Rodgers

TECHNICAL MANUAL

SPECIFICATION 660/990

RODGERS INSTRUMENT CORP., HILLSBORO, OREGON

1905-088

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SPECIFICATION 660/990

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SPECIFICATION 660/990

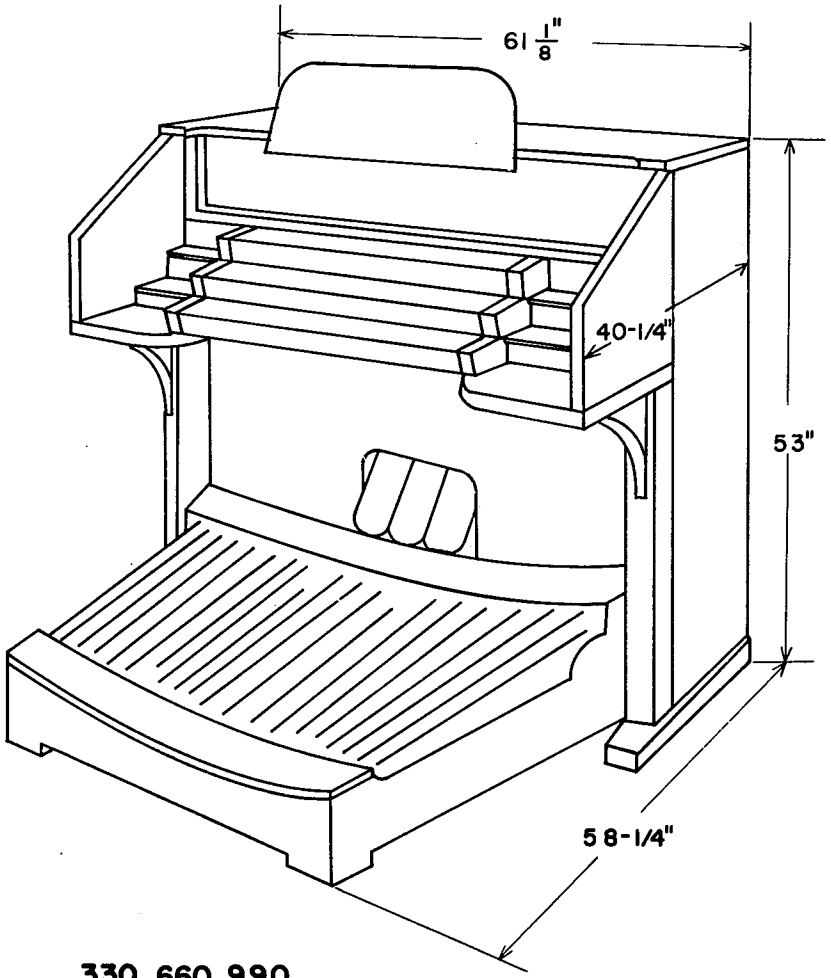
GENERAL DESCRIPTION OF THE RODGERS ORGAN

SPECIFICATION 660/990

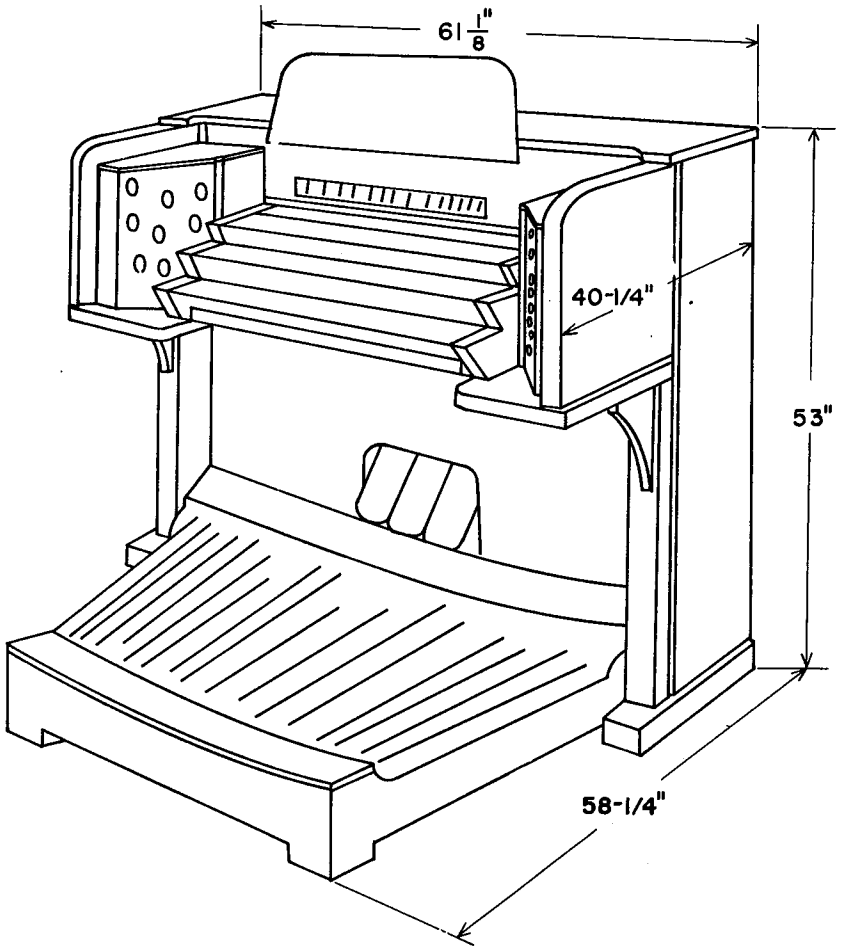
The Rodgers Specification 990 is a completely transistorized Classic organ designed for the church, studio, and home. Standard equipment includes three 61-note tilted and overhanging keyboards; 32-note concave and radiating pedalboard; matching bench; illumination for plexiglass music rack, keyboards, stop rail, and pedals; three expression pedals (including Crescendo); Sforzando; Flute Chiff; Air Sound with Activity. Standard on the Specification 990 are the Harp and Carillon. Options are Drawknobs, Computer Capture Combination Action, and Tracker Touch. The organ console and pedalboard conform fully to all A. G. O. specifications.

