.

Since this signal keyer goes only to Note 61, the last 12 notes (keys 50 - 61) for the 4' CLAIRON stop (Swell voice) are obtained by keying the Swell Unit Diapason Signal Keyer.

Celeste Signal Keyer (Schematic 13)

The 220-II has two Celeste stops; 8' VIOLA CELESTE (Swell voice) and 8' FLUTE CELESTE II (Great voice). Oscillator signal for both stops is supplied by the Celeste Oscillator (Schematic 7). Signal keyers for both Celeste stops are located on the Celestes Signal Keyer Board (Loc. 2-J), and have a compass of 49 notes (Notes 13 - 61). They are straight signal keyers which means that they are keyed only at the 8' pitch.

8' VIOLA CELESTE (Swell): This signal keyer is keyed from the Swell keyboard through isolation resistors R80. This signal keyer is of the single-diode variety D81) and contains an etched-circuit capacitor to collect a cancelling signal to reduce feed-thru (singing). Being a straight voice, the output is controlled by Transistor Audio Switch Q528-Q529.

Service Notes: Set the Feed-Thru adjust R529, (Loc. 1-I) for minimum feed-thru with the 8' VIOLA CELESTE stop ON, the Swell expression shoe open (maximum volume), and with no keys depressed.

8' FLUTE CELESTE II (Great): The Roman Numeral II indicates that this stop turns on two voices; the FLUTE CELESTE and the 8' BOURDON. The Bourdon is turned on softer than normal and is called the unison voice. The signal keyer for this voice is of the double-diode variety, and its output is controlled by Transistor Audio Switch Q488-Q489.

Great Krummhorn Signal Keyer (Schematic No. 14)

The Great Krummhorn Signal Keyer is a straight signal keyer which obtains its keying voltage from series isolation resistor R40 located on the Great Diode Gate Board (Loc. 3-D). The compass of this keyer is 61 notes. Oscillator signal for Notes 1 - 12 and 61 is supplied from the Main Oscillator (Schematic 7) and Notes 13 - 60 are supplied by the Ensemble Oscillators (Schematic 7). The double-diode signal keyer D43 - D44 is designed to operate with a high level sine-wave input signal to produce a square-wave signal which is differentiated by the output coupling capacitor C45. Square-wave symmetry is maintained by a special bias circuit located on the Output Preamp Circuit Board (Loc. 1-I). Since the bias voltage is critical to the voicing of the Krummhorn, adjustment R317 is provided. This adjustment should be made by ear as the point of symmetry without the aid of highly sophisticated instruments would be difficult to find. However, it is easy to hear.

The signal from the Krummhorn Signal Keyer is connected through a shielded cable to the Krummhorn Amplifier and voicing circuit on the Output Preamp Board. Voicing is achieved with a group-formant voicing network consisting of L306, L307, C303, C304, C306, and C307. Voicing adjustment is made by rotating the caps on the ferrite cup core. When making this voicing adjustment, be sure to check the entire compass of the keyboard after each adjustment for best results. The Krummhorn Signal Keyer utilizes a transistor audio switch for stop control. Audio switch Q309 - Q310 is located at the output of this voicing circuit. When the 8' KRUMMHORN (Great voice) is OFF, Q309 and Q310 conduct to shunt the Krummhorn signal to ground.

Great Harp/Carillon Signal Keyer (Schematic No. 15)

The Harp/Carillon Signal Keyer (Loc. 2-G) is, in reality, three signal keyers combined into one. The first two signal keyers are of the single-diode variety; one for the Harp (D609) and one for the Carillon (D606). There are two methods of achieving stop control for these voices; one of these is by controlling the above mentioned signal keyers. The second means of stop control is through the transistor audio switches located in the Harp/Carillon Preamp (Schematic 16).

HARP/CARILLON KEYS: The Harp has a compass of 49 notes (Notes 13 - 61) while the Carillon has a compass of only 37 notes (Notes 13 - 49). Oscillator signal for this signal keyer is supplied from the Main Oscillators. (Schematic 7), Notes 13 - 73. Four individual oscillator signals are mixed together for each note of the Carillon. These four signals are connected to the input of the first single-diode keyer (D606) through R602, R603, R604, and R605. The first signal keyer is controlled by the Great CARILLON stop.

The second single-diode keyer (D609) is used for the Harp. It has only one signal connected to it, and is controlled by the Great HARP stop. The output of both the Harp and Carillon single-diode keyers are then fed to the third signal keyer which is of the double-diode variety (D611 - D612). This third signal keyer is keyed through a special keying network that provides the sustain and signal-strike characteristics of the Harp and Carillon voices.

SINGLE-STRIKE/SUSTAIN KEYER: Keying voltage is connected to isolation diode D615 in the single-strike portion of the circuit. (NOTE: There are two similar keyers with identical numbers shown on this schematic.) As the key is depressed, single-strike capacitor C616 begins to charge. Charging current for this capacitor is through the third signal keyer, D611 - D612, and the sustain capacitor C619. During this charging cycle, the third signal keyer turns ON and allows signal to pass until single-strike capacitor C616 is completely charged; then the signal keyer turns OFF to end the note. C616 stays charged as long as the key is held depressed; it begins to discharge through R616 and R617 when the key is released. Diode D619 isolates the now present charge on sustain capacitor C619, thus allowing the sustain capacitor to discharge into the signal keyer D611 - D612 and through the sustain-length circuitry R620 - D620. The negative voltage present at the emitter of Q660 determines how fast the sustain capacitor discharges, thus controlling the length of the sustain. A Sustain Length control is provided for both the Harp (R644) and the Carillon (R640) and are activated by the respective stop controls. Q633 serves to immediately discharge the sustain capacitors when both the HARP and CARILLON stops are OFF.

Harp/Carillon Preamp (Schematic 16)

The Harp/Carillon signal from the Harp/Carillon Signal Keyer is connected to the Harp/Carillon Preamp through grounded-base amplifier Q626. This signal is amplified by Q1 - Q2 - Q3 and connected to separate outputs for the Harp and Carillon. Transistors Q673 and Q678 provide stop control for the Harp and Carillon respectively.

Pedal Signal Keyer (Schematic 17)

Signal keying for the 16' and 32' Pedal voices is provided by the Pedal Signal Keyer (Loc. 1-K, 1-L). Oscillator signal for these keyers is obtained from the Main Oscillators, Notes 001 - 20 (Schematic 7). Keying voltage is applied

to these signal keyers through resistors R670, R680, and R690 located on the Pedal Diode Gate Board whenever a Pedal key is depressed. The 16' Pedal Flute Signal Keyer, D673 - D674 is of the double-diode type and provides the signal for the 16' BOURDON and 16' LIEBLICH GEDECKT voices. Pre-amplification is provided for this signal by a three stage preamp consisting of Q717, Q718, and Q818.

The 16' Pedal Pulse Signal Keyer provides the signal for the 16' PRINCIPAL, 16' VIOLONE, and 16' BOMBARDE voices. Double-diode keyer D683 - D684 provides signal to three-stage preamp Q717, Q718, and Q719.

The 32' Pedal Diapason Signal Keyer provides signal for the 32' CONTRA VIOLONE voice. D694 is the signal keying diode for this circuit.

Pedal Voicing (Schematic 18)

Signal from the three Pedal Signal Keyers is amplified by three separate preamps (Loc. 1-I), and then fed into the appropriate voicing circuits. Notice that the 16' BOMBARDE includes formants for voicing. Output of the voicing circuits are controlled by transistor audio switching circuits which, in turn, are controlled by the Pedal stops. The audio switching circuit for each Pedal voice contains a level control. The voices are then mixed together and terminated in a master level control, R794, located on the Output Preamps Board (Schematic 20, Loc. 1-I).

Output Preamps (Schematics 19 and 20)

The Output Preamps circuit contains the majority of the summing, mixing, expression, A.M. Tremulant, and final output mixing preamps. This board is located on the outermost rack (Loc. 1-I), and contains most of the voice-leveling adjustments. For a better understanding of what is located on this board, refer to the 220-II Signal Block Diagram, Schematic 6.

Following is a brief description of the various circuits found on this circuit board. Since many of these circuits are duplicated for the various voices, they will be covered in a generalized manner.

PREAMPS: The 220-II has six separate preamp channels located on the Output Preamp Board. The input signal to each preamp is applied through a level control which can be set for proper balance of the organ voices. The output of each channel is connected to an output socket. This allows use of a separate speaker for each channel. The mixing switches allow the channels to be mixed to a minimum of two speakers. The mixing switches mix the outputs as follows:

Mixing Switch No. 1 - Mixes Swell Unit Flute and Unit Diapason with the Swell Unit Reeds and Viola Celeste. Output is through the Swell Unit REEDS-CELESTE socket.

Mixing Switch No. 2 - Mixes Great Unit Diapason, Flute Celeste, Carillon, and Harp with the Great Unit Flute and Krummhorn. Output is through the FLUTE-KRUMMHORN socket.

Mixing Switch No. 3 - Mixes Pedal with the Great Unit Flute and Krummhorn. Output is through the Great Unit FLUTE-KRUMMHORN socket.

Service Note: If a voice is missing from the output, check the setting of the associated level control. Also, check that the mixing switch associated with this channel is in the correct position.

If this organ is equipped with the optional Echo speakers, the wrong combination of the MAIN OFF and ECHO ON stops can remove one or all of the voices from the output, depending on the type of Echo adapter used. When the MAIN OFF stop is pressed down, the main speakers associated with the channel or channels connected to the Echo adapter will be disconnected. If the ECHO ON stop is not turned on, this channel or channels will not be heard.

EXPRESSION: There are a total of seven expression circuits in the Model 220-II, all of which operate on the same principle. For our explanation, we will use the Swell Unit Reed and Viola Celeste Expression circuit (Schematic 19). Transistor Q565, LDR 560 (Light Dependent Resistor), R560 through R565, and C561 - C564 - C565 make up the expression circuit. This is a passive expression circuit with the exception of emitter follower Q565 which has a high input impedance and a low output impedance with a voltage gain of almost one. LDR 560 and R563 form a voltage divider. Since the resistance of LDR 560 varies according to the amount of light falling on it from the expression lamp the output signal level can be controlled by changing the voltage across the expression lamp. R561, R562, and C561 form a low-frequency bypass. This causes the circuit to express the upper frequencies more than the lower ones, thus compensating for the Fletcher-Munsen effect and giving expression control more like a pipe organ.

There are two separate expression shoes (pedals) and associated lamp circuits. The lamp associated with the Swell expression shoe is mounted in a lamp housing with LDR 373, LDR 560, and LDR 633 which provide expression for the Swell Unit Flute and Unit Diapason, Swell Unit Reeds and Viola Celeste, and Swell Unit Flute and Diapason (Leslie), respectively. The lamp associated with the Great expression shoe is mounted in a lamp housing with LDR 283, LDR 433,

LDR 673, and LDR 813 which provide expression for the Great Unit Flute and Krummhorn, Great Unit Flute and Diapason (Leslie), Great Unit Diapason-Flute Celeste-Carillon-Harp, and Pedal, respectively.

Service Note: To mechanically adjust the expression potentiometers (located behind the expression shoe), connect a voltmeter between the arm of the potentiometer and the -12 volt power supply. Loosen the nut securing the potentiometer with a thin 1/2 inch open-end wrench. With the expression shoe open (pressed down), adjust the rotation of the potentiometer for 25 volts, and retighten the nut to secure the pot. The fixed 22K resistor, connected between the arm of the pot and +25 volts, is used to set the minimum volume level. If a greater or lesser expression range is desired, this resistor can be changed after the above adjustment has been made. If this resistor is changed, recheck for +25 volts across the expression lamp.

SWELL A. M. TREMULANT: There are two preamps with tremulant control located on the Output Preamp board. These preamps are the Swell Unit Reed and Viola Celeste and the Swell Unit Flute and Unit Diapason. Only the Swell Unit Reed and Viola Celeste circuitry will be described since the two are similar.

Three-stage preamp Q1 - Q2 - Q3 provides mixing and tremulant for the Swell Unit Reed and Viola Celeste. LDR 594, R558, R593, R594, and C593 make up the feedback network for this preamplifier. When the resistance of LDR 594 is minimum (light on), it shunts part of the feedback signal to ground, thereby increasing the gain of the amplifier. The tremulant lamp is located in a single lamp housing with LDR 594 and LDR 366 in the Swell Unit Flute and Unit Diapason preamp. Power for the lamp is obtained from the Tremulant Oscillator (see Schematic 7). When the Swell TREMULANT stop is on, the power to the lamp varies at the rate of the Tremulant Oscillator, producing a slow, undulating sound.

LESLIE SWITCHING: Two stop controls are used to control the Leslie. These stop controls are the FLUTE TREMULANT FULL and the FLUTE/DIAPASON CHORUS. With a Leslie Speaker connected to the Output Panel of the model 220-II, and all stops turned off, there will be no signal to the Leslie Speaker. However, the motor-driven rotor runs at low speed.

Signal from the following signal keyers can be channeled into the Leslie Speaker. The associated level control (Loc. 1-I), is also listed.

Swell Unit Flute	R625
Swell Unit Diapason	R615
Great Unit Flute	R425
Great Unit Diapason	R415

The Leslie Switch Control circuit, consisting of Q971 and Q977 (see Schematic 20) control the transistor audio switches that handle the signal switching functions for the Leslie. When the FLUTE TREMULANT FULL stop control is activated, the following sequence takes place:

Transistor Switch Q971 of the Leslie Switch Control conducts thus grounding the cathode end of diodes D970, D982, and D972 thru D975. These diodes control the transistor audio switches used for the signal switching functions of the Leslie. D974 will now cause Q914 to conduct and shunt the Swell Unit Flute signal to ground, turning off the Swell Unit Flute's main speaker. In the same manner, D973 will cause Q266 to conduct and shunt the Great Unit Flute signal to ground. At the same time D972 and D975 will cause Q624 and Q424 of the Swell Unit Flute To Leslie and Great Unit Flute To Leslie to turn off and allow signal to pass through to the Leslie amplifier. Simultaneously, the Leslie rotor speed is switched into high speed by reed relay K1 located on the back of the Speaker Output Panel (Loc. 1-F). This relay is normally operating in the energized mode. When the FLUTE TREMULANT FULL stop is activated, transistor Q971 and D970 shunt current away from this relay. This causes K1 to become de-energized to switch the Leslie rotor to high speed. Diode D982, also connected to the collector of Q971 serves as an override for the FLUTE/DIAPASON CHORUS stop control. If both the FLUTE TREMULANT FULL and FLUTE/DIAPASON CHORUS stops are turned on at the same time, the FLUTE TREMULANT FULL stop overrides the FLUTE DIAPASON CHORUS, preventing it from operating.

When the FLUTE/DIAPASON CHORUS stop control is turned on (FLUTE TREMULANT FULL stop off), the following sequence takes place: Transistor Q977 of the Leslie Switch Control conducts, turning transistors Q614, Q414, Q624, and Q424 off through diodes D981, D980, D979, and D986, respectively. This allows the Swell and Great Unit Flute as well as the Swell and Great Unit Diapason signal to pass to the Leslie preamps. Relay K1 remains energized so the Leslie rotor remains at low speed. When this stop is on, output is heard through both the main and Leslie speakers.

Each Leslie channel has its own level control. These are used to balance the voices through the Leslie channels, or to exclude selected voices according to personal taste.

Service Notes: If the Leslie level controls R415, R425, R615, and R625 are turned down, the respective voices will not appear in the Leslie speaker.

117 volts AC is connected to the Leslie socket located on the Output Panel. This voltage is supplied to the Leslie socket through a zip cord connected to the power supply with a standard plug. This plug must be in the switched receptacle for proper operation.

COMBONS

Tutti (Schematic 21)

The TUTTI piston turns on predetermined stops for a full organ sound (refer to Section 6 for a list of stops added by TUTTI). This circuit can be actuated by either the TUTTI piston or the TUTTI toe stud.

Pressing the piston or the toe stud applies -12 volts to the input of Schmitt circuit Q109, Q112 through R108, R109. This triggers the Schmitt circuit and it produced a sharp output pulse which is applied to bistable multivibrator Q102, Q106. Q106 is switched "off" and Q102, Q107, Q131, Q132 are all switched "on" activating those stops associated with the Tutti circuit, and the Tutti indicator lamp.

The pulsing circuit, R101 insures that Q106 always comes on first when the organ is first turned ON. This inhibits the turning on of Q102 and prevents the Tutti from operating until a piston or toe stud is depressed.

Preset Combination Action (Schematic 22)

The Preset Combination Action provides pistons located beneath the Swell manual to allow selection of one of five voice combinations which have been wired into the organ at the factory. In addition to the five buttons which select the preset combination, a Stop Rail piston is provided to return stop selection control to the stop board.

All of the pistons are of the double-touch variety. Each piston actuates two switch contacts (see left side of Schematic 22). When the piston is pressed lightly, the first contact closes and the voice combinations wired to this piston are added to whatever stops have already been selected. Pressing the piston further actuates the second set of contacts to cancel all stops except those which are selected by this piston.

When the organ is first turned on, SCR Q406 is biased into conduction by R405, R408. Capacitor C406 will charge through R407 and the gate circuit of SCR Q400. Q400 will now conduct and supply power to the Stop Rail bus (labeled SR on the schematic), and Stop Rail indicator lamp. The purpose for this is to insure that the Stop Rail will override the Presets when the organ is first turned on. The Stop Rail bus is connected through the isolation diodes to the stop control switches of each division of the organ.

If the organist wishes to add the stop combination provided by Piston #1 to stops already selected on the stopboard, he can press this piston to the first-touch position. This closes the first set of contacts and applies +12 volts to the gate of SCR Q410 through R411, turning it on. The current through Q410

turns on the #1 lamp and applies power to the #1 bus (any other lights and busses previously activated remain so). All diodes whose anodes are connected to this bus are forward biased, activating the associated stop (notice that these diodes by-pass the switches).

To cancel the previously selected stops, Piston #1 is pressed to the second-touch position. This connects +12 volts through diodes D401, D421, D431, D441, and D451 to the junctions of C404 - R404, C424 - R424, C434 - R434, and C454 - R454, respectively. The +12 volts is coupled through the two series capacitors, momentarily raising the cathode potential of the associated SCRs (all except Q410). If any of these SCRs are conducting, they are turned off disconnecting any stops which they control.

Setterboard Combination Action Option (Schematic 23)

The Setterboard Combination Action allows the organist to call up preselected voice combinations by pressing any one of 12 pistons or four toe studs. The voice combinations are selected by slide switches located on the setterboard which is mounted in a drawer beneath the Great manual.