CONSOLE DIMENSIONS

CONSOLE WIDTH	61-1/8"
CONSOLE HEIGHT.	51-1/2"
CONSOLE DEPTH	40"
CONSOLE DEPTH, with Pedalboard .	58-1/2"
WEIGHT OF ORGAN	800 lbs., approx.



330,660,990
CONSOLE



330D,660D,990D,990
CONSOLE

2

LTR	DATE	BY	DESCRIPTION
C	6·5·73	BT	ECO 3355
B	10·28·68	WU	ERRORS
A	9·30·68	WU	NAME CHANGES
			REPLACES DWG.'S 1238 & 1239

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	4·2·68	60		1276C

TITLE
330,660,990
ORGAN CONSOLE

SPECIFICATION 660

ALL RODGERS CHURCH ORGANS COMPLY WITH AMERICAN GUILD OF ORGANIST STANDARDS

ALL RODGERS INSTRUMENTS ARE GUARANTEED FOR FIVE YEARS

ALL TONE GENERATORS CONTAINED IN CONSOLE

The RODGERS SPECIFICATION 660 is available in either STOP TABLET (pictured above) or DRAWKNOB Console (cover photo)

CONSOLE DIMENSIONS:
Height: 53"
Width: 40" (through door)
Length: 61 1/8"
Depth: 58 1/2" (including Pedals)
Minimum Pit Size: 62" x 64"

Pedal

32′ Contra Violone
16′ Principal
16′ Bourdon
16′ Lieblich Gedeckt
16′ Dulciana
8′ Octave
8′ Flute
8′ Gemshorn
4′ Choralbass
16′ Bombarde
8′ Trompette (sw)
4′ Clairon (sw)

8′ Great to Pedal
4′ Great to Pedal
8′ Swell to Pedal
4′ Swell to Pedal
8′ Choir to Pedal
4′ Choir to Pedal

Great

16′ Gemshorn
8′ Principal
8′ Bourdon
4′ Octave
4′ Spitzflöte
2-2/3′ Twelfth
2′ Super Octave
2′ Blockflöte
Mixture III
4′ Great to Great

16′ Swell to Great
8′ Swell to Great
4′ Swell to Great
16′ Choir to Great
8′ Choir to Great
4′ Choir to Great

Swell

8′ Geigen Diapason
8′ Rohrflöte
8′ Salicional
8′ Voix Celeste
8′ Flute Celeste II
4′ Prestant
4′ Nachthorn
16′ Fagotto
8′ Trompette
8′ Oboe
4′ Clairon
16′ Swell to Swell
Swell Unison Off
4′ Swell to Swell

Choir

8′ Viola
8′ Gedeckt
8′ Quintade (w/chiff)
8′ Dulciana
4′ Principal
4′ Koppelflöte
4′ Quintadena (w/chiff)
2-2/3′ Nazard
2′ Flachflöte
1-3/5′ Tierce
1′ Sifflöte
Harp
Carillon
16′ Choir to Choir
Choir to Unison Off
4′ Choir to Choir

16′ Swell to Choir
8′ Swell to Choir
4′ Swell to Choir

Combination Actions

SETTERBOARD
(in drawer under choir)
4 Swell Pistons
4 Great & Pedal Pistons
4 Choir Pistons
4 Collective Master Pistons (duplicated by Toe Studs)
1 General Cancel Piston

COMPUTER-CAPTURE
(Optional) (console-contained)
4 Swell Pistons
4 Great Pistons
4 Choir Pistons
4 Pedal Pistons (duplicated by Toe Studs)
6 General Pistons (Ind.) (duplicated by Toe Studs)
1 General Cancel Piston
1 SET Piston

Antiphonal Provisions

Swell Main Off
Swell Antiphonal On

Great/Choir Main Off
Great/Choir Antiphonal On

Balanced Expression Pedals

1. Great, Choir and Pedal
2. Swell

Balanced Crescendo Pedal

(with indicator lights)

Sforzando

Piston & Toe Stud
(with indicator light)

Tremulants

Main Tremulant
Flute Tremulant—Light
Flute Tremulant—Full

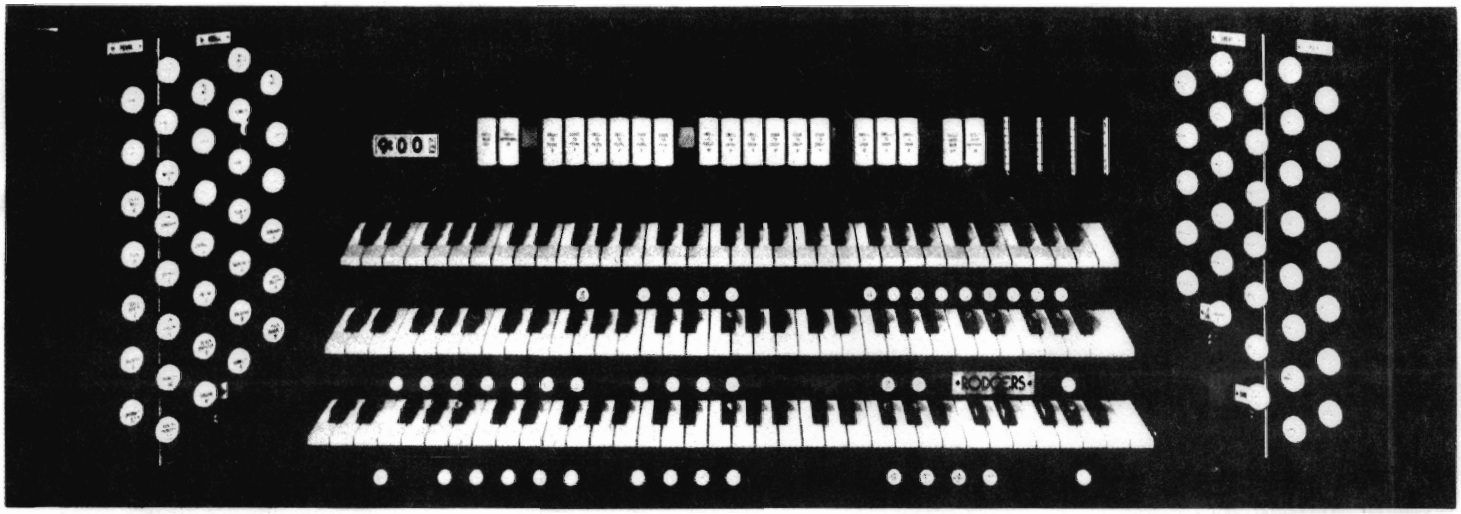
Air Sound

Tracker-Touch Keyboards

(Optional)

Reversible

Piston & Toe Stud
Great to Pedal 8′
(8′ 4′ Off)



HERITAGE 990

ALL RODGERS CHURCH ORGANS COMPLY WITH AMERICAN GUILD OF ORGANIST STANDARDS

ALL RODGERS INSTRUMENTS CARRY A 5 YEAR LIMITED WARRANTY.

The RODGERS HERITAGE 990 is available in either DRAWKNOB or LIGHTED DRAWKNOB Console.

CONSOLE DIMENSIONS:
Height: 53" (135 cm)
Width: 40" (101-1/2 cm) (through door)
Length: 61-1/8" (155 cm)
Depth: 58-1/2" (149 cm) (including Pedals)
Weight: 810 pounds

Pedal
32′ Contra Violone
16′ Principal
16′ Bourdon
16′ Lieblich Gedeckt
16′ Violone (sw)
8′ Octave
8′ Flute
8′ Gemshorn (sw)
4′ Choralbass
Mixture II
16′ Bombarde
8′ Trompette (sw)
4′ Clairon (sw)

8′ Great to Pedal
4′ Great to Pedal
8′ Swell to Pedal
4′ Swell to Pedal
8′ Choir to Pedal
4′ Choir to Pedal

Great
16′ Gemshorn
8′ Principal
8′ Bourdon
8′ Gemshorn
4′ Octave
4′ Spitzflöte
2-2/3′ Twelfth
2′ Super Octave
2′ Blockflöte
Mixture III
4′ Great to Great

16′ Swell to Great
8′ Swell to Great
4′ Swell to Great
16′ Choir to Great
8′ Choir to Great
4′ Choir to Great

Swell
16′ Violone
8′ Geigen Diapason
8′ Rohrflöte
8′ Salicional
8′ Voix Celeste
8′ Flute Celeste II
4′ Prestant
4′ Nachthorn
4′ Gemshorn
2′ Doublette
Plein Jeu III
16′ Fagotto
8′ Trompette
8′ Oboe
8′ Vox Humana
4′ Clairon
Tremulant
16′ Swell to Swell
Swell Unison Off
4′ Swell to Swell

Choir
8′ Viola
8′ Viola Celeste
8′ Gedeckt
8′ Quintade
8′ Unda Maris II
8′ Aeoline
4′ Principal
4′ Koppelflöte
4′ Quintadena
2-2/3′ Nazard
2′ Flachflöte
1-3/5′ Tierce
1-1/3′ Nineteenth
1′ Sifflöte
8′ Krummhorn
8′ Schalmei
Harp
Carillon
Tremulant
16′ Choir to Choir
Choir Unison Off
4′ Choir to Choir

16′ Swell to Choir
8′ Swell to Choir
4′ Swell to Choir

Computer-Capture Combination Action
5 Swell Pistons
5 Great Pistons
5 Choir Pistons
5 Pedal Pistons
(duplicated by Toe Studs)
10 General Pistons (Ind.)
(duplicated by Toe Studs)
1 General Cancel Piston
4 Divisional Cancel Pistons
1 SET Piston

Antiphonal Provisions
Swell Main Off
Swell Antiphonal On

Great/Choir Main Off
Great/Choir Antiphonal On

Sforzando
Piston & Toe Stud
(with indicator light)

Balanced Expression Pedals (with indicators)
1. Great, Choir & Pedal
2. Swell

Transposer
(with illuminated indicator)
Nine position, Piston Operated

Balanced Crescendo Pedals
(with illuminated indicators)

Transients
1. Air Sound
2. Natural Activity

Reversibles
Pistons & Toe Studs
Great to Pedal 8′
(8′ 4′ Off)
Swell to Pedal 8′
(8′ 4′ Off)
Swell to Great 8′
(16′ 8′ 4′ Off)

INSTALLATION NOTES FOR THE RODGERS

SPECIFICATION 660/990

ELECTRICAL REQUIREMENTS:

Voltage	117 VAC
Frequency	60 Hertz
Power Consumption (Console Only)	800 Watts
Power Consumption, Each Tone Cabinet	150 Watts, Maximum
Power Output, Each Tone Cabinet (S100-B)	100 Watts rms

Electrical Circuits Required:

A separate circuit (15 amp-117 VAC) is desirable to avoid interference from other electrical equipment nearby.