Schematic 23 shows part of the setterboard circuit which controls the Swell voices. Note that there are four Swell pistons, four Master pistons, and four Master toe studs. Not shown are the four Great/Pedal pistons. Pressing Swell piston #1 (or the Master #1 piston or toe stud) grounds the base of transistor Q1, causing it to conduct. The emitter of Q1 is near ground potential causing current to flow through each of the isolation diodes connected to the slide switches, and finally through the 'on' or 'off' stop-actuating coil, depending on the position of the switch. The stop control now moves to the position selected by the slide switch. The Master piston or toe stud operates in a similar way with the exception that it will also actuate all of the same numbered divisions on the organ.

The General cancel piston connects ground to all 'off' coils of the Swell and Great/Pedal stops. This moves all stop tabs to the off positions.

Capture Combination Action Option (Schematics 24 and 25)

NOTE: The Capture Combination Action is a relatively complex circuit. We will only examine this circuit in brief detail.

The Capture Combination Action is an extremely versatile and reliable system for programming the organ stops for later recall. This system permits the organist to program the combinations from the keyboard. Four independent pistons are provided for each of the three divisions. Each of these pistons can be individually programmed for any combination of stops from the applicable division. There are also six General pistons which can be individually programmed to simultaneously call up combinations from all of the manuals by pressing a single piston.

Key component in the operation of this circuit is the ferrite magnetic core. Separate ferrite cores are provided for each stop in a division. These cores are connected together into a matrix associated with the individual combination action pistons. The six matrixes for the General pistons include a core for each stop on the organ.

The cores store information by the direction of their magnetization. For purposes of this explanation, we'll refer to the direction of magnetization that turns the stops off as the 'O' or 'off' state, and that which turns the stops on as the 'I' or 'on' state.

CALLING UP PREVIOUSLY MEMORIZED COMBINATIONS: Assume that a combination of stops has been previously stored for one of the computer capture combination action pistons. When this piston is pressed again (labeled SETTABLE PISTON on Schematic 24), the Piston Pulse generator Q1 - Q2 switches and produces an output pulse on the 'READ' pulse line. This pulse is connected to the base of Q29 (Schematic 25) and the amplified pulse at its collector is connected through all of the ferrite cores, labeled T1, associated with this piston.

The SCR Power Gate circuit (Schematic 24) is also activated through D2. This circuit applies power to the SCR Digit Sense and Digit Sense Inhibit circuits (Schematic 25).

If an 'on' or 'I' condition was stored in one of the cores, the read pulse causes the core to switch to the 'O' state. This change in magnetism induces a pulse into the 'digit' line which also runs through the core (there is a separate 'digit' line and SCR Digit Sense circuit for each stop, resulting in individual control for each stop). This pulse is amplified by Q18 and applied to the gate of SCR Q19. Q19 is triggered on to conduct through the 'on' coil associated with this stop, moving the stop to the on position. Triggering of the 'off' SCR Q25 is prevented by D24.

If the core had a 'O' or off condition stored, there is no reversal of magnetic field in T1, and therefore no pulse is produced on the 'digit' line. As a result, Q19 remains off and no current flows through the 'on' coil.

The Cancel Pulse Generator (Schematic 24) is also triggered when the SETTABLE PISTON is pressed. The timing in this circuit produces a cancel output pulse a few milliseconds after the 'on' coil has been energized. This pulse is amplified by the Cancel Pulse Amplifier on Schematic 25 and is applied to SCR Q25 through R42. This turns on all of the SCRs labeled Q25 associated with each piston unless Q19 has previously been turned on (then Q25 is held off through D24). When SCR Q25 turns on, it conducts through the 'off' coil, turning off all stops except those previously turned on.

The Cancel Pulse also triggers Q301 in the Digit Sense Inhibit circuit. This turns off Q18 through Q305 - Q308 to prevent a stray electrical noise from accidentally triggering SCR Q19.

Another circuit activated by the Cancel Pulse Generator is the Piston Disconnect circuit (Schematic 24). A few milliseconds after the Cancel Pulse causes power to be applied to the 'off' coils, the Piston Disconnect circuit switches its output level to disconnect ground from all SETTABLE PISTONS. This disables the pistons so that a second piston cannot be accidentally pressed, causing incorrect recall of the combinations.

When this sequence of events is complete, the SCR Power Gate circuit shuts off to disconnect power from the SCR Digit Sense circuit, thereby removing power from the 'ON' and 'OFF' coils. The Piston Pulse Generator also reverts to its original state, producing a write output pulse. This pulse is connected to the base of Q10 (Schematic 25) which results in a 'WRITE' pulse through all cores associated with that piston. However, this pulse alone is not sufficient to change the direction of magnetism of T1.

The 'WRITE' pulse is also connected to the Digit Driver circuit Q14 - Q17 through D12. The output of the Digit Driver is fed through each of the cores associated with this piston. If the stop associated with a particular core is in the ON position, a switch connected to the stop (junction of D101 - D102) completes the circuit so current flows through the core from the Digit Driver circuit. This current adds to the 'WRITE' pulse from Q10 to switch the core and store a '1'. If the stop is in the OFF position, the circuit is not complete and the core is not switched so a '0' is stored in the core. Thus, the piston is reprogrammed so the cores are magnetized as they were before the piston was pressed.

After this final step in the cycle is complete, all circuits return to their quiescent or resting state. However, if the SETTABLE PISTON is still held depressed, the cycle begins again. The total amount of time required for each complete cycle is less than half a second.

STORING A NEW COMBINATION: To store a new combination, first the desired stops are set up manually. Then, the 'SET' piston is pressed and held. This disables the SCR Power Gate circuit, which in turn prevents the SCR Digit Sense circuits from operating. Next, the desired 'SETTABLE PISTON' is pressed and the 'READ' pulse produced by the Piston Pulse Generator switches all cores to the '0' condition. However, since the SCR Digit Sense circuits are disabled, neither the 'ON' or 'OFF' coils are activated as a result of this readout of the cores. The cycle continues as described previously until the 'WRITE' pulse is produced at the end of the cycle. Then, the pulse stores a '1' in the cores associated with the stops that are in the 'ON' position.

CANCELLING ALL STOPS: When the cancel piston (labeled 'O') is pressed, the Cancel Pulse Generator and the SCR Power Gate are both activated. Since the Piston Pulse Generator is not activated, the cores are not read out and none of the SCRs Q19 can be triggered. Therefore, the cancel pulse triggers all of the 'off' SCRs, Q25. The 'OFF' coils are activated, moving all stops to the 'OFF' position. The stored programs are not destroyed since the magnetism of the cores has not been disturbed by the cancel sequence.

CAPTURE SYSTEM POWER SUPPLY: The Capture System Power Supply provides a voltage output which varies inversely with temperature to match the current requirements of the core circuitry. The power supply maintains a regulated output at the temperature-compensated output voltage level.

Service Notes: To check or adjust the output level of this supply, first check the ambient temperature of the room where the organ is installed. Then, find the output voltage for this temperature from the Voltage/Temperature Chart. Connect a voltmeter to the -10 volt bus and adjust R257 for the correct output voltage.

Lighted Capture System Option (Schematic 26)

While the Lighted Capture System is much the same as the Computer Capture Combination Action just described, it differs in that it is a totally electronic system. As a result, much of the circuitry differs. However, it may be easier to understand this circuit if you first read the description for the Capture Combination Action.

CALLING UP PREVIOUSLY MEMORIZED COMBINATIONS: Again, assume that a combination of stops has been stored for one of the combination action pistons. When this piston is pressed (labeled SETTABLE PISTON on schematic) SCR Q115 turns on and supplies power to the Off Pulse Generator circuit through D2. C151 in the Off Pulse Generator circuit begins to charge and Q154 conducts to turn off Darlington-pair transistors Q157 - Q158. These transistors normally supply power to the Sense Enable and the Stop Sense circuits. With this power interrupted, any stops that are on are turned off. When C151 reaches full charge, Q154 shuts off to allow power to again be applied to the Sense Enable and Stop Sense circuit. However, the stops remain off.

At the same time, power is applied to charge C4 through R2 - D4. When C4 charges enough to switch Q1 on, Q2 is switched off. This results in two actions. First, the negative-going level at the collector of Q1 is connected to Q221 in the Piston Disconnect circuit.

This transistor conducts and C4 in its collector circuit begins to charge. Secondly, the switching action of Q1 is also connected to the base of Q111 located in the Piston Pulse Generator circuit) through R1 - C104. Q111

amplifies the pulse at its base and the signal at its collector is coupled to the base of Q29 in the Read Driver circuit. Q29 further amplifies the pulse to a level sufficient to switch the memory core.

If a '1' was stored in this core, the pulse causes it to switch to the '0' state. This change in magnetism generates a pulse which is picked up by the digit sense line running through the core which is connected to Q18 in the Stop Sense circuit. The amplified signal at the collector of Q18 is applied to the gate of SCR Q19, causing it to switch on. As a result, current flows through lamp L19 causing it to light to indicate that the stop is on. Q25 also turns on to forward bias D25 and D26. D26 activates the stop associated with this circuit. D25 will be used later in this cycle to restore the memory cores to their original state.

During this action, C4 in the Piston Disconnect circuit has been charging until it reaches the level where Q1 conducts. Schmitt trigger Q1 - Q2 switches, turning off Q225 - Q226. This disconnects power from all of the SETTABLE PISTONS and from all SCRs Q115, preventing another piston from being pressed until this cycle is complete. This action also starts the last sequence of events.

When Q115 switches off, Q306 in the Sense Enable circuit is switched off through D2. It in turn shuts off Q308 to disable Q18 in all Stop Sense circuits. This prevents these amplifiers from picking up a stray noise pulse and accidentally turning on a stop circuit.

C4 in the Piston Pulse Generator also began to discharge when Q115 switched off. When it discharges to the triggering level of Schmitt trigger Q1 - Q2, transistor Q1 switches off and Q2 switches on. The level at the collector of Q2 is coupled to Q112 through C110, turning it on momentarily. The pulse at the collector of Q112 is connected to both the Write Driver Q10 and the Digit/Stop Driver Q14 - Q17. Write Driver Q10 conducts causing current to flow through the magnetic core. However, this current does not have enough amplitude to cause the core to switch states. Notice the current path for the collector of Q14 - Q17; through R21, the wire through the magnetic core, and through D25 to the collector of Q25. You will recall that D25 was forward biased by Q25 in those circuits where a '1' has been stored. Therefore, only these circuits allow current to flow from the Digit/Stop Driver. This current through the core adds to the current from the Write Driver, causing the core to store a '1'. If D25 were reverse biased because the stop was originally off, no current can flow through the Digit/Stop Driver circuit and the core is not switched so a '0' is stored in the core. Thus the SETTABLE PISTON is re-programmed so the cores are magnetized as they were before the piston was pressed.

This completes the cycle and all circuits return to their quiescent condition unless the SETTABLE PISTON is still held depressed. Then, the cycle begins again.

STORING A NEW COMBINATION: To store a new combination, the desired stops are first set up manually. Then, the SET piston is pressed. This prevents the previously described operation of the Off Pulse Generator and also turns off Q308 to disable Q18 and 'lock in' the selected combination. Next, the SETTABLE PISTON is pressed and the sequence of events described previously occurs with the exception that SCRs Q19 in the Stop Sense circuit cannot be turned off because they are 'locked in'. The cycle continues, storing the new combination in the memory core.

CANCELLING ALL STOPS: The GENERAL CANCEL piston (labeled 'O') applies a positive voltage to the Off Pulse Generator. This circuit is activated to reset all SCRs Q19 in the Stop Sense circuit, cancelling all stops. Since none of the other circuits are activated, the cores are not read out and no new combinations are called up. The stored programs are not destroyed since the magnetism of the cores is not disturbed.

CAPTURE SYSTEM POWER SUPPLY: This circuit operates the same as described for the standard Computer Capture Combination Action. Refer to the previous description.

VARIABLE LAMP BRIGHTNESS: Transistors Q40 - Q41 - Q42 along with variable resistor R41 provide a variable lamp brightness for all of the stops on the stopboard. R41 is adjustable by means of a knob on the stopboard.

Great to Pedal Reversible Option (Schematic 27)

The GT. TO PED. piston or toe stud reverses the setting of the 8' GREAT TO PEDAL coupler, either turning it on or off, depending on its previous position. There are three versions of the reversible available for the Model 220-II; reversible for organs with setterboard combination action, reversible for organs with a capture combination action, and reversible for lighted drawknob models.

Referring to the schematic for the setterboard reversible (Schematic 27), pressing the GT. TO PED. piston or toe stud applies ground to SCR control circuits Q1 and Q7. Only one of these SCRs will conduct as determined by the position of the 8' GREAT TO PEDAL coupler stop switch S1. For example, if S1 is in the 'on' position, Q1 will be triggered and conduct through the off coil. This current through K1 switches S1 to the 'off' position. The switching signal at the collector of Q1 is also connected to the off coils associated with the 4' GREAT TO PEDAL coupler, switching this coupler to the 'off' position.

When the GT. TO PED. piston or toe stud is pressed again, Q7 will be triggered. Now, current will flow through the on coil to switch the 8' GREAT TO PEDAL coupler tab to the 'on' position. Notice that there is no turn-on signal to the 4' coupler.

For organs equipped with capture, the general operation of the Great to Pedal Reversible is the same as just described. The only difference is the addition of D8 and D13 in the 'on' side of the coupler tab switch S1. This signal is connected to the Computer Capture Combination Action circuit (Schematic 25).

Lighted Reversible (Schematic 28)

When the Lighted Capture System option is added this circuit is used to provide the Great to Pedal Reversible action. Note that the circuitry shown inside the dotted lines is part of the Lighted Capture System (see Schematic 26). Assume that the 8' GREAT TO PEDAL stop is in the off position and the GT. TO PED. piston or toe stud is pressed. Q9 turns on and triggers SCR Q19 through R9 - R20 and turns Q4 off through D9. Q19 conducts through Q23 and lamp L20 lights. The stop can also be turned on or off by actuating it on the stopboard.

Pressing the GT. TO PED. piston or toe stud again results in a low level at the collector of Q3. This turns off Q4, which in turn shuts off Q9 through D4. At the same time, Q23 is turned off through D6 which also turns off SCR Q19. A low level is also connected to the 4' GREAT TO PEDAL stop circuits turning them off. Notice that there is a turn off signal for this latter stop, but no turn on.

POWER SUPPLIES AND AIR SOUND

Power Supply (Schematics 29 and 30)

Two types of power supplies are used in the Model 220-II organ. The Type VII Power Supply (Schematic 29) is used for the models with Preset pistons. All other models use the Type VIII Power Supply (Schematic 30). These two supplies differ only in that the Type VIII supply provides more current for the +15 volt supply.

The power supplies provide five DC voltages and two AC voltages. The +12 and -12 volt supplies are electronically regulated to provide stable output voltages. The +12 Adjust R8 sets this supply for accurate output.

Service Notes: If there is no power output from the supply, first check line fuse F3 and for presence of power at the input; then check for output from transformer T1.

If there is no power output from an individual supply, check fuse F1 for the +12 and +25 volt supply or fuse F2 for the -12 and -25 volt supply.

If the output of an individual supply is incorrect, first check the output of the +12 volt supply and Adjust R8 for the correct output (the +12 supply provides the reference voltage for the -12 supply). If this does not correct the problem, disconnect the load from that supply to isolate the problem to the supply itself or to the load circuits.

To adjust the output level of this supply, connect a voltmeter to the +12 volt bus and Adjust R8 for +12 volt output.

Air Sound (Schematic 31)

The Air Sound circuit consists of an air sound generator, six stop-sensing circuits, and six air sound gates. This circuit provides the characteristic 'breathy' component of a pipe-organ sound. With the 220-II, this sound may be switched in or out as desired by the organist.

AIR SOUND GENERATOR: Air Sound signal is produced by the reverse-biased base-emitter junction of transistor Q280. The 'white noise' generated by this transistor is amplified by two-stage preamp Q283 - Q285 to provide air sound for all manuals of the organ. The AIR SOUND switch, located beneath the Great manual (or on the setterboard), grounds the base of Q285 to prevent output in the off position, or allow signal to pass when on.

STOP SENSING: A Stop Sensing Circuit is provided for the Flutes and Diapasons of each manual and the pedal (total of six circuits). Transistor Q996 acts as an audio switch to control the output from this circuit. This audio switch is, in turn, controlled by actuation of an associated stop (either Flute or Diapason). As stops are turned on, Q984 will be progressively turned off, thus allowing more air sound signal to pass to the output when a key on this manual is played.

AIR SOUND GATES: Keying voltage from each key of the two keyboards and the pedal is connected to the air sound gates. There are two air sound gates for each manual and the pedal. When a key is depressed and a Diapason or Flute stop of this manual is on, the air sound signal is allowed to pass through Q995 and Q996. If a tremulant stop has been actuated, the air sound signal will be amplitude modulated by D989 - D990. Amplitude of the output signal can be set by Air Level Adjust R997. Output signal from the arm of R997 is connected to the respective Main Signal Keyers (Schematics 8, 9, 10, and 11).

ACCESSORIES

EN-II Practice Panel Option (Schematic 32)

The EN-II Practice Panel is an audio control circuit which allows the organist to control the output sound for silent practice with earphones or to add reverberation for a fuller sound. The practice panel also includes input and output jacks for use with a tape recorder.

The signals at the output of the organ are routed through this circuit. Separate two-stage channel preamps for each signal provide input signal mixing and output division to drive the various outputs.

REVERBERATION: Signal for the Reverberation circuit is obtained from each channel through resistors R59, R69, R79, and R89 and is summed at the base of Q13. This five-stage amplifier provides the signal to drive the mechanical delay mechanism. The delayed output is amplified by Q34, Q37, Q39, and Q42, and is connected back into the two-stage preamps through REVERB control R44 and resistors R61, R71, R81, and R91. Notice that the amount of delay through the Reverberation circuit is fixed and that the REVERB control only varies the amplitude of this output signal. The sound mixed back into each channel is not divided by voice; therefore, all divisions of the organ will be heard in each speaker when the reverberation is on. Reverberation can be shut off by turning the REVERB control fully counterclockwise. The main use for the REVERB control is to give a fuller organ sound in a small room which lacks the normal acoustical reverberation, and to add reverberation to recordings made from the practice panel, or to provide more realistic sound when using headphones.

TAPE INPUT AND OUTPUT: Signal at the outputs of the two-stage channel preamps is summed together through R58 and R68 for the Right tape output and R78, R88 for the Left output. Each channel contains a level adjustment to balance the output from all of the channels. The TAPE LEVEL knob also serves as a tape function switch. When pulled out, S1 turns on Q122 to apply power to Q4 and Q9. At the same time, the tape playback circuit, Q51 and Q57, is disabled through D127.

For tape playback, push the TAPE LEVEL knob in. This disconnects power from Q4 and Q9 to disable the tape output circuits, and activate Q51 and Q57. Playback level is determined by the TAPE LEVEL control. Signal from the tape inputs is connected to the channel amplifiers through R64, R74, R84, and R94. This allows the tape recorder to be played back through the speakers of the organ.

HEADPHONES: The same signal that is connected to the tape output circuit is connected to the headphone amplifiers, only through isolation resistors R66A, R76A, R86A, and R96A. The Level adjustments R66, R76, R86, and R96 can be set for the desired sound level to the headphones and to balance the sound from all four channels.

SPEAKERS ON-OFF: The REVERB control also serves as a speaker control switch. When this knob is pulled out, S2 is closed to shunt the actuating current away from relays K1 through K4. This will de-energize the relays and cause the contacts to open thus turning the main organ speakers off. When the knob is pushed in, the switch S2 will open causing the relays to be energized and the relay contacts to close allowing signal to pass to the main speakers. Signal to the tape output and headphones will not be affected by this switching.

Echo Adapter Option (Schematics 33 and 34)

Echo speakers can be added to any of the speaker output channels. Stop switches to control the echo and main speakers are provided on the stopboard of the organ. Two versions of the Echo adapter are available. They differ in the number of echo output channels provided.

EC IIB Echo Adapter (Schematic 33)

This adapter provides output for a single echo channel from any one of the Main output channels. Several adapters can be used together to provide additional echo channels. Signal from the organ output socket is connected to the MAIN and ECHO output sockets through a light dependent resistor (LDR). These LDRs are mounted adjacent to lamps which are controlled from the stopboard of the organ through the ECHO CONTROL socket on the organ. When the MAIN OFF and ECHO ON stops are off, the lamp associated with the LDR3 is on while the lamp associated with LDR4 is off. As a result, the resistance of LDR3 is minimum to allow the signal to pass to the MAIN output socket. At the same time, the resistance of LDR4 is maximum to block signal from the ECHO output.

Actuating the ECHO ON stop connects voltage to the lamp adjacent to LDR4, and the resistance of the LDR drops to minimum to allow signal to pass to the ECHO socket. Since the voltage to the Main lamp has not changed, signal is also heard through the Main speakers.

When the MAIN OFF stop is actuated, voltage is shunted from the Main lamp and resistance of LDR3 goes to maximum. This blocks the signal to the Main speakers.

Service Note: The the MAIN OFF stop is actuated but the ECHO ON stop is left off, the channel which is connected to the Echo speaker will be missing from the output signal. Therefore, if all channels are routed through the Echo Adapter, there will be no output from the organ under this condition.

EC VI Multichannel Echo Adapter (Schematic 34)

This Echo Adapter can be used to provide signal from all five main output channels to the echo speakers. Separate level controls are provided to set the amount of echo signal from each channel. The echo signal is amplified by preamp Q1, Q2, Q3 and connected to two output connectors. Notice that the output to the Echo speakers is not divided by voice.

Basic operation of this circuit is the same as described for the EC IIB. The Echo channel is controlled by LDR1 and the Main channel by LDR2 through LDR5.

Transposer (Schematic 35)

The transposer consists of nine control circuits and a diode gate matrix to transpose the keyboard output up to four semitones flat or four semitones sharp. Only five of these control circuits are shown on the schematic.

The nine circuits controlled by the transposer pistons are connected so only one of the circuits is activated at a time. For example, if the 'O' piston is pressed to provide normal pitch, ground is connected to the 'O' bus. This activates the transistor in all transposer control circuits except Q53; in this circuit the ground level is connected to the gate of SCR Q57. The transistors that are activated shut off the associated SCR if it is on. However, Q57 conducts to light 'O' lamp L57 and reverse bias Q59. Diode D6 in the 61 diode gates connected to the collector of Q59 is also reverse biased to allow the keying current to pass through diode D5. Notice that when Key 25 is played on any manual, output is provided on the Note #25 bus during this time slot through the single transistor amplifier Q3 on the right side of the schematic (Note #25 bus connected to bottom transistor labeled Q3).

Now, if the piston labeled '1#' is pressed, SCR Q67 is turned on and all other SCRs turned off. Action of the circuit is the same except that now when Key 25 is played, output is provided on the Note #26 bus.

Expression Indicator (Schematic 36)

The Expression Indicators provide a reference point so the organist can pre-set the expression shoes for the desired audio level. The circuitry for the Swell and Great/Pedal Expression Indicators is located on a small chassis beneath the keyboards. Included with the Expression Indicator is a custom Crescendo Indicator, and with the Transposer, a custom Transposer Indicator is provided.

SWELL AND GREAT/PEDAL EXPRESSION INDICATORS: Power for this circuit is supplied from the Main Power Supply of the organ. All of the voltages

except +15 volts are protected in the power supply. The +15 volt supply is protected by circuit breaker CB1. If an overload on this supply occurs, CB1 opens the circuit and lights to indicate this condition.

The circuits for both expression shoes are identical and operate in a similar manner. Control voltage from the expression-shoe potentiometer is connected to the base of Q11 through R17 and Bias adjust R8. Differential amplifier Q11, Q14 amplifies this control signal for application to the expression circuit. The Bias adjust R8 and Gain Control R12 provide adjustment for correct operation of the expression indicators.

Output from the differential amplifier is connected to the control bus which, in turn, is connected to the input of each of the nine Lamp switch circuits. Notice that each of the Lamp switch circuits is also connected to a series-string of diodes, all labeled D6. As the expression shoe is opened (pressed down), the control voltage from the differential amplifier increases until it exceeds the combined voltage drop of the base-emitter junction of Q6 and D6 (circuitry associated with bottom diode in series-string). Then, Q6 and Q3 turn on to light Expression Indicator #1. As the expression shoe is pressed down further, the voltage on the control bus continues to increase until it exceeds the combined voltage drop of the base-emitter drop of transistor Q6 in the circuit associated with the second indicator lamp and the two diodes in the series-string. Then, Expression Indicator #2 turns on. In a similar way, the remainder of the Lamp switches are turned on as the expression shoe is pressed down further.

Service Note: Correct adjustment procedure for the custom Expression Indicator circuit is given on Schematic 36. Due to mechanical variations in the expression shoes, mechanical linkages, and potentiometers, the Swell and Great/Pedal Expression Indicators may not track perfectly. If close tracking is required, adjust the circuits for similar indication near the center of the range of the expression shoe.

CRESCENDO/TUTTI INDICATOR: The Crescendo Indicator lamps are controlled by a switch rotor connected to the Crescendo shoe. Power is connected to the indicator lamps through series dropping resistors located on the Main Stop Interconnect Board (Loc. 3-B). As the Crescendo pedal is pressed, the switch contacts add progressively louder stops to the selected voices (refer to Section 6 for a list of stops and the associated lights for either the standard or custom Crescendo Indicator). Indicator lights on the stop rail indicate the level of Crescendo being added. The standard model has four indicator lamps, and the custom model has seven indicator lamps. The highest lamp on each model lights to show when the TUTTI is on.

AMPLIFIERS AND SPEAKERS:

S-100 Power Amplifier (Schematic 37)

Power to the remotely located S-100 Power Amplifier is controlled by relay K1 (one relay located in each amplifier). This relay, in turn, is controlled by application of +15 volts from the Main Power Supply, located in the organ console. When the organ is turned on, relay K1 is actuated to connect AC line voltage to the power supply in the amplifier.

Signal from the Output Preamp is also connected to the amplifier through the interconnect plug. The amplifier does not contain a gain control since the level of all voices is determined in the Output Preamp. Bias Adjust R9 sets the amplifier for equal clipping under full load. Hum balance R32 compensates the circuit for minimum low-frequency noise, or hum, in the output signal.

Service Notes: With the exception of transistor Q1, all stages in the S-100 Amplifier are DC coupled. Service wise, this means that one defective transistor can upset the bias for the others, and may in some cases cause damage to otherwise good transistors. To prevent further damage when servicing, connect a ballast consisting of a 117 volt, 100 watt bulb in series with the AC line. Under these conditions, the amplifier will work normally at low signal levels if the circuit is working properly. However, if shorted transistors or other components are present in the circuit, the lamp will glow brightly and help prevent damage to the remaining transistors.

When the amplifier is defective, it is sometimes difficult to take meaningful measurements due to the fact that full supply voltage cannot be applied to the amplifier. One measurement that can be made with fairly certain accuracy is to measure the voltage drop between base to emitter on each transistor. The voltage drop between the base and emitter of any of the transistors, even at reduced supply voltage, should be about 0.6 volts. Note the polarity of this reading: NPN transistors Q1, Q2, Q4, Q6, and Q7 should be positive on the base and negative on the emitter; PNP transistors Q3 and Q5 will be negative on the base and positive on the emitter. Before replacing any transistors which appear defective, first check that the components in series with this transistor are not defective.

BIAS AND HUM ADJUSTMENT: Connect a four ohm resistive lead to the output terminals of the amplifier. If an oscilloscope is available, apply a 400 hertz signal to the input of the amplifier. As you increase the signal level, observe the output waveform and set Bias Adjust R9 for equal clipping at full power. If the amplifier has a Hum balance adjustment, remove the input signal and short the amplifier input terminals to ground. With the oscilloscope adjusted for the maximum sensitivity (use line-sync triggering), adjust the Hum balance control for minimum line-frequency hum. Since these controls interact, recheck the Bias Adjust.

An alternative method of adjusting these controls is with a DC voltmeter. Connect the voltmeter between chassis ground and the positive side of the output coupling capacitor C16. Set Bias Adjust R9 for a reading of 38 volts. Adjust the Hum balance R32 for minimum audible hum while listening to the speakers connected to the amplifier.

This completes the Technical Description for the Cambridge 220-II.

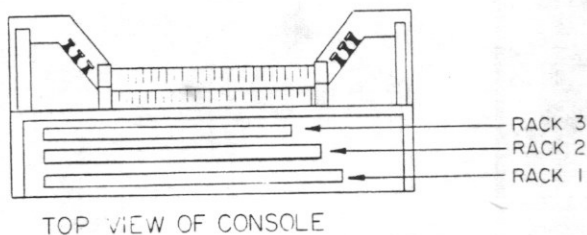
CAMBRIDGE 220-II

INDEX TO SCHEMATICS

<u>PAGE</u>	<u>TITLE OF DRAWING</u>	<u>DRAWING NO.</u>
GENERAL		
1	Parts Location	1430
2	Keying Chart	1243
3	Keying Block Diagram (Part I)	1453
4	Keying Block Diagram (Part II)	1452
5	2-Manual Coupler System	1443
AUDIO		
6	Signal Block Diagram	1445
7	Oscillator/Tremulants/Activity	1427
8	Great Unit Diapason	1434
9	Great Unit Flute	1429
10	Swell Unit Diapason	1435
11	Swell Unit Flute and Chiff	1446
12	Swell Unit Trompett/Reed	1444
13	Celestes	1428
14	Krummhorn	1441
15	Harp/Carillon Keyer	1422
16	Harp/Carillon Preamps	1423
17	Pedal Signal Keyers	1440
18	Pedal Voicing	1439
19	Output Preamps (Part I)	1431
20	Output Preamps (Part II)	1432
COMBONS		
21	Silicon Sforzando or Tutti	1271
22	Presets	1470
23	Setterboard Combination Action	1442
24	Capture System - Moving Tab (Part I)	1297
25	Capture System - Moving Tab (Part II)	1298
26	Lighted Capture System	1396
27	Reversible - Moving Tab	1280
27	Lighted Reversible	1401

INDEX TO SCHEMATICS

<u>PAGE</u>	<u>TITLE OF DRAWING</u>	<u>DRAWING NO.</u>
POWER SUPPLIES AND AIR SOUND		
29	Type VII Power Supply	1426
30	Type VIII Power Supply	1418
31	Air Sound	1438
ACCESSORIES		
32	EN-II Entertainment Center	1248
33	EC II B Echo Adapter	1180
34	EC VI Multichannel Echo Adapter	1413
35	Transposer	1404
36	Expression Indicator	1405
37	220-II Outdoor Carillon Adapter	1462
AMPLIFIERS AND SPEAKERS		
38	S-100 Amplifier	1200
39	W6-100U Speaker System	1314
40	M-13 Speaker Systems	1247



ENSEMBLE 2-A OSCILLATORS	EMPTY 2-D	2-G HARP/ CARRILON SIGNAL KEYERS	2-I SWELL UNIT REED/TROMP. SIGNAL KEYERS
ENSEMBLE OSC. 2-B CELESTE OSC.	EMPTY 2-E	KRUMM - HORN SIGNAL KEYERS	CELESTE SIGNAL KEYERS
CELESTE OSC. 2-C	EMPTY 2-F	2-H	2-J

RACK 2

1-A MAIN OSC.	1-D TREM- ULANT	1-G MAIN * SIGNAL KEYERS 25-60	1-I OUTPUT PIREAMPS & FILTERS	1-K 16' PEDAL SIGNAL KEY- ERS
1-B MAIN OSC.	1-E			32' PEDAL SIGNAL KEYERS
1-C MAIN OSC.	1-F SPEAKER OUTPUT PANEL	1-H MAIN * SIGNAL KEYERS 61-85	1-J MAIN * SIGNAL KEYERS 01-24	1-L

RACK 1

MAIN STOP INTERCONNECT 3-A	COMPLERS 3-C	GREAT DIODE GATES 3-D	SWELL DIODE GATES 3-F
TRANSPOSER (OPTIONAL) 3-B		EMPTY 3-E	SWELL DIODE GATES 3-G PEDAL DIODE GATES
	3-H SWELL CHIFF DIODE GATES		

RACK 3

* SWELL UNIT DIAPASON
SWELL UNIT FLUTE
GREAT UNIT DIAPASON
GREAT UNIT FLUTE

1

LTR	DATE	BY	DESCRIPTION
REVISIONS			
RODGERS ORGAN COMPANY			
DRAWN W.W.F.	DATE 8-17-72	SCALE 40	MODEL 220-II
CHECKED	DATE	PRJ. ENG.	ENG. MRG.
REL. DATE			
TITLE 220-II PARTS LOCATION			

PULSE TO D.C. CONVERTERS

SWELL DIODE GATES

⑥ WHEN THE SWELL 8' TROMPETTE STOP CONTROL IS TURNED ON, D.C. KEYING VOLTAGE WILL PASS THRU THE 8' DIODE GATE TO THE SWELL UNIT TROMPETTE SIGNAL KEYER.

SIGNAL KEYERS

OSC. 3 SETS

⑦ D.C. KEYING VOLTAGE IS PRESENT AT ONE (DETERMINED BY WHICH KEY WAS DEPRESSED) OF THE SIGNAL KEYERS, THUS ALLOWING THE MAIN OSC SIGNAL TO PASS THRU TO THE AUDIO SYSTEM.

⑧ IN THE AUDIO SYSTEM, THE SIGNAL IS EXPRESSED & AMPLIFIED BEFORE GOING ON TO THE ORGAN'S SPEAKERS.

61 CONDUCTORS FROM "A" SWELL COUPLER CURRENT AMP.

SWELL TIME SLOT PULSES ARE NOW PRESENT AT THE INPUT OF THE SWELL COUPLER CURRENT AMPLIFIER & ARE CONVERTED TO D.C. KEYING VOLTAGE.

D.C. KEYING VOLTAGE IS NOW PRESENT AT THE INPUT OF ALL SWELL DIODE GATES.

61 CONDUCTORS FROM "B" GREAT COUPLER CURRENT AMP.

GREAT DIODE GATES

AIR KEYER ISOLATION STOP CONTROLS

GREAT UNIT FLUTE GATES

2' FIFTEENTH STOP CONTROLS

2' GATES

4' OCTAVE STOP CONTROLS

4' GATES

8' GATES

8' PRINCIPAL STOP CONTROLS

TYPICAL DIODE GATE GREAT UNIT DIAPASON

PEDAL DIODE GATES

32 CONDUCTORS FROM "C" PEDAL COUPLER CURRENT AMP.

AIR KEYER ISOLATION

4' & 8' SW U-REED GATES

16' PEDAL FLUTE ISOLATION STOP CONTROLS

GREAT U-DIAP GATES

16' PED PULSE ISOLATION

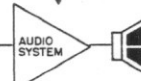
32' PEDAL ISOLATION

STOP CONTROL

GREAT U-FLUTE GATES

AIR GEN

AUDIO SYSTEM

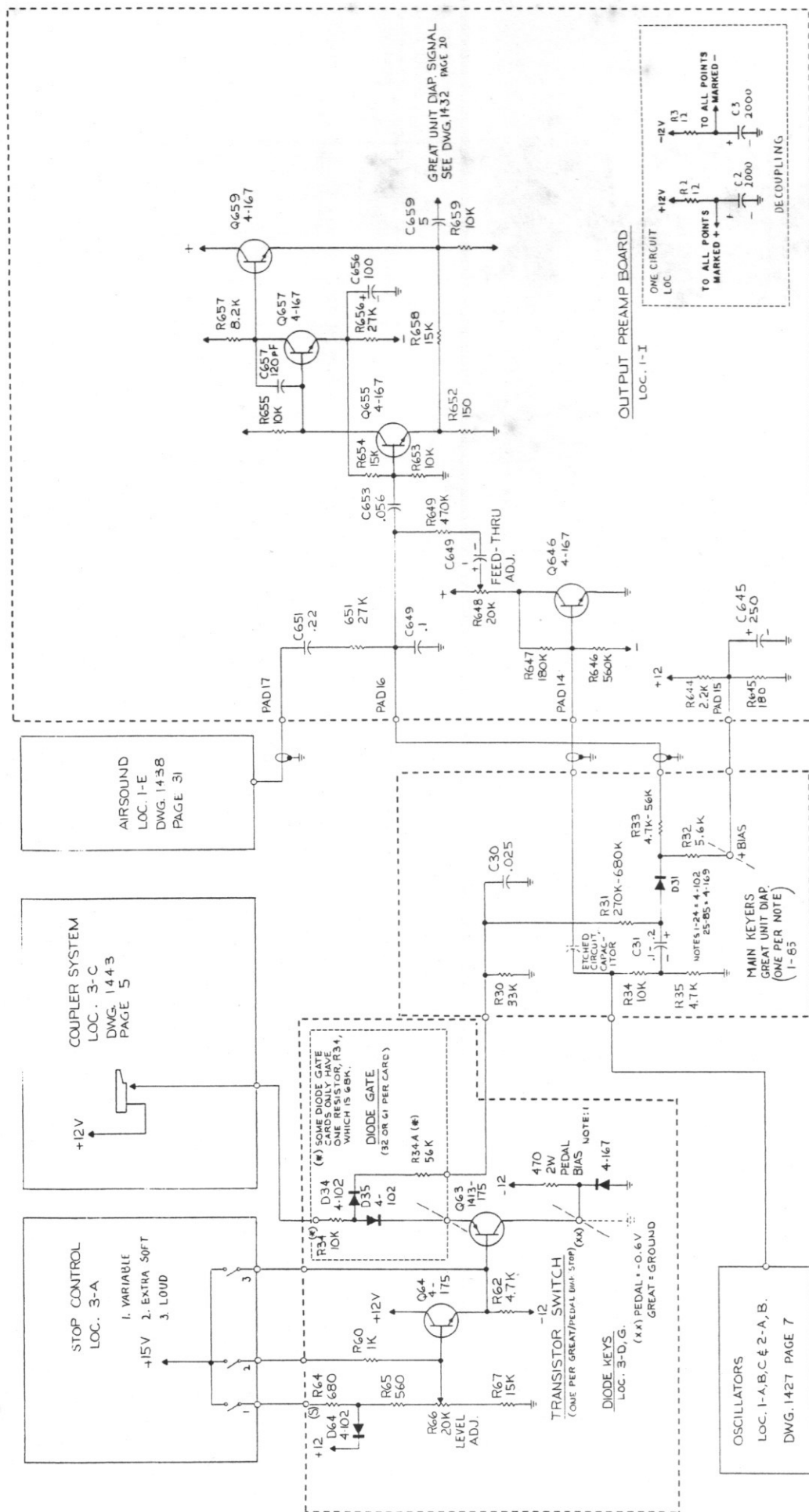


4

REVISIONS			
LTR	DATE	BY	DESCRIPTION
RODGERS ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
W.W.F.	11/30/72	25	220-II
CHECKED	DATE	PRJ. ENG.	REL. DATE
TITLE 220-II KEYING BLOCK DIAGRAM			

LOC: 1-1
DWG. 1431 PAGE 14
1432 PAGE 23

[illegible]



NOTE 1: BIAS NETWORK USED IN PEDAL KEYS ONLY, LOCATION 3-G.
BIAS NETWORK NOT USED ON GREAT KEYS, LOCATION 3D, POINT XX IS GROUNDED.