When possible, a second circuit should be provided, with outlets in each chamber, for the Tone Cabinet complement.

Conduit, where Codes require it, for the Tone Cabinet cables which carry 15 volts DC. (Do NOT pull AC power cables through the same conduit that carries the Tone Cabinet cables.) The conduit size will be determined by the total amount of cabling that must pass through it and/or by Local Building Codes. Do NOT use conduit smaller than 3/4", thin wall.

TYPICAL SPEAKER COMBINATIONS FOR THE 660

Minimum Complement - 3 Cabinets

M13-100	- Combined Swell Voices
W3-100	- Combined Great Unit Diapason & Choir Unit Flute
P2-100 or B2-100	- Pedal Voices

4-Cabinet Installation

M13-100	- Combined Swell Voices
M13-100	- Unit Diapason
W3-100	- Choir Unit Flute
P2-100 or B2-100	- Pedal Voices

5-Cabinet Installation

M13-100	- Swell Unit Reed & Swell Celeste
M13-100	- Swell 8' & 4' Voices
M13-100	- Great Unit Diapason
W3-100	- Choir Unit Flute
P2-100 or B2-100	- Pedal Voices

Antiphonal Organ Installation - 1 Cabinet

M13-100U or WM13-100	- Combined Swell, Great, & Choir

2-Cabinet Antiphonal

M13-100U or WM13-100	- Combined Swell
M13-100U or WM13-100	- Combined Great/Choir

3-Cabinet Antiphonal - Full Antiphonal

M13-100U or WM13-100	- Combined Swell
M13-100U or WM13-100	- Combined Great/Choir
B2-100 (or P2-100, or W2-100)	- Pedal Voices

LIST OF OUTPUT CHANNELS ON THE 660,

AND STOPS ASSOCIATED WITH EACH

There are five general output channels on the Specification 660:

SWELL A SWELL B GREAT/CHOIR A GREAT/CHOIR B PEDAL

In addition, there are three Antiphonal channels which provide "echo," if desired, as well as the Outdoor Carillon, which allows the Unit Flute to be played through an outdoor speaker system (T4-100).

SWELL UNIT REED, Celeste	Swell	- 16' Fagotto, 8' Trompette, 4' Clairon, 8' Voix Celeste, Celeste portion of 8' Flute Celeste II
	Pedal	- 8' Trompette, 4' Clairon
8', 4' SWELL	Swell	- 8' Geigen Diapason, 8' Rohrflote, Flute portion of 8' Flute Celeste II, 8' Salicional, 4' Prestant, 4' Nachthorn, 8' Oboe
UNIT DIAPASON	Great	- 16' Gemshorn, 8' Principal, 4' Octave, 2-2/3' Twelfth, 2' Super Octave, Mixture III
	Choir	- 8' Viola, 8' Dulciana, 4' Principal
	Pedal	- 8' Octave, 8' Gemshorn, 4' Choralbass
UNIT FLUTE	Great	- 8' Bourdon, 4' Spitzflote, 2' Blockflote
	Choir	- 8' Gedeckt, 8' Quintade, 4' Koppelflote, 4' Quintadena, 2-2/3' Nazard, 2' Flachflote, 1-3/5' Tierce, 1' Sifflote, Harp, Carillon
	Pedal	- 16' Lieblich Gedeckt, 8' Flute
PEDAL	Pedal	- 32' Contra Violone, 16' Principal, 16' Bourdon, 16' Dulciana, 16' Bombarde

SWELL ECHO	Carries all Swell voices combined
GREAT/CHOIR ECHO	Carries Unit Diapason & Unit Flute Combined
PEDAL ECHO	Carries all 16' & 32' Pedal voices
OUTDOOR CARILLON	Carries Unit Flute, unexpressed

TYPICAL SPEAKER COMBINATIONS FOR THE 990

Minimum Complement - 3 Cabinets

W6-100	Combined Swell Voices
W6-100	Combined Great & Choir Voices
P2-100 or W6-100	16' & 32' Pedal Voices

4-Cabinet Installation

W6-100	Combined Swell Voices
M13-100	Great Unit Diapason & Choir Celeste
W6-100	Choir Unit Flute & 8' Choir Voices
P2-100 or W6-100	16' & 32' Pedal Voices

6-Cabinet Installation

M13-100	Swell Unit Reed & Swell Celeste
W6-100	Swell Unit Gemshorn, 8' & 4' Flues & other Reeds
M13-100	Great Unit Diapason & Choir Celeste
W6-100	Choir Unit Flute & 8' Choir Voices
P2-100 or W6-100	16' & 32' Pedal Voices
H-1 Horn	8' Ch Reed Option

Antiphonal Organ Installation - 1 Cabinet

M13-100U or WM 13-100	Combined Swell, Great, & Choir

2-Cabinet Antiphonal

M13-100U or WM13-100	Combined Swell
M13-100U or WM13-100	Combined Great/Choir

3-Cabinet Antiphonal - Full Antiphonal

M13-100U or WM13-100	Combined Swell
M13-100U or WM13-100	Combined Great/Choir
P2-100 or W6-100	16' & 32' Pedal Voices

Revised August, 1970

LIST OF OUTPUT CHANNELS ON THE 990,

AND STOPS ASSOCIATED WITH EACH

There are five Main output channels on the Specification 990.

In addition, there are three Antiphonal channels which provide "echo," if desired, as well as the Outdoor Carillon, which allows the Unit Flute to be played through an outdoor speaker system (T4-100).