NOTES
ALL CAPACITORS GIVEN IN MICROFARADS
UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS;
K = 1,000 ; M = 1,000,000.

1A	1D	1G	1I	1K
1B	1E	1H	1J	1L
1C	1F			

3A	3C	3D	3F	
3B	3H		3E	3G

RACK 1
(OUTER RACK - PARTS SIDE)

LOC. PART NUMBERS	APPROX. C.N. TYPE	END COLOR	SYMBOL
1414-176	1414-182	3702	RED
1414-173	1414-186	3706	BLUE
1414-183	1414-187	3707	GREEN
1414-174	1414-175	3708	WHITE

TRANSISTOR IDENTIFICATION

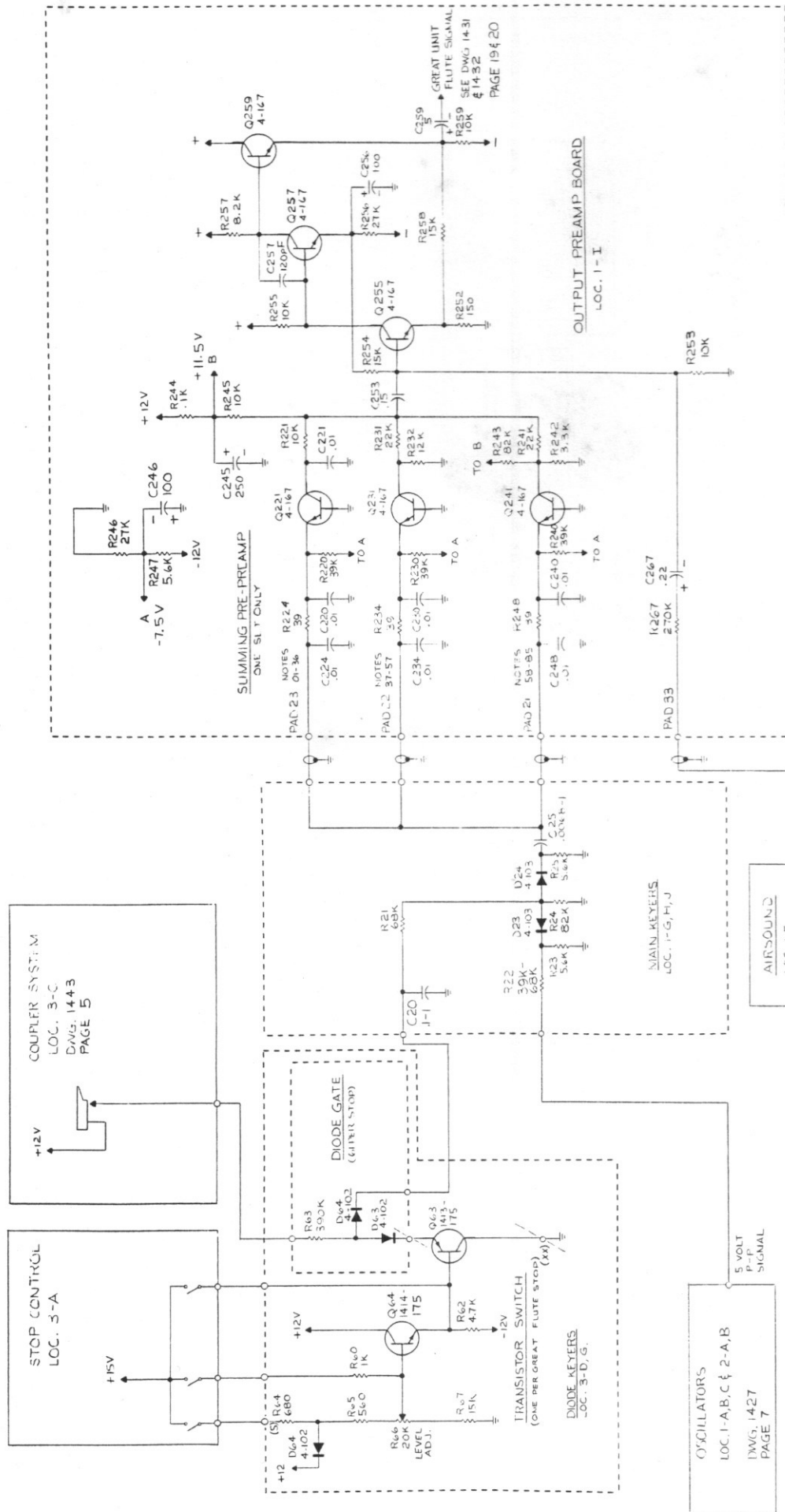


RODGERS ORGAN COMPANY

DATE	SCALE	MODEL	DWG. NO.
8-22-72	30	220-II	1434A
CHECKED	DATE	ENG. MGR.	REL. DATE
W.W.F.			

LTR.	DATE	BY	DESCRIPTION
15	4-5-73		PROTOTYPE CHANGES

TITLE 220-II GREAT UNIT DIAPASON



RODGER'S ORGAN COMPANY			
DATE	SCALE	MODEL	DWG. NO.
4-5-75	8-17-72	220-II	1429A
CHECKED	DATE	ENG. MGR.	REL. DATE
TITLE 220-II GREAT UNIT FLUTE			

TRANSISTOR IDENTIFICATION			
ROC. PART NUMBERS	APPROX. PIN TYPE	END COLOR	SYMBOL
10-92	TO-98	3702 RE D	
1414-176	1414-162	3706 BLUE	
1414-173	1414-166	3707 GREEN	
1414-183	1414-167	3708 WHITE	
1414-174	1414-175		

RACK 1 (OUTER RACK - PARTS SIDE)			
1A	1D	1G	1K
1B	1E	1H	1J
1C	1F	1I	1L

RACK 2 (MIDDLE RACK - PARTS SIDE)			
2A	2D	2G	2I
2B	2E	2H	2J
2C	2F	2I	2L

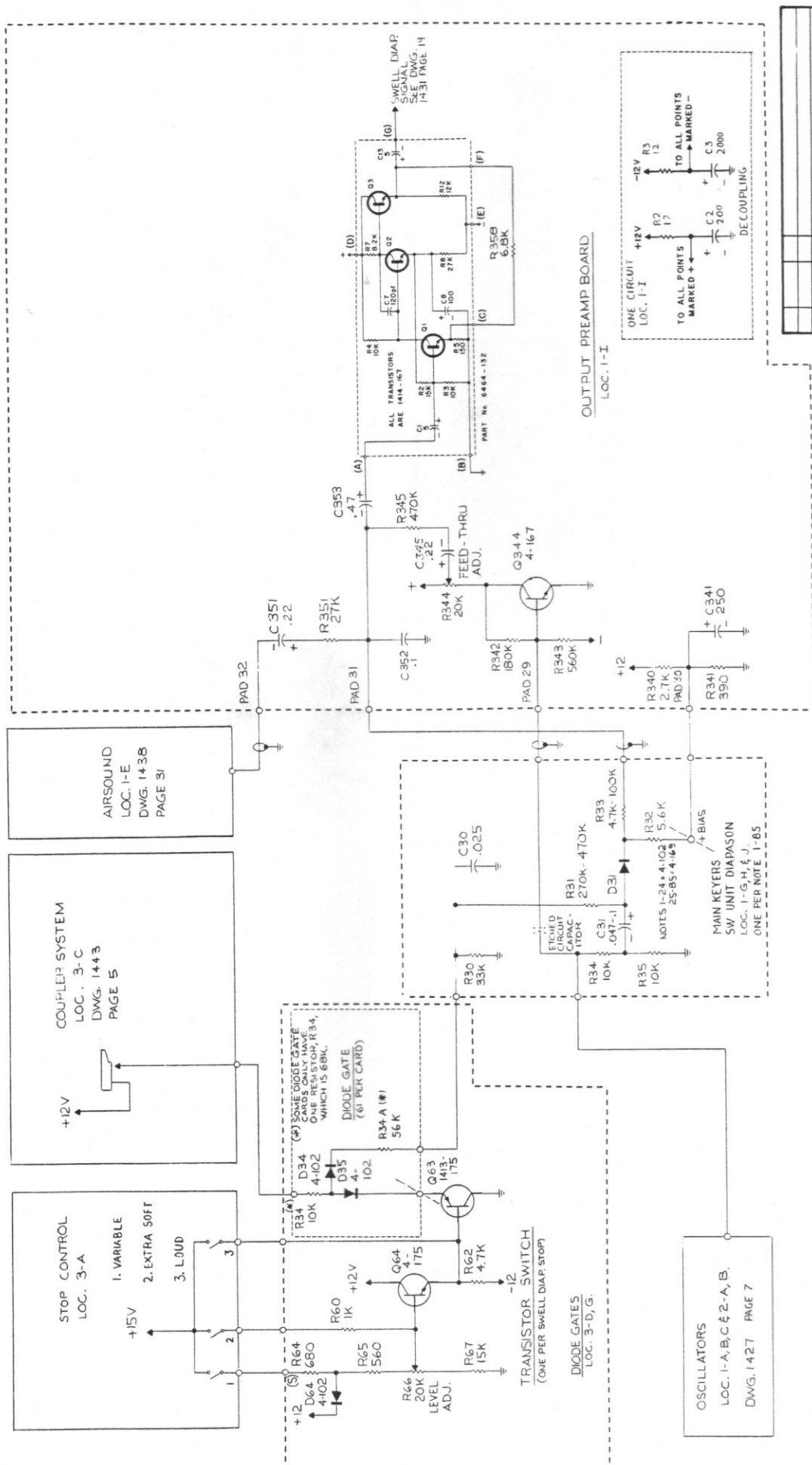
RACK 3 (INNER RACK - PARTS SIDE)			
3A	3C	3D	3F
3B	3E	3H	3J
3C	3F	3I	3L

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

ALL RESISTANCES GIVEN IN OHMS: K=1,000; M=1,000,000.

LOC. 1-A,B,C & 2-A,B
DWG. 1427
PAGE 7



REVISIONS		RODGER'S ORGAN COMPANY	
DATE	BY	DATE	BY
4-5-73	B	8-24-72	30
DESCRIPTION		MODEL	
A 4-5-73 B		220-II	
LTR		DWG NO	
DATE		1435A	
BY		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

TRANSISTOR IDENTIFICATION		RODGER'S ORGAN COMPANY	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

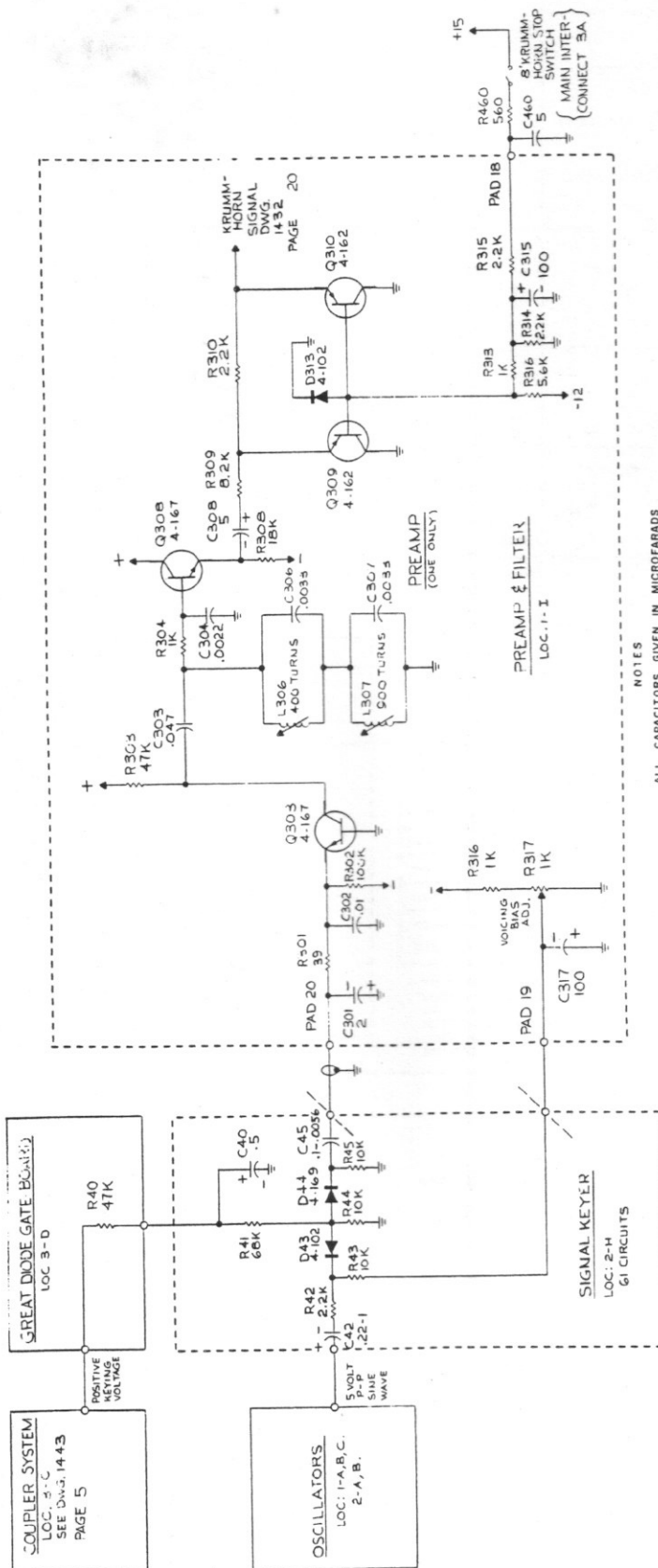
NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

10

NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	

NOTES		TRANSISTOR IDENTIFICATION	
LOC. 1-I	DESCRIPTION	DATE	BY
4-5-73	B	8-24-72	30
LTR		MODEL	
DATE		220-II	
BY		DWG NO	
		1435A	
		REL DATE	
		TITLE 220-II SWELL UNIT DIAPASON	



RACK 1			
1A	1D	1G	1I
1B	1E	1H	1J
1C	1F	1K	1L

(OUTER RACK - PARTS SIDE)

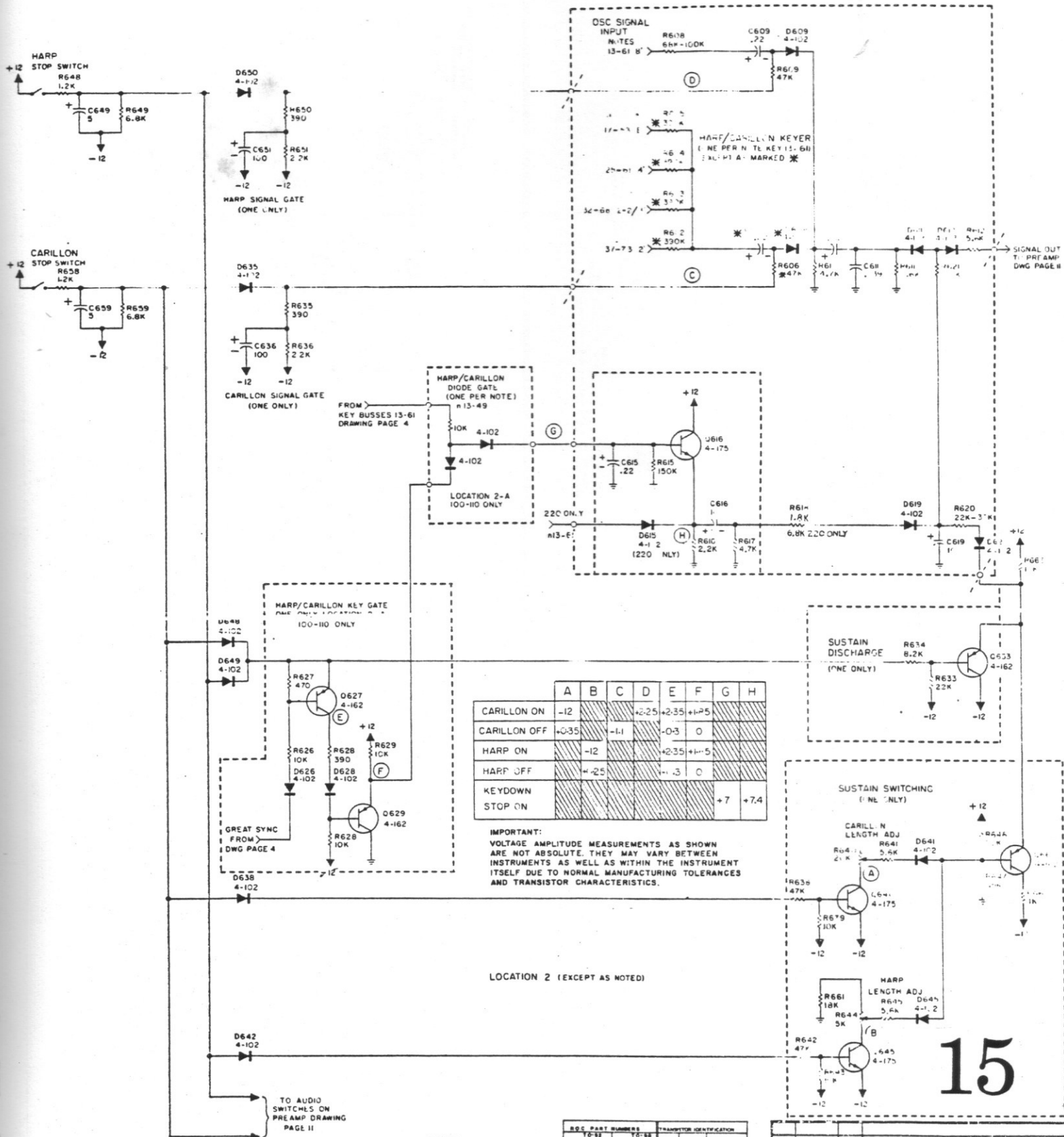
RACK 2			
2A	2D	2G	2I
2B	2E	2H	2J
2C	2F	2K	2L