SWELL A

SWELL UNIT REED, CELESTE

SWELL - 16' Fagotto, 8' Trompette, 4' Clairon, 8' Voix Celeste, Celeste portion of 8' Flute Celeste II

PEDAL - 8' Trompette (SW), 4' Clairon (SW)

SWELL B

SWELL FLUES & OTHER REEDS

SWELL - 16' Violone, 8' Geigen Diapason, 8' Rohrflote, 8' Salicional, Unison portion of 8' Flute Celeste II, 4' Prestant, 4' Nachthorn, 4' Gemshorn, 2' Doublette, Plein Jeu III, 8' Oboe, 8' Vox Humana

PEDAL - 16' Violone (SW), 8' Gemshorn (SW)

GREAT/CHOIR A

UNIT DIAPASON & CHOIR CELESTE

GREAT - 16' Gemshorn, 8' Principal, 8' Gemshorn, 4' Octave, 2-2/3' Twelfth, 2' Super Octave, Mixture III

CHOIR - 4' Principal, 1-1/3' Nineteenth, 8' Viola Celeste, Celeste portion of 8' Unda Maris II

PEDAL - 8' Octave, 4' Choralbass, Mixture II, Upper portion of 32' Contra Violone

GREAT/CHOIR B

UNIT FLUTE, 8' CHOIR VOICES	GREAT	- 8' Bourdon, 4' Spitzflote, 2' Blockflote
	CHOIR	- 8' Viola, 8' Gedeckt, 8' Quintade, Unison portion of 8' Unda Maris II, 8' Aeoline, 4' Koppelflote, 4' Quintadena, 2-2/3' Nazard, 2' Flachflote, 1-3/5' Tierce, 1' Sifflote, 8' Krummhorn, 8' Schalmei, Harp, Carillon
	PEDAL	- 16' Lieblich Gedeckt, 8' Flute

PEDAL

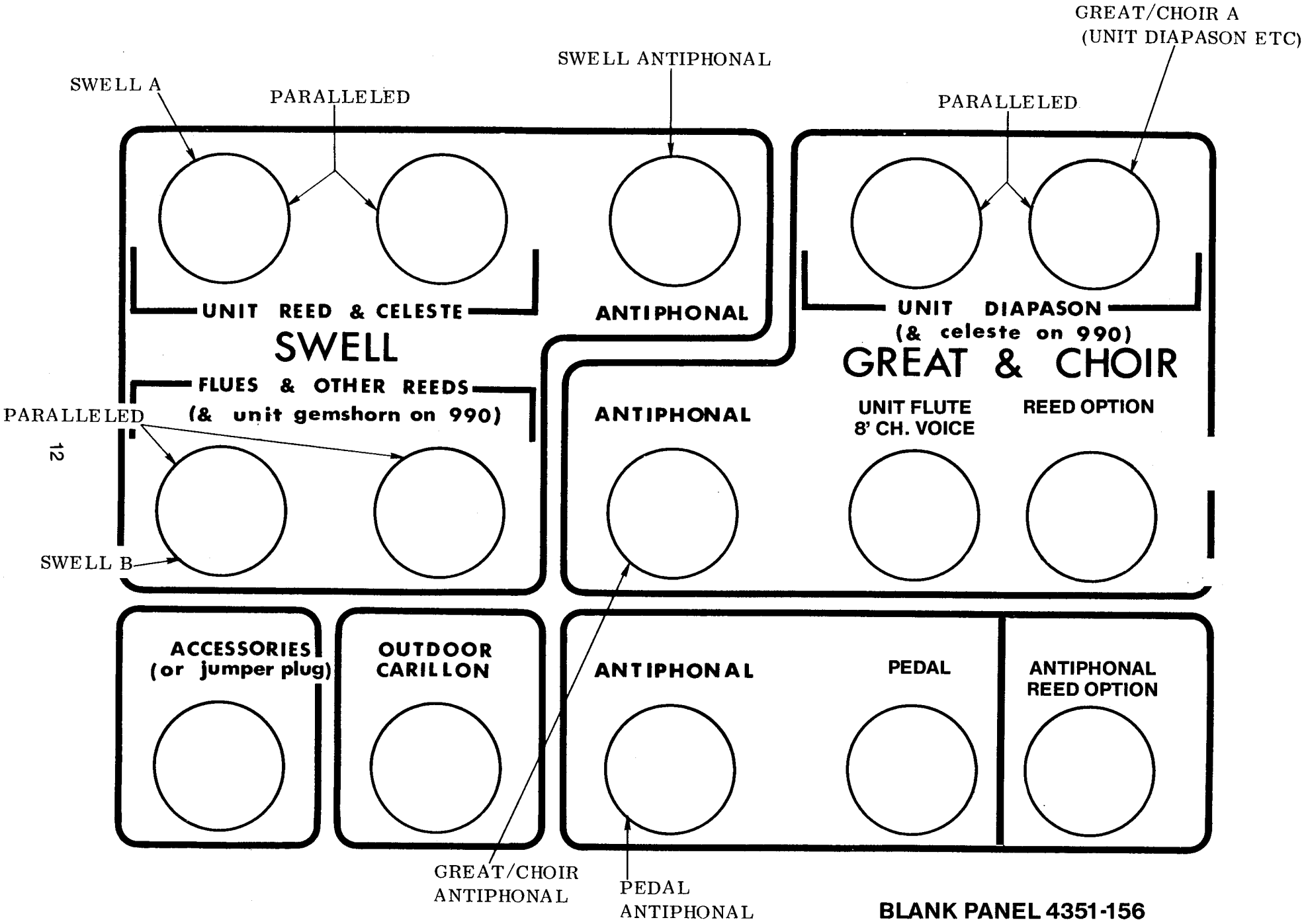
PEDAL VOICES	PEDAL	- 32' Contra Violone, 16' Principal, 16' Bourdon, 16' Bombarde

SWELL ANTIPHONAL - Carries all Swell voices combined

GREAT/CHOIR ANTIPHONAL - Carries all Great, Choir voices, and Pedal 8' & 4' Voices, except Swell borrows.

PEDAL ANTIPHONAL - Carries 16' & 32' Pedal Voices, same as Pedal Main

OUTDOOR CARILLON - Carries Unit Flute, unexpressed



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660/990 OUTPUT PANEL

BLANK PANEL 4351-156
SILK SCREEN 3039
ASSEMBLED PANEL 6551-156

DISASSEMBLY PROCEDURE

Specifications 660 and 990

I. TO GAIN ACCESS TO THE GENERATOR RACKS, POWER SUPPLY, OUTPUT CHASSIS, AND DIODE GATES/SWITCHES:

A. Remove the Back of the organ by removing three bronze wood screws along the top edge of the Back, and one in each side of the Back.

B. Move the Rolltop to the forward, or closed position.

C. Remove the rack screws: one through the bottom rail, and one through the top metal plate on each rack.

II. TO GAIN ACCESS TO THE STOP TAB/DRAWKNOB AND KEY CONTACTS:

A. Remove three bronze wood screws located in the Upper Back, just above the top of the Back.

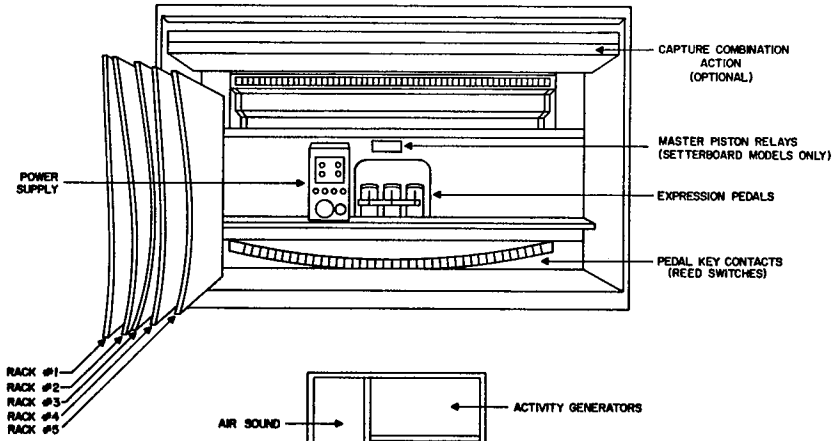
B. Slide the Top evenly toward the front of the console, about 1/2 inch. When free of the guide screws, lift the Top up and off the console.

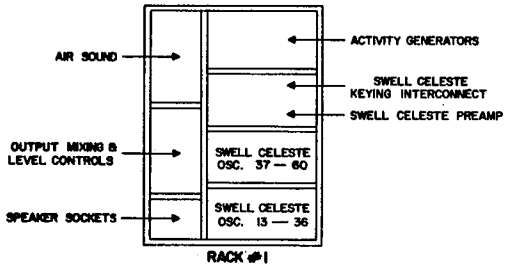
C. Move Rolltop to the forward, or closed position.

D. Pull Rolltop towards the rear again, lifting the Top up and out of the guide slots. Remove it carefully.

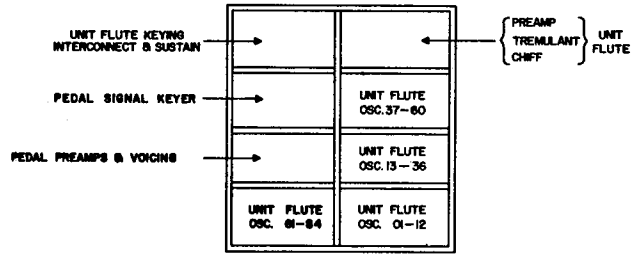
E. Stop Rail is now accessible, and hinged at each end to allow it to move in an upward direction.

F. The Choir Keyboard has hold-down screws (one under each key cheek) to secure them to the console deck. The Swell and Great manuals are hinged independently, and can be raised up for under-the-keys inspection.





RACK #1



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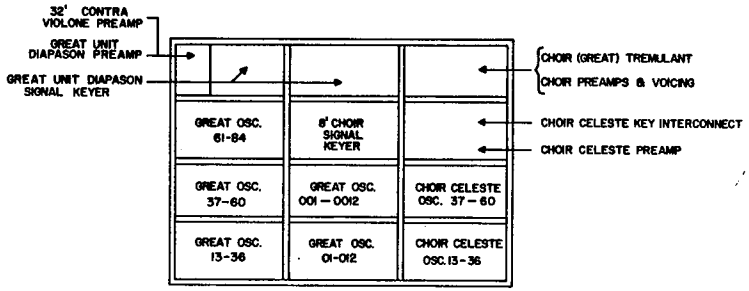
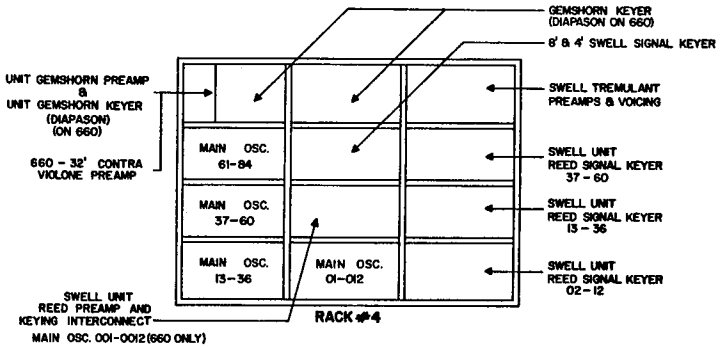
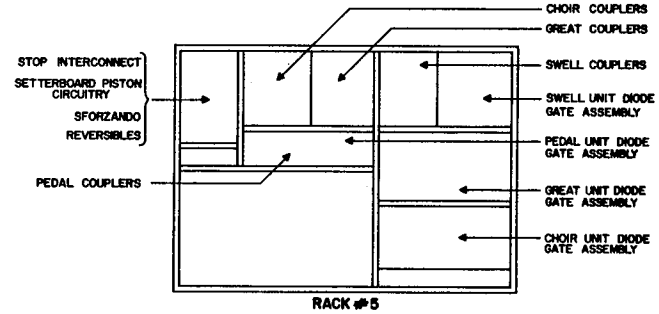