(MIDDLE RACK - PARTS SIDE)

RACK 3			
3A	3C	3D	3F
3B	3E	3G	3H

(INNER RACK - PARTS SIDE)

TRANSISTOR IDENTIFICATION			
ROC PART NUMBERS	APPROX. TYPE	END COLOR	SYMBOL
TO-92	C-18	3702	RED
TO-92	C-18	3706	BLUE
TO-92	C-18	3707	GREEN
TO-92	C-18	3708	WHITE

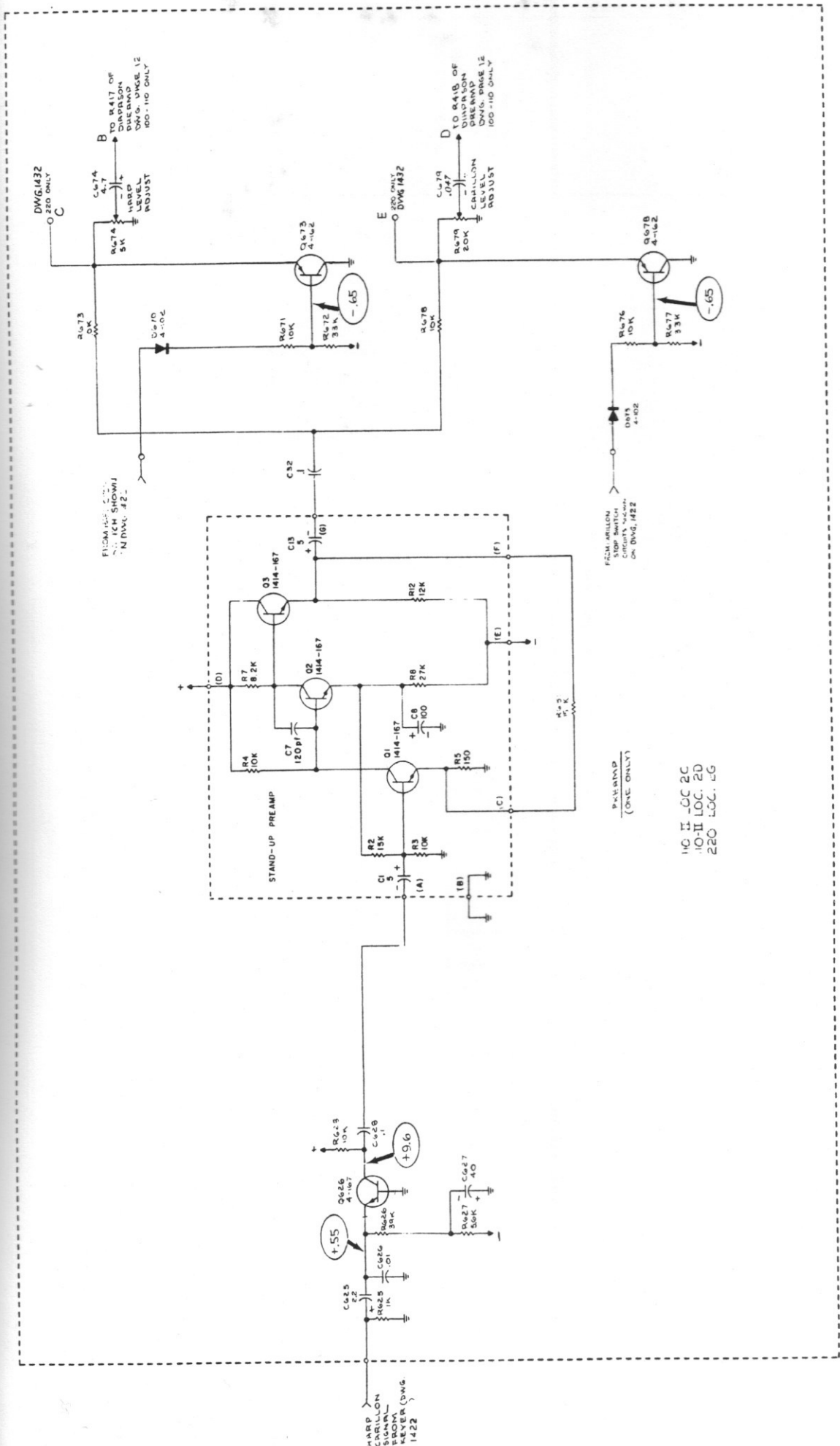


NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS;
K=1,000 M=1,000,000.

R.O.C. PART NUMBERS		TRANSISTOR IDENTIFICATION			
TO-18	TO-18	MARK	END	TYPE	SYMBOL
100-175	100-182	3702	RED		
100-173	100-186	3703	BLUE		
100-183	100-187	3707	GREEN		
100-174	100-175	3708	WHITE		
100-188	100-189	3704	DOUBLE		

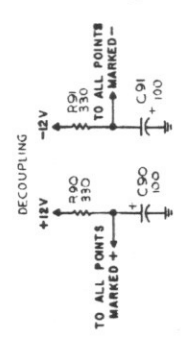
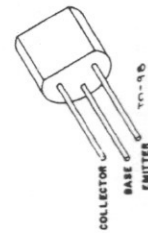
A 2-14-74 K.C. 100-34-9 REPLACES DWG 14224					
L.T.R. DATE BY DESCRIPTION					
REVISIONS					
RODGERS ORGAN COMPANY					
DRAWN	DATE	SCALE	MODEL	DWG. NO.	
K.C.	2-14-74	3"		1473 A	
CHECKED	DATE	PRJ. ENG.	ENG. MGR.	REL. DATE	
TITLE					
100-11/110-11/22 2-110-11/22 HARP/CARILLON KEYER					

15



TRANSISTOR IDENTIFICATION

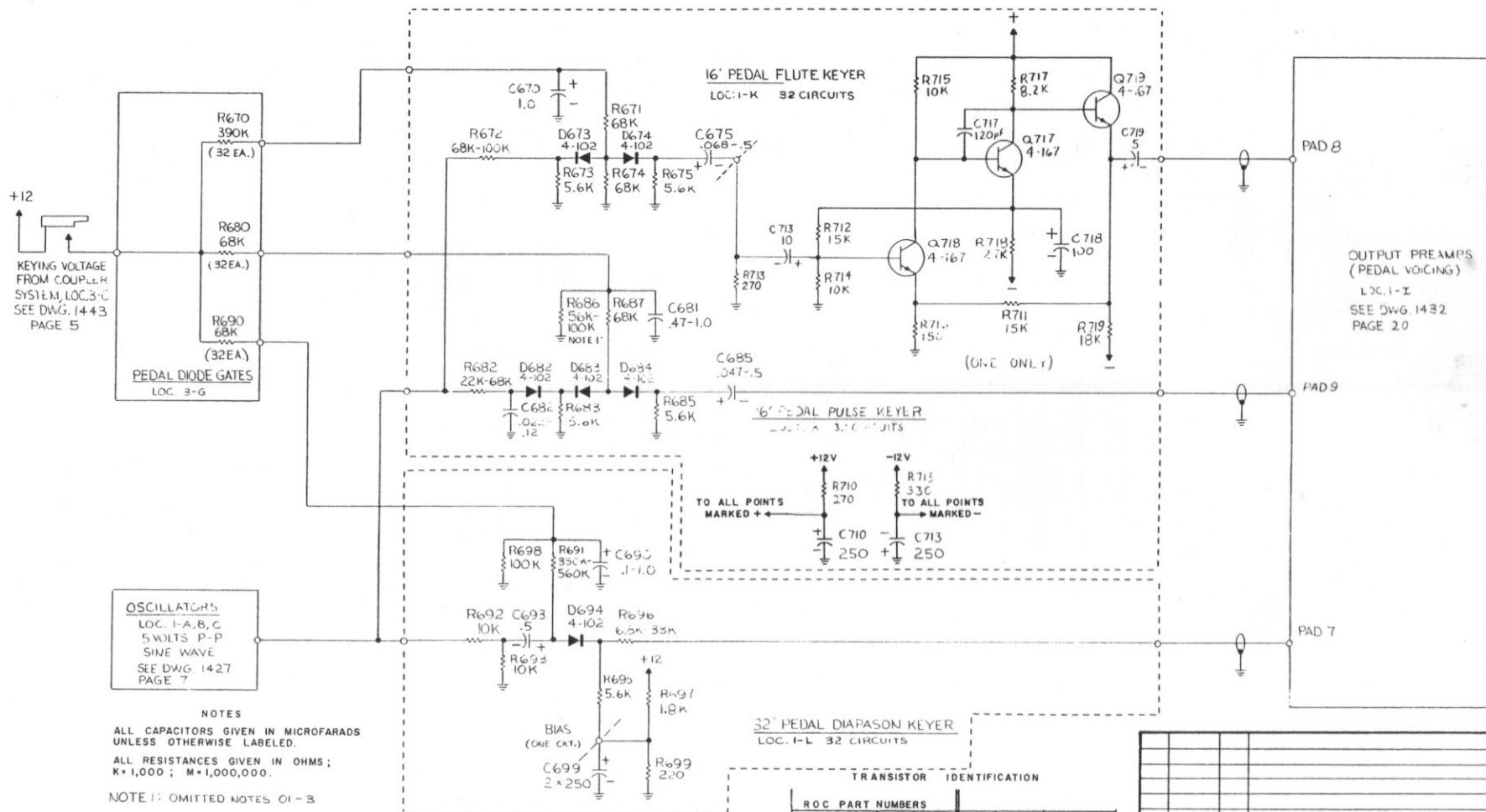
IOC Part No.	Triangular	Round	End Color
101-101	101-101	101-101	White
101-102	101-102	101-102	White
101-103	101-103	101-103	White
101-104	101-104	101-104	White
101-105	101-105	101-105	White
101-106	101-106	101-106	White
101-107	101-107	101-107	White
101-108	101-108	101-108	White
101-109	101-109	101-109	White
101-110	101-110	101-110	White



NOTES
ALL CAPACITORS GIVEN IN MICROFARADS
UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS
R=1,000 ; M=1,000,000
LOCATION 2
(UNLESS NOTED)



REVISIONS		DESCRIPTION	
LTR.	DATE	BY	DESCRIPTION
A	9-13-72	BT	ECO 3318
B	9-13-72	BT	ECO 3318
C	9-13-72	BT	ECO 3318
DRAWN		DATE	SCALE
G.G.M		5-8-72	30
CHECKED	DATE	ENG.	MGR.
TITLE		1423 C	
100-II/110-II		HARP/CARILLON PREAMPS	



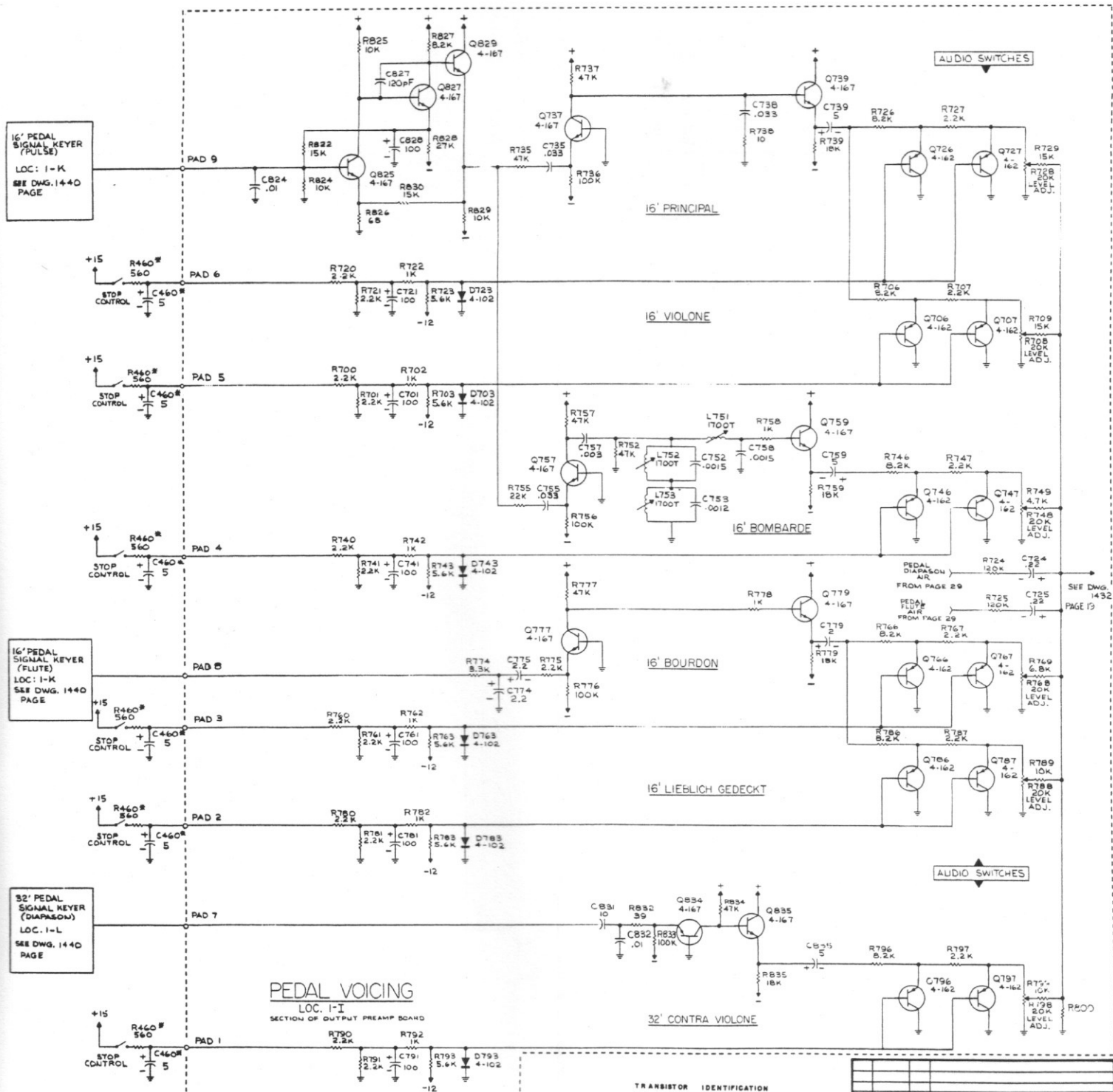
3A	3C	3D	3F	1A	1D	1G	1I	1K
3B		3E	3G	1B	1E	1H	1J	1L
1C	1F	1H	1J	1L				

RACK 3 (INNER RACK - PARTS SIDE)

RACK 1 (OUTER RACK - PARTS SIDE)

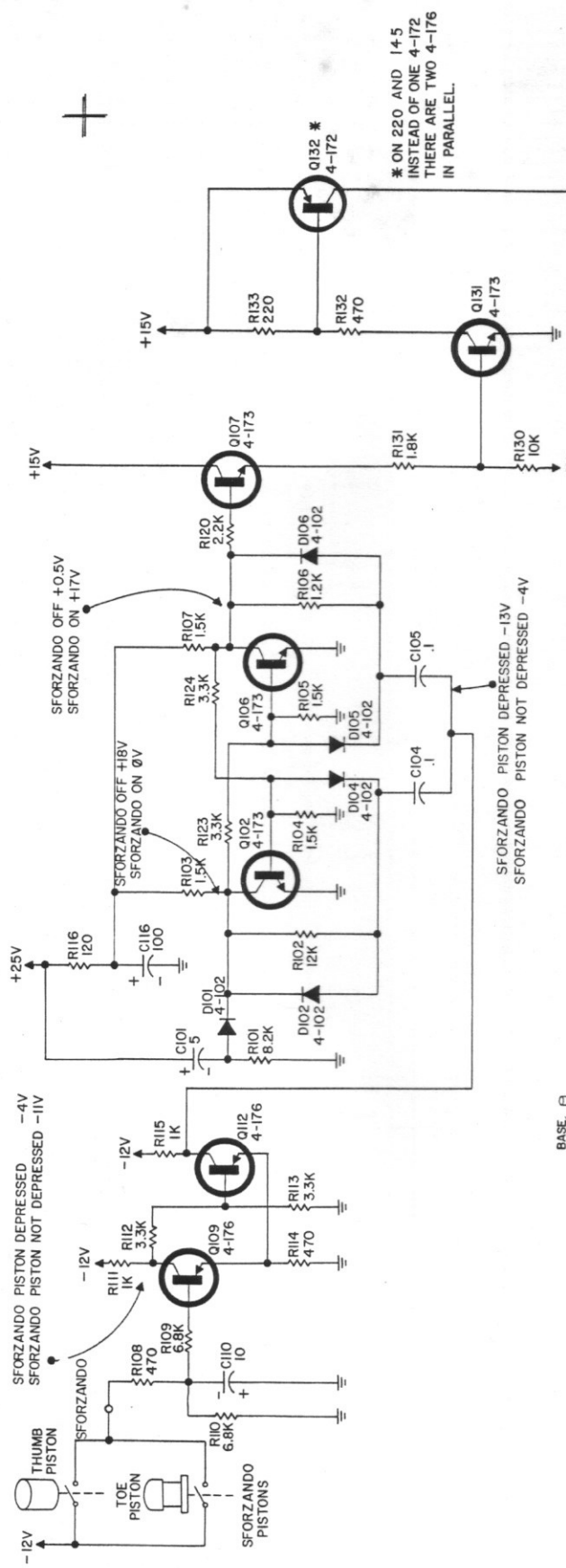
TO-92	TO-98	APPROX 2N TYPE	END COLOR	SYMBOL
1414-176	1414-162	3702	RED	⬤
1414-173	1414-166	3706	BLUE	⬤
1414-183	1414-167	3707	GREEN	⬤
1414-174	1414-175	3708	WHITE	⬤

A	4-10-73	B	PROTOTYPE CHANGES
LTR	DATE	BY	DESCRIPTION
REVISIONS			
RODGERS ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
W.W.F.	9-1-72	3C	220-II
CHECKED	DATE	PRJ	ENG
		ENG	MRG
		REL	DATE
TITLE 220-II PEDAL SIGNAL KEYS			