RACK #3 (990 ONLY)



RACK #4



RACK #5

LTR	DATE	BY	DESCRIPTION
E	2-14-69	GM	CORRECTIONS
D	12-10-68	DV	8226-35341/38009,38005
C	10-15-68	DV	8177,8178/35328,38001
B	9-26-68	WU	CORRECTIONS
A	8-20-68	WU	DESIGN CHANGES

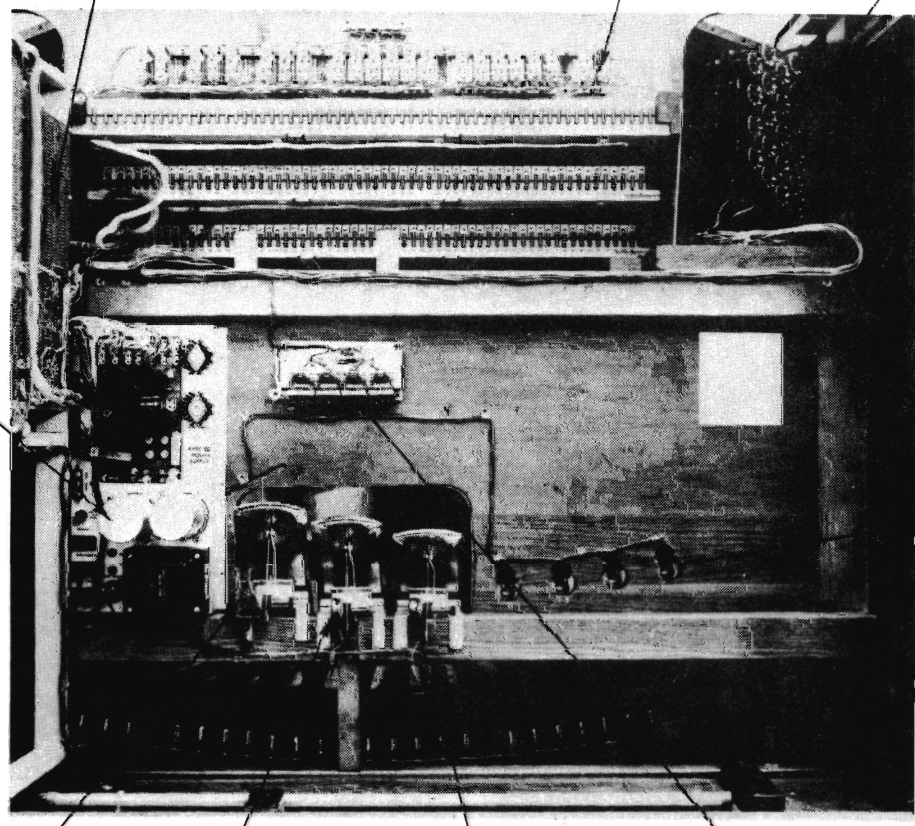
REVISIONS

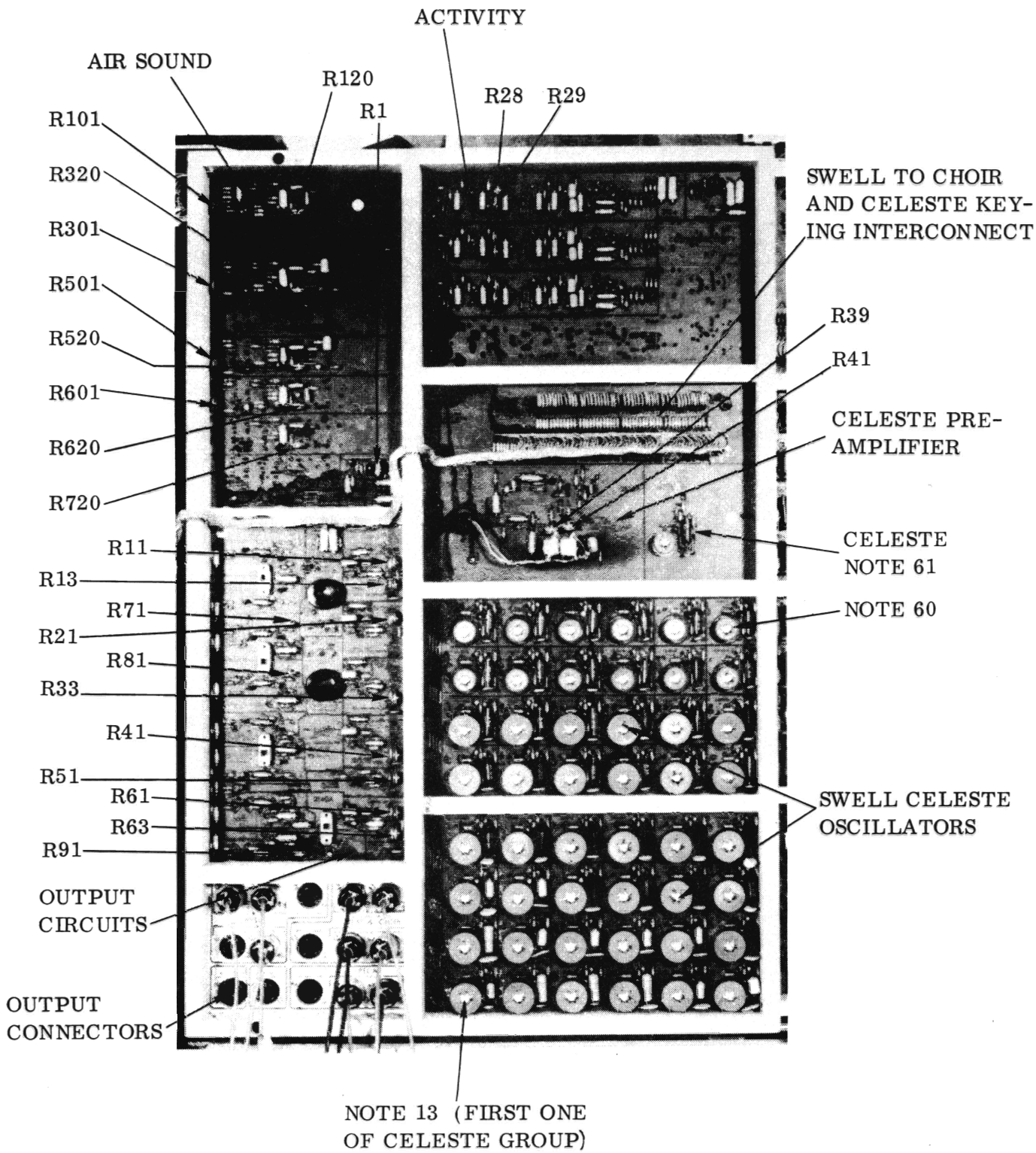
RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	7-19-68	30		1267E