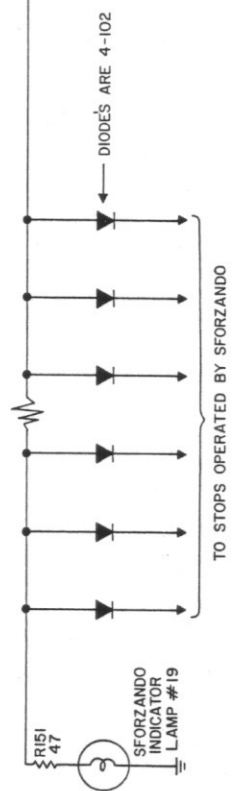
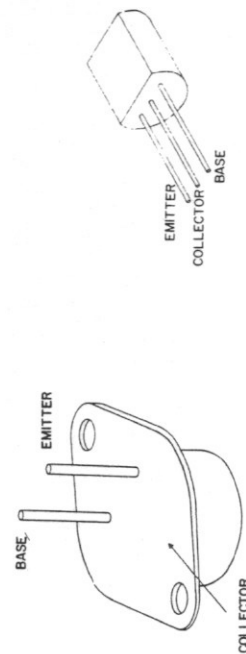


TRANSISTOR IDENTIFICATION			
ROC PART NUMBERS	TO-92	TO-98	
E	C	B	
TYPE	TYPE	TYPE	
APPROX 2N	END	END	SYMBOL
COLOR	COLOR	COLOR	
1414-176	1414-182	3702	RED
1414-173	1414-188	3708	BLUE
1414-183	1414-187	3707	GREEN
1414-174	1414-175	3708	WHITE

RODGER'S ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
W.W.F.	8-31-72	25	220-II
CHECKED	DATE	PRJ. ENG.	REL. DATE
TITLE			
220-II PEDAL VOICING			



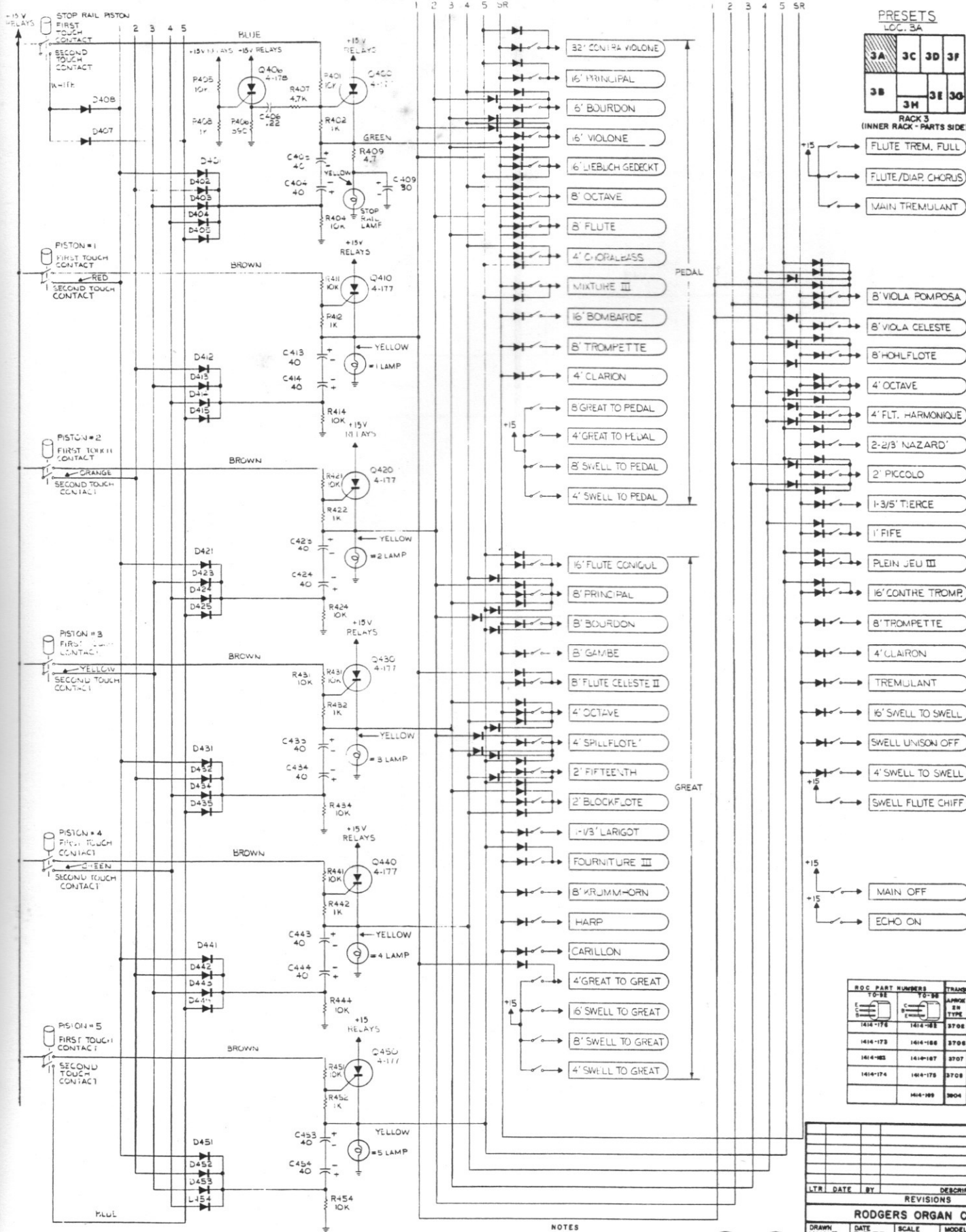
R.O.C. PART NUMBERS		TRANSISTOR IDENTIFICATION	
T0-92	T0-98	APPROX 2N TYPE	SYMBOL
1414-176	1414-162	3702 RED	
1414-173	1414-166	3706 BLUE	
1414-183	1414-167	3707 GREEN	
1414-174	1414-175	3708 WHITE	
	1414-169	3904 DOUBLE GREEN STRIPE	



IMPORTANT:
VOLTAGE AMPLITUDE MEASUREMENTS AS SHOWN
ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN
INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT
ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES
AND TRANSISTOR CHARACTERISTICS.

DWG. 1271G

G 4-573		Q		PROTO CHANGE	
LTR	DATE	BY	DESCRIPTION		
REVISIONS					
RODGER'S ORGAN COMPANY					
DRAWN	DATE	SCALE	MODEL	DWG. NO.	
WRU	3-15-68	40		1271G	
TITLE					
SILICON SFORZANDO (TUTTI)					



NOTES
ALL CAPACITORS GIVEN IN MICROFARADS
UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS;
K=1,000; M=1,000,000.
ALL DIMENSIONS 4-102 UNLESS OTHERWISE NOTED.

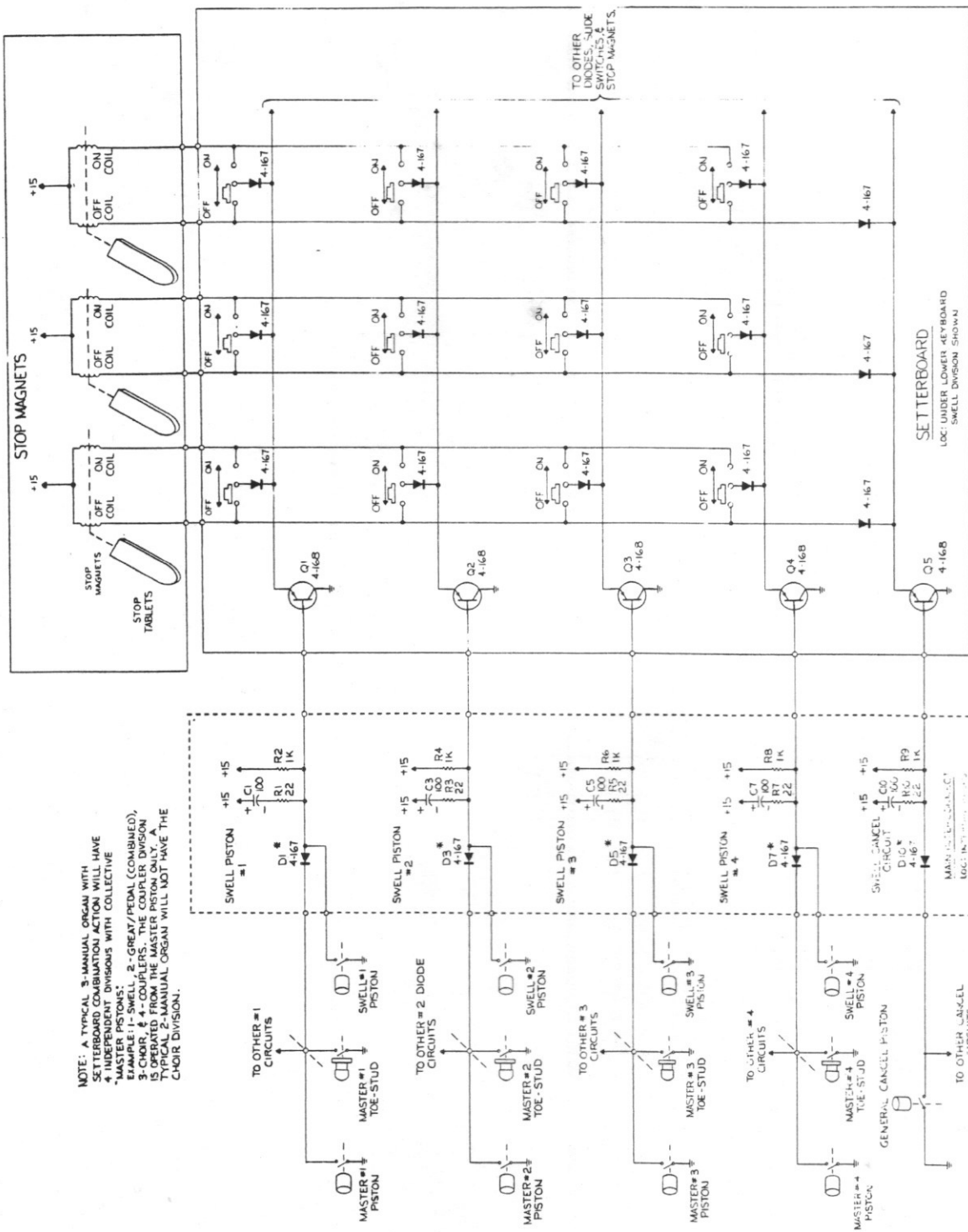
22

RODGER PART NUMBERS		TRANSISTOR IDENTIFICATION	
TYPE	10-55	APPROX. EN. TYPE	END COLOR
1414-176	1414-185	3708	RED
1414-178	1414-186	3708	BLUE
1414-182	1414-187	3707	GREEN
1414-174	1414-175	3708	WHITE
	1414-189	3804	DOUBLE GREEN/WHITE

DATE	BY	DESCRIPTION

RODGERS ORGAN COMPANY			
DRAWN W.W.F.	DATE 5-3-73	SCALE 25	MODEL 220-II
CHECKED	DATE	PR. ENL.	REL. DATE

TITLE 220-II PRESETS



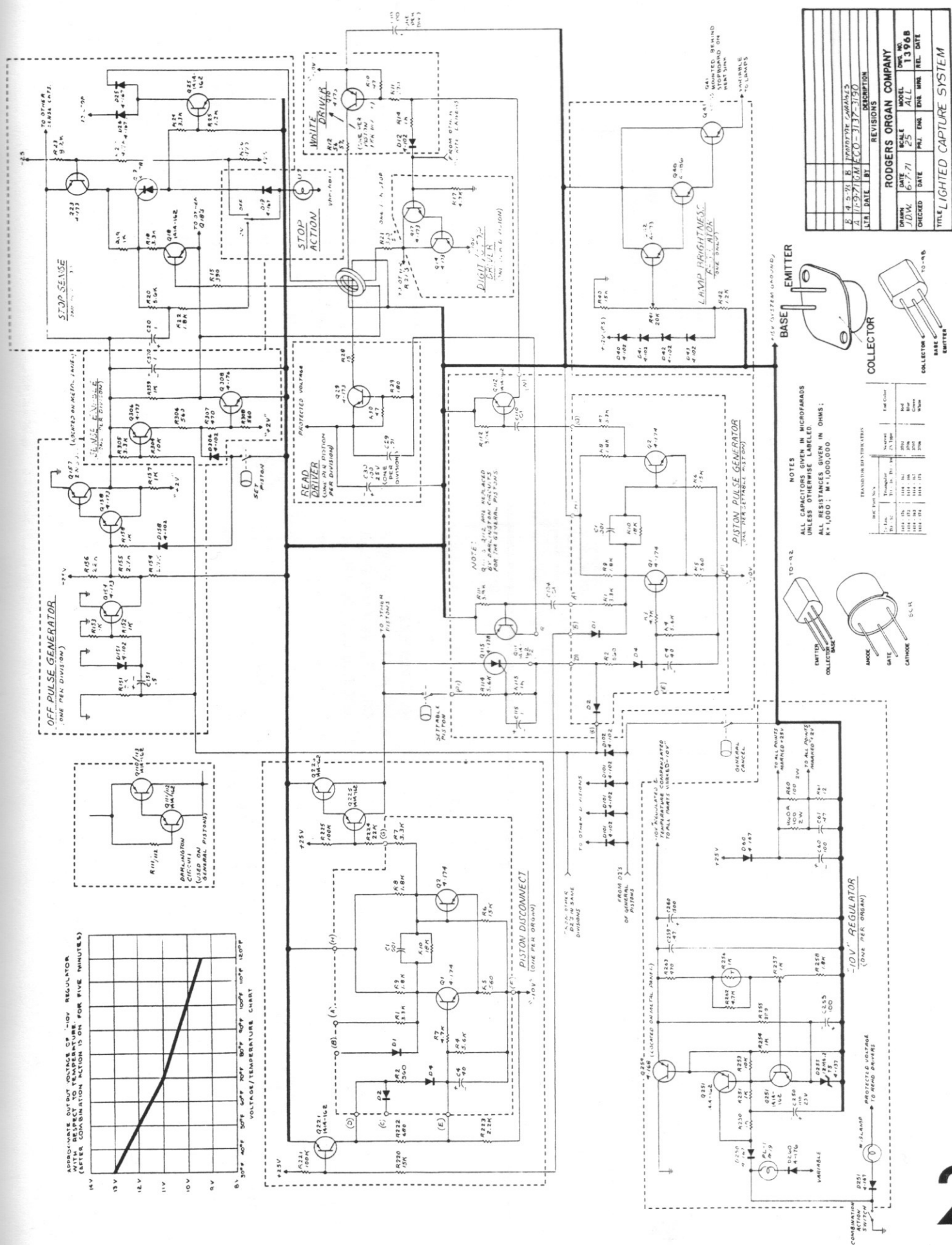
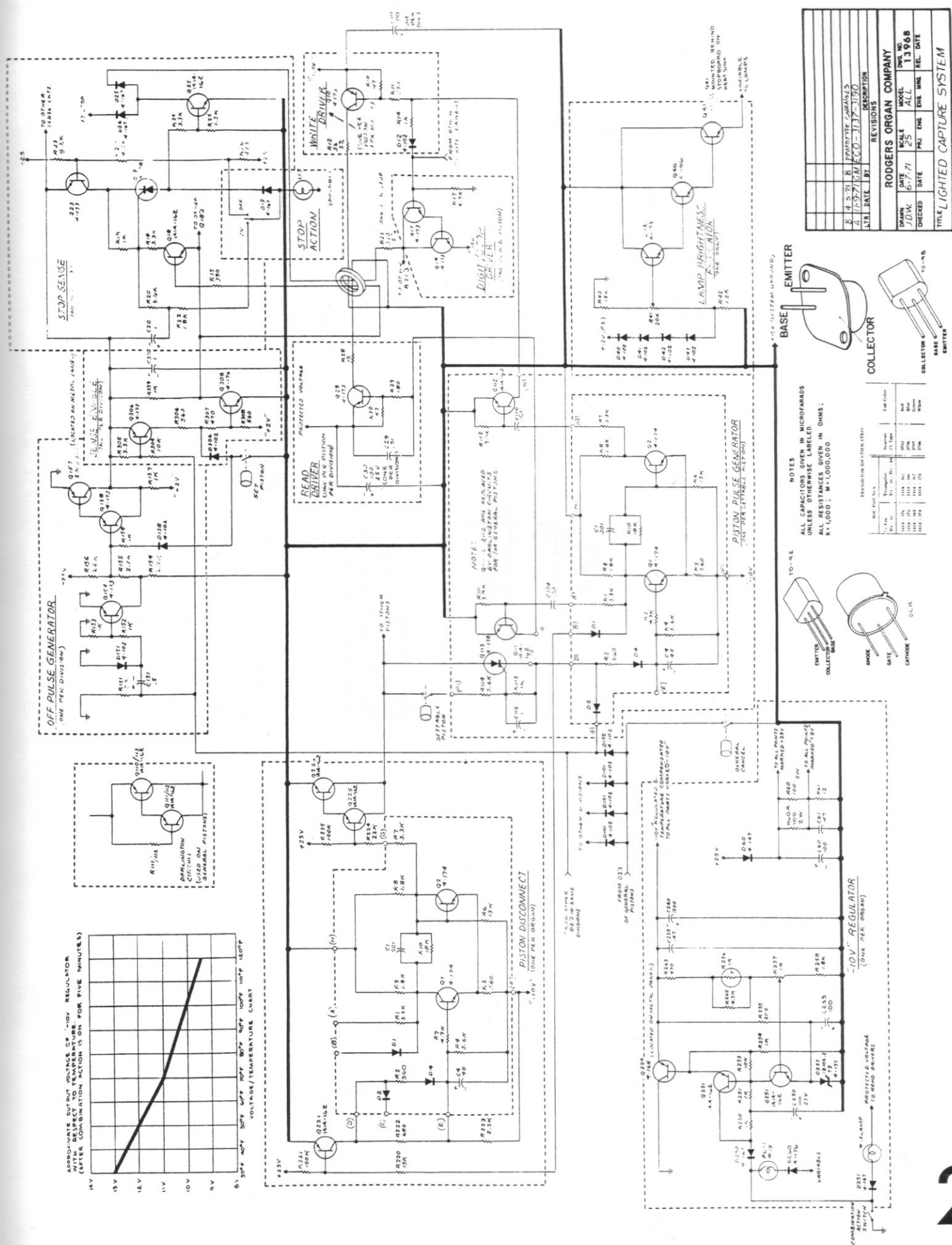
NOTES

ALL CAPACITORS GIVEN IN MICROFARADS

ALL RESISTORS ARE UNLESS OTHERWISE SPECIFIED IN OHMS

R-1,000 = M-1,000,000

R.O.C. PART NUMBERS		TRANSISTOR IDENTIFICATION	
TO-18	TO-98	APPROX. END TYPE	SYMBOL
		3708 RED	
1414-173	1414-182	3708 BLUE	
1414-174	1414-176	3707 GREEN	
1414-175	1414-177	3708 WHITE	

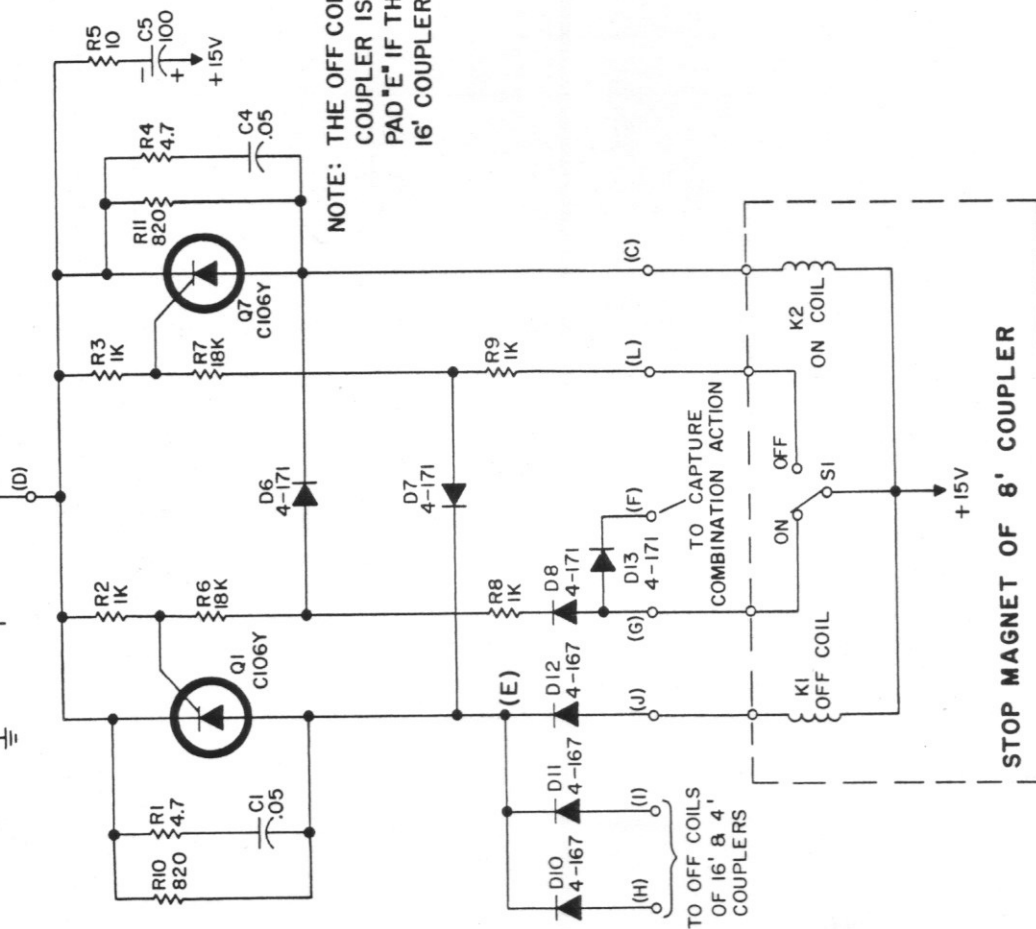
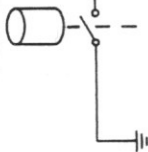


Infrared No's	Transmittance		Nearest % Type	End Color
	ν Lau. 10 - 50	10 - 100		
1014 - 172	1010 - 162	1702	100%	Red
1014 - 172	1010 - 162	1702	99%	Blue
1014 - 172	1010 - 162	1702	97%	Green
1014 - 172	1010 - 162	1702	95%	Green

REVISED		DATE		BY		DESCRIPTION	
RODGERS ORGAN COMPANY							
DRAWN	DATE	SCALE	MODEL	DWG. A			
10/10/71	6-7-71	25	ALL	13			
CHECKED	DATE	PLT.	ENG.	MFG.	REL.		

Diagram of a 3-pin transistor package. The pins are labeled: COLLECTOR, BASE, and EMITTER. The package is labeled TO-18.

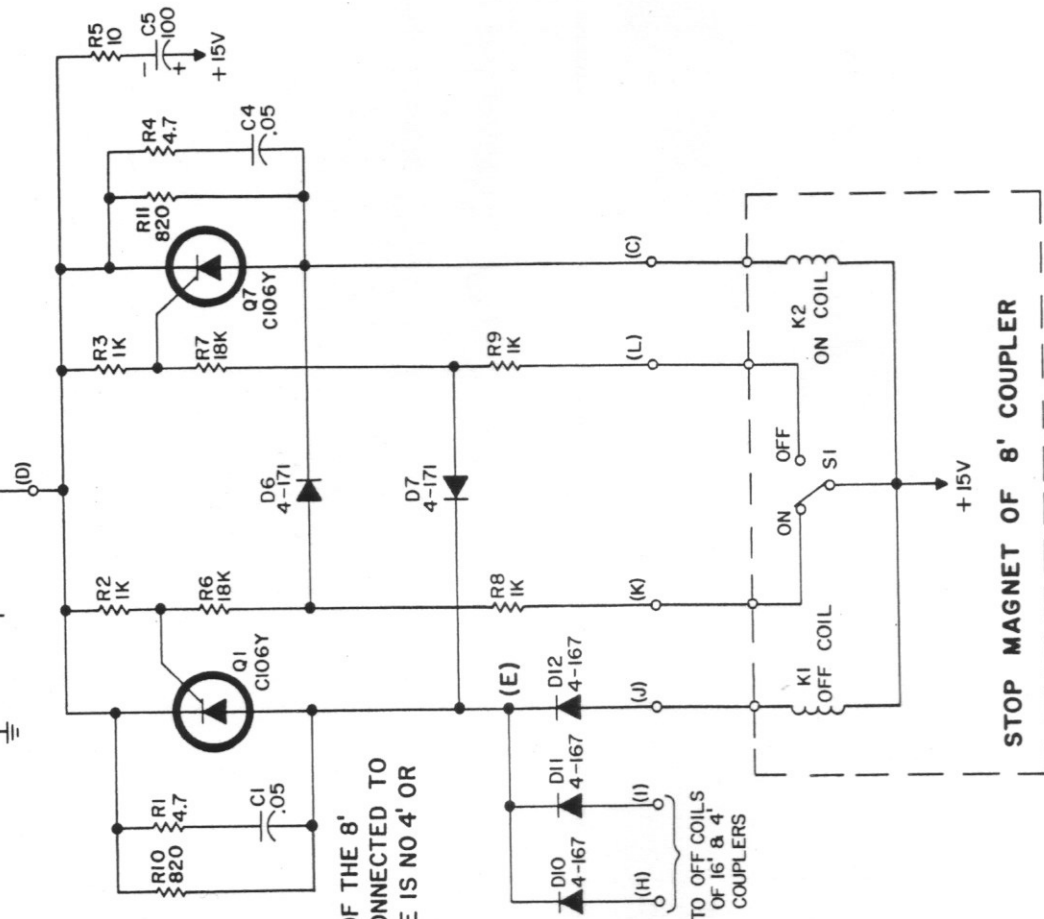
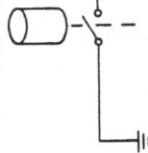
"PISTON"



STOP MAGNET OF 8' COUPLER

REVERSIBLE USED WITH CAPTURE SYSTEM

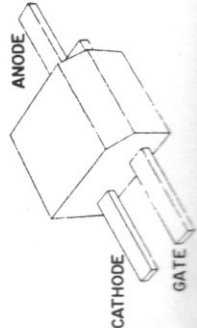
"PISTON"



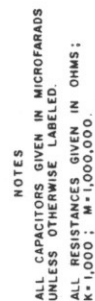
REVERSIBLE USED WITH SETTERBOARD

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS
UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS;
K = 1,000; M = 1,000,000.

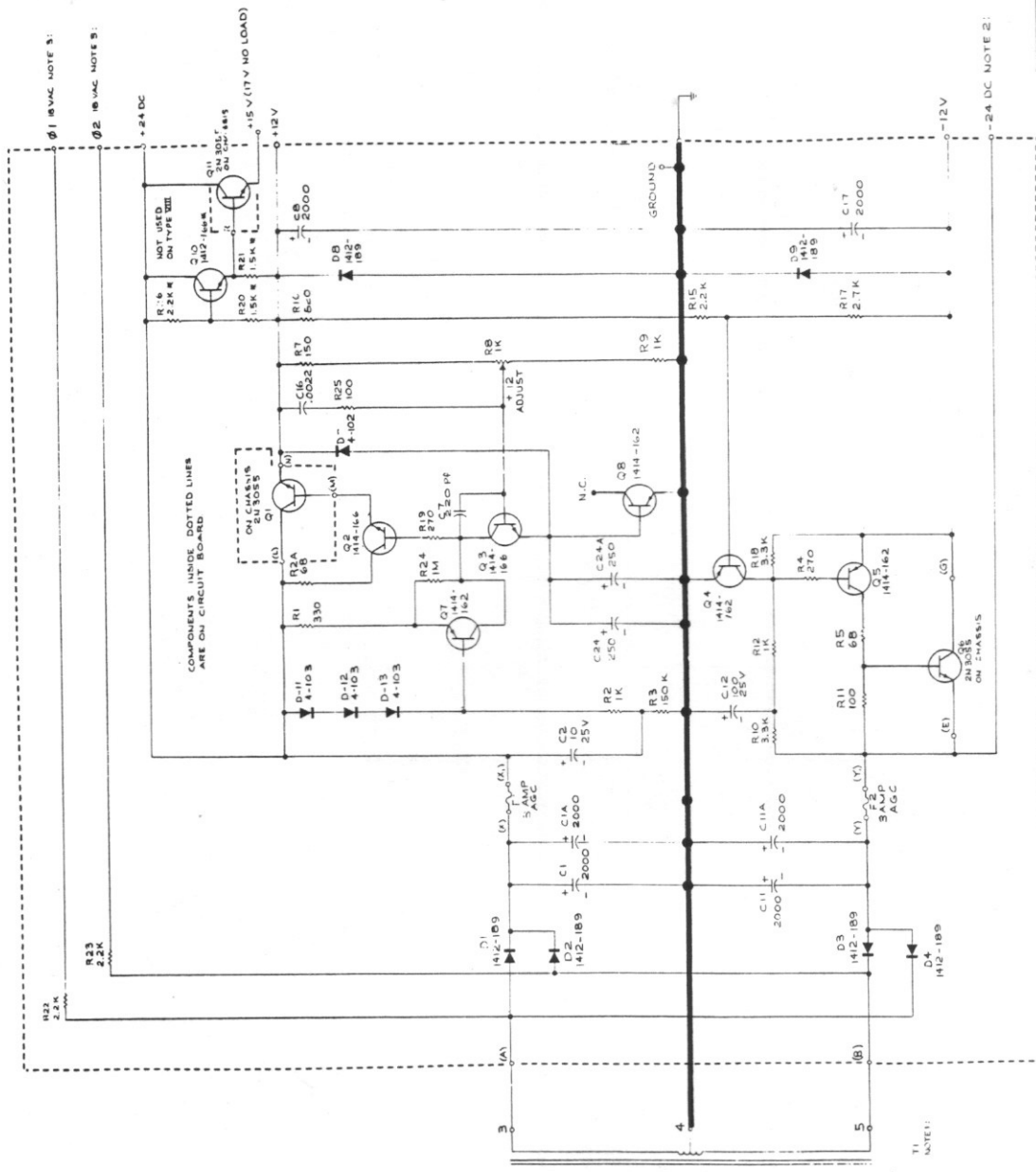


REVISIONS				RODGERS ORGAN COMPANY			
LTR	DATE	BY	DESCRIPTION	DATE	SCALE	MODEL	TITLE
C	4-16-71	J.W.	ECO-3025				
B	9-27-68	WU	CORRECTIONS - ADDITIONS				
A	8-13-68	WU	CORRECTIONS - ADDITIONS				
				DATE	SCALE	MODEL	TITLE
				4-10-68	50		1280C
				REVERSIBLE FOR NPN ORGANS			

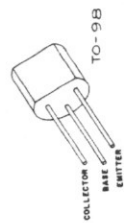
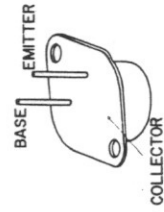


TRANSISTOR IDENTIFICATION			
RUC Part No's.		Nearest ZIN Type	End Color
In-Line TO - 9:	Triangular TO - 18, TO - 18A		
1414 - 176	1414 - 162	3702	Red
1414 - 172	1414 - 166	3706	Blue
1414 - 167	1414 - 167	3707	Green
1414 - 174	1414 - 175	3708	White

[illegible]

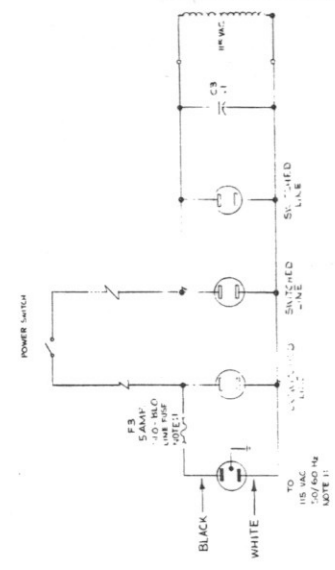


1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----



TRANSISTOR IDENTIFICATION

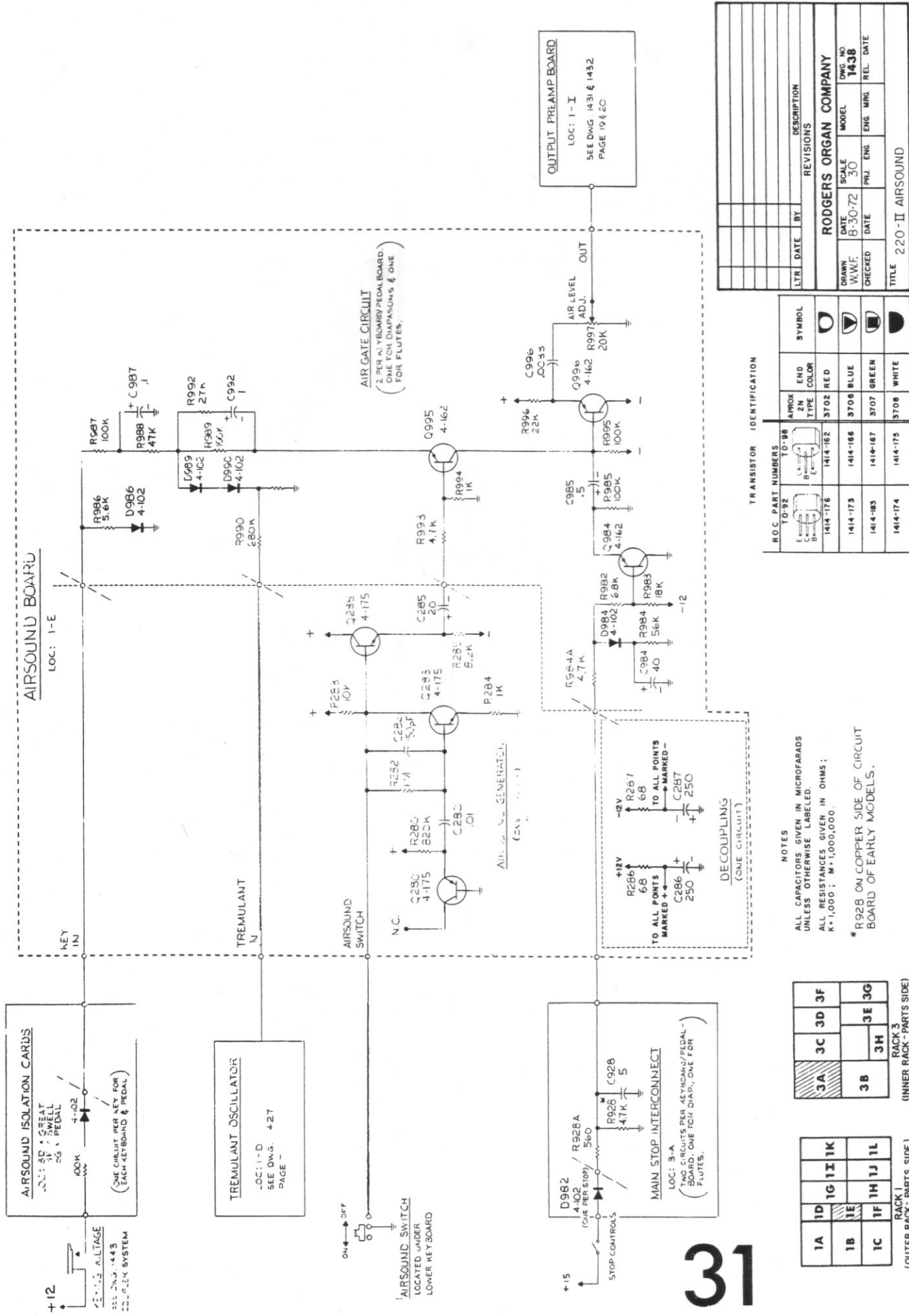
ROC PART NUMBER	TRANSISTOR	END	SYMBOL
1414-172	1414-172	3708 RED	
1414-173	1414-173	3708 BLUE	
1414-174	1414-174	3708 GREEN	
1414-175	1414-175	3708 WHITE	

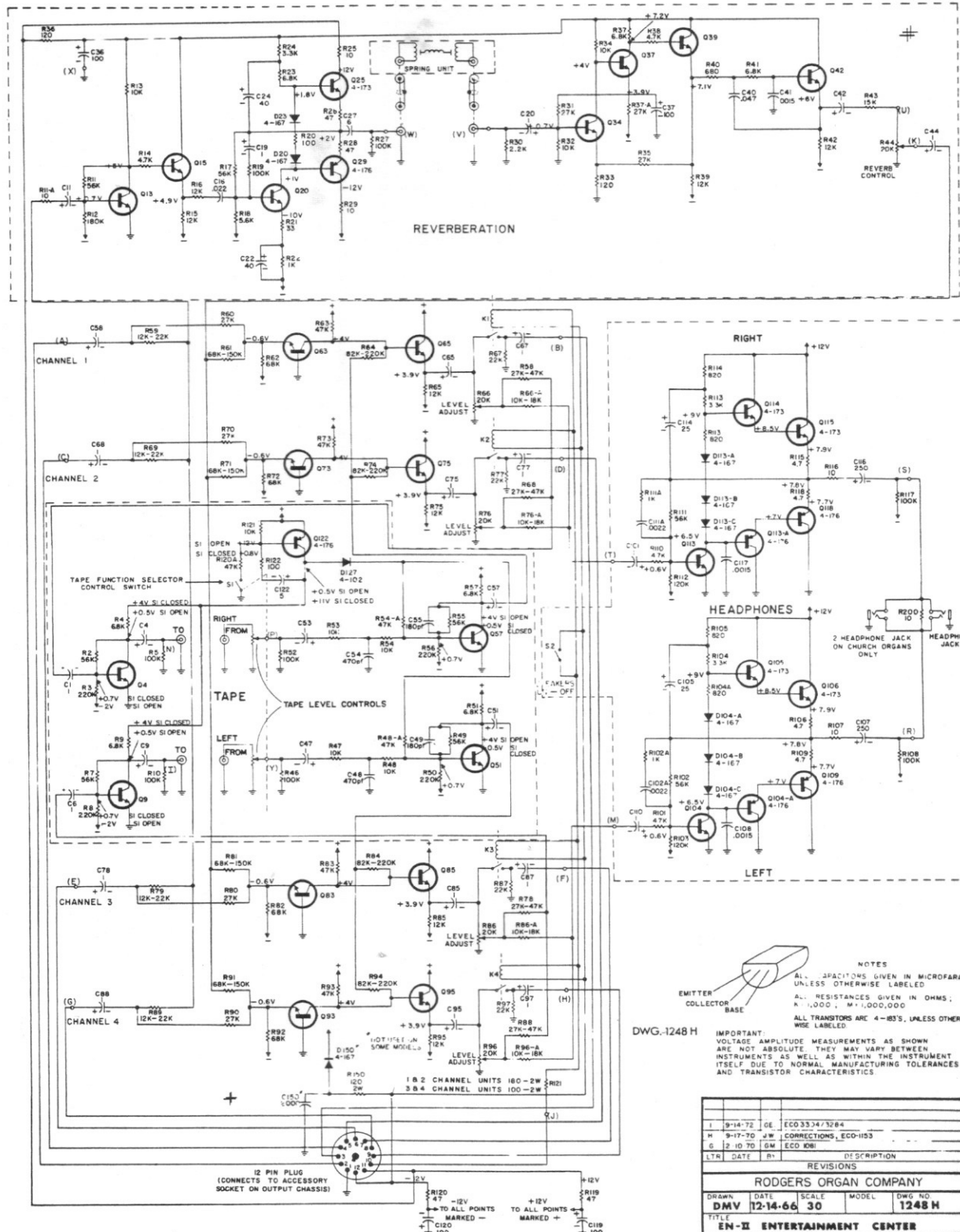


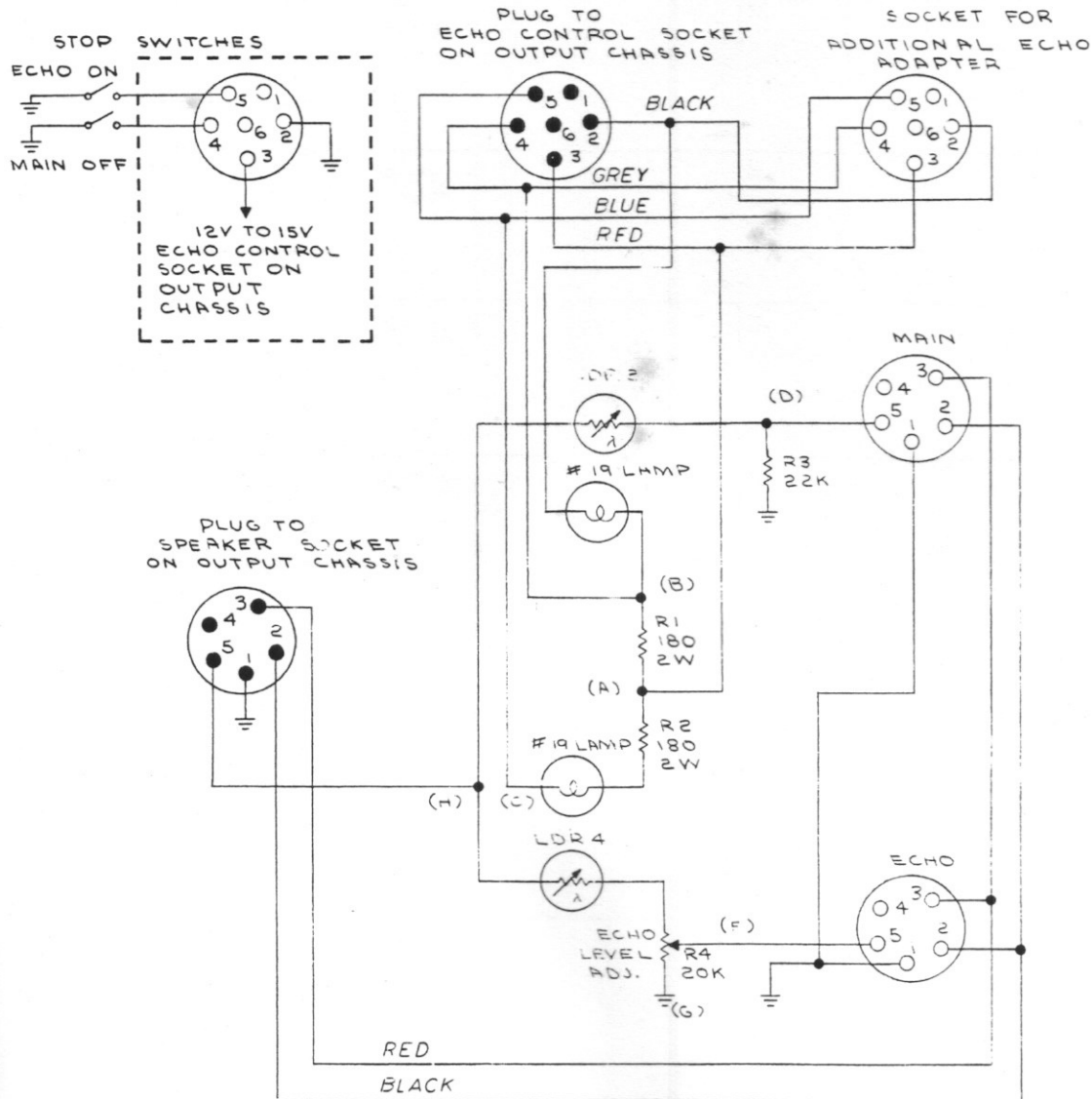
NOTE 1: ON CURRENT MODELS, T1 HAS A 250 VDC SECONDARY, ES IS A 3 AMP SEC-BLO, CS IS RATED AT 50V. CS ALSO USED FOR NUCS BACK LIGHTS.

NOTE 2: SINGLE 250V CAPACITOR-LOCATED ON PRINTED CIRCUIT BOARD.

NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED
ALL RESISTANCES GIVEN IN OHMS
K=1,000; M=1,000,000





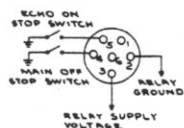
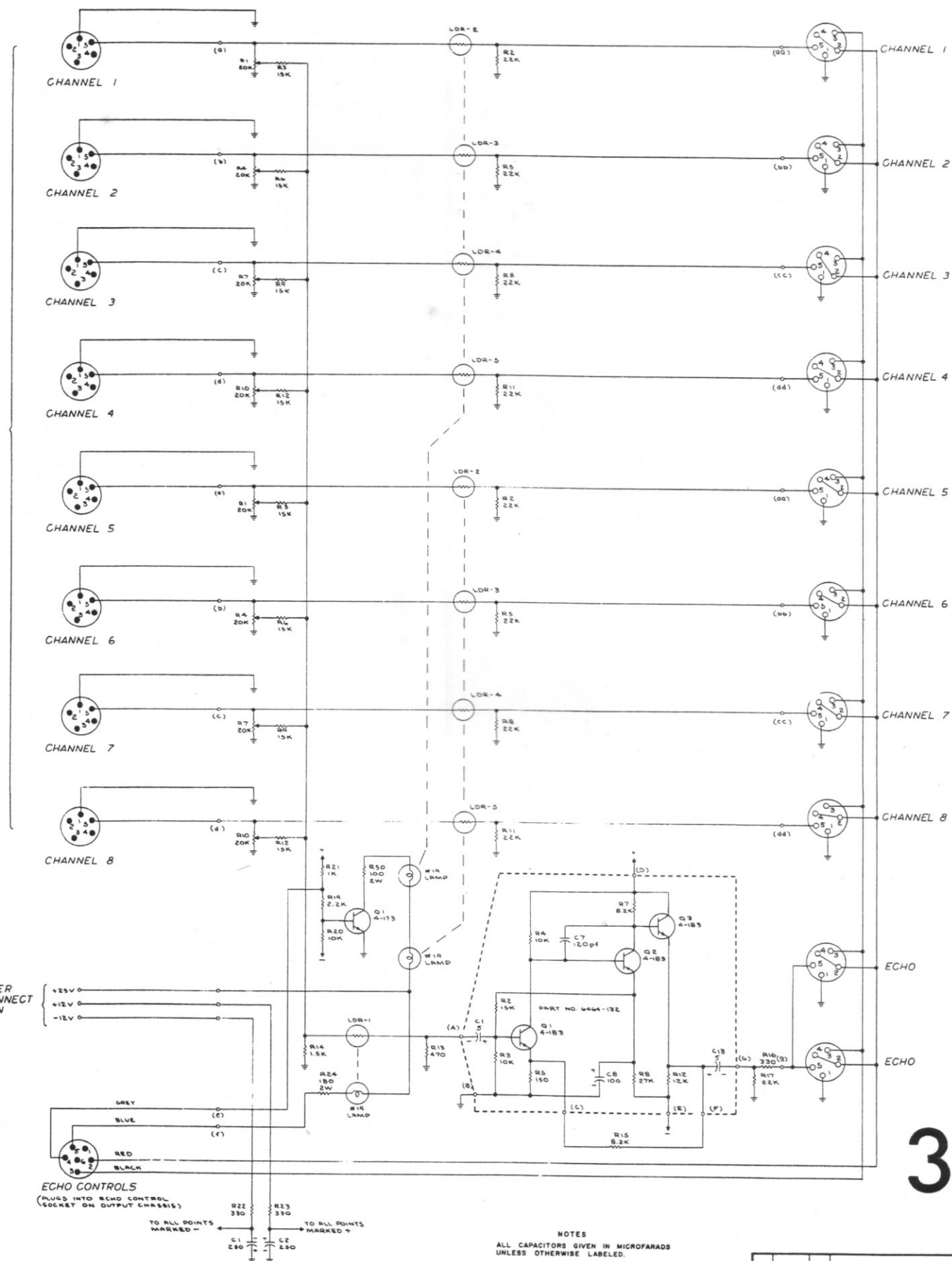


33

B	8-30-71	GM	ECO-3087
A	2-16-67	DBL	LABELING MODIFIED
LTR	DATE	BY	DESCRIPTION
REVISIONS			
RODGERS ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
D.M.V.	10-12-66	50	
CHECKED	DATE	PRJ. ENG.	ENG. MRG.
BT.	15 SEPT 71		
DWG. NO.			
1180 B			
REL. DATE			
TITLE			
EC. II B ECHO ADAPTER			

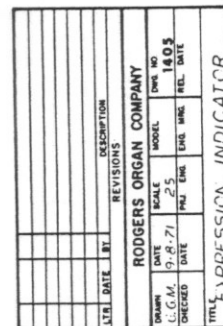
TO
OUTPUT
SOCKETS
ON
OUTPUT
CHASSIS

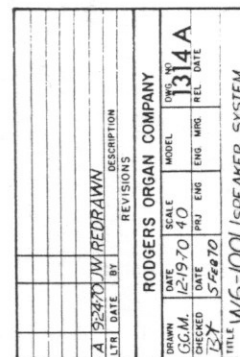
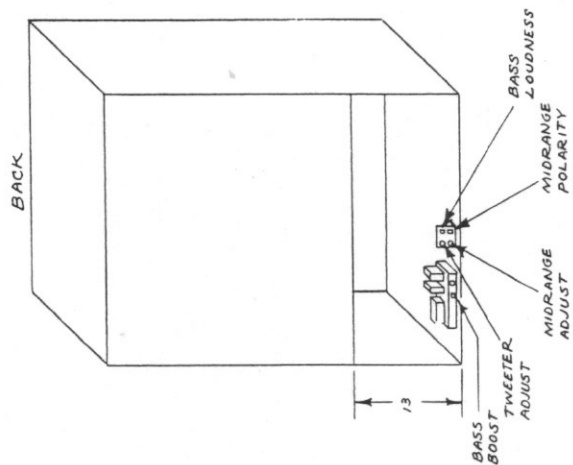
TO POWER
INTERCONNECT
IN ORGAN

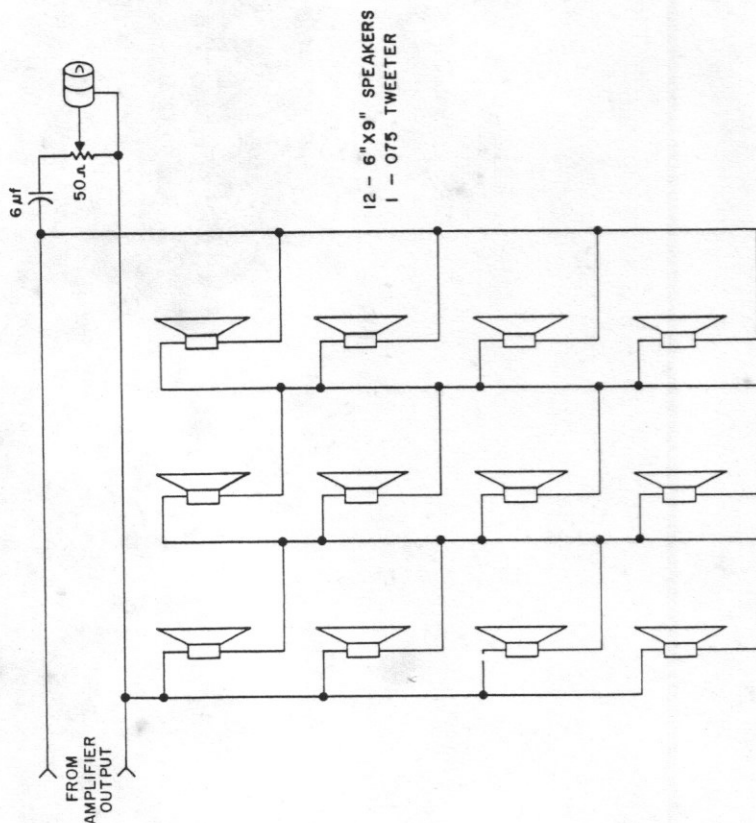
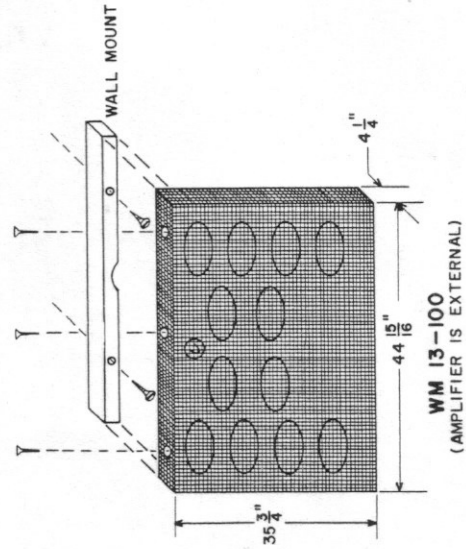
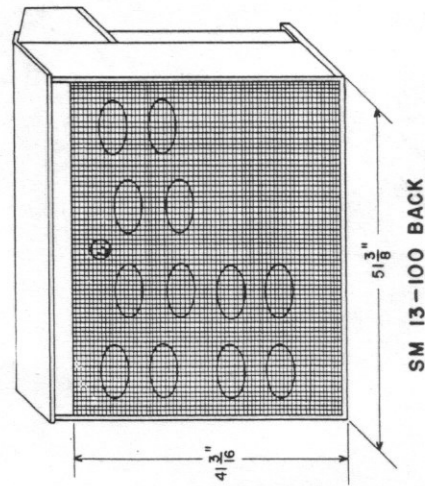
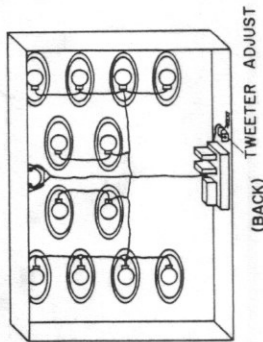
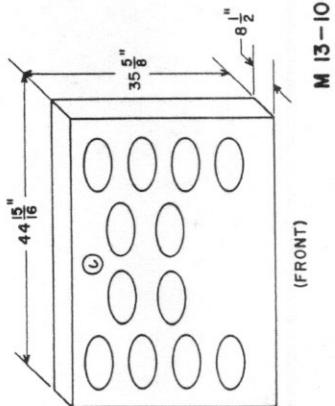
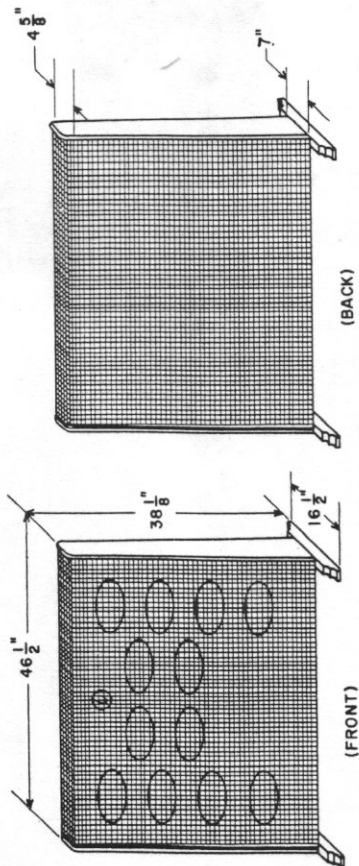


34

REVISIONS			
DATE	BY	DESCRIPTION	
RODGERS ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
G-G-M	12-30-71	25	1413
CHECKED	DATE	PRJ. ENG.	REL. DATE
TITLE			
EC 77 MULTICHANNEL ECHO ADAPTOR			







REV	DATE	BY	DESCRIPTION
B	4-9-68	DV	TM 13-100 DELETED
A	12-29-67	DV	REDRAWN
LTR	DATE	BY	DESCRIPTION
REVISIONS			
RODGERS ORGAN COMPANY			
DRAWN	DATE	SCALE	MODEL
DMV	12-29-67	40	1247B
TITLE	M 13-100 SPEAKER SYSTEMS		