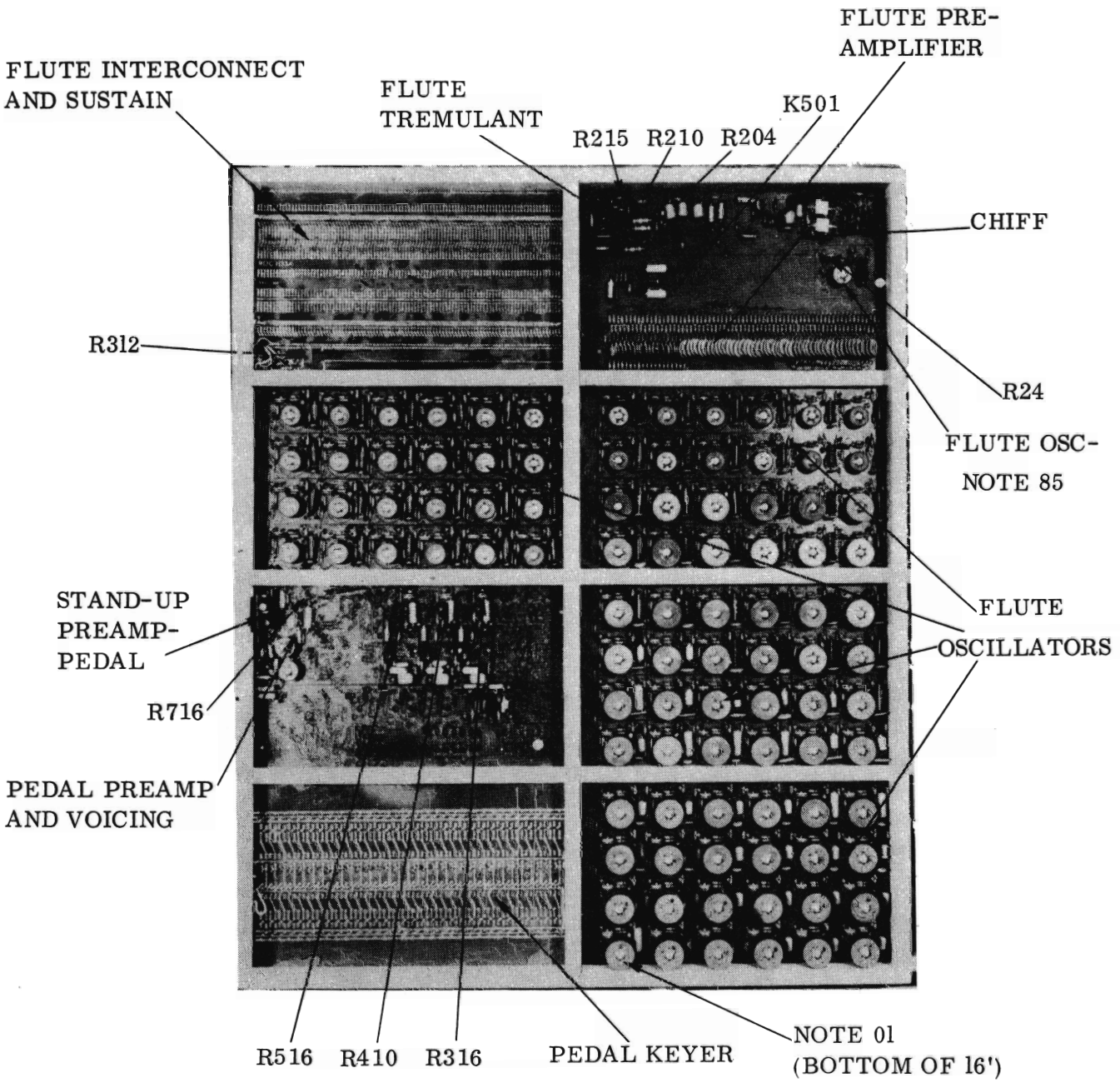
TITLE 660/990 PARTS LOCATION

RODGERS SPECIFICATION 660 - CONSOLE INTERIOR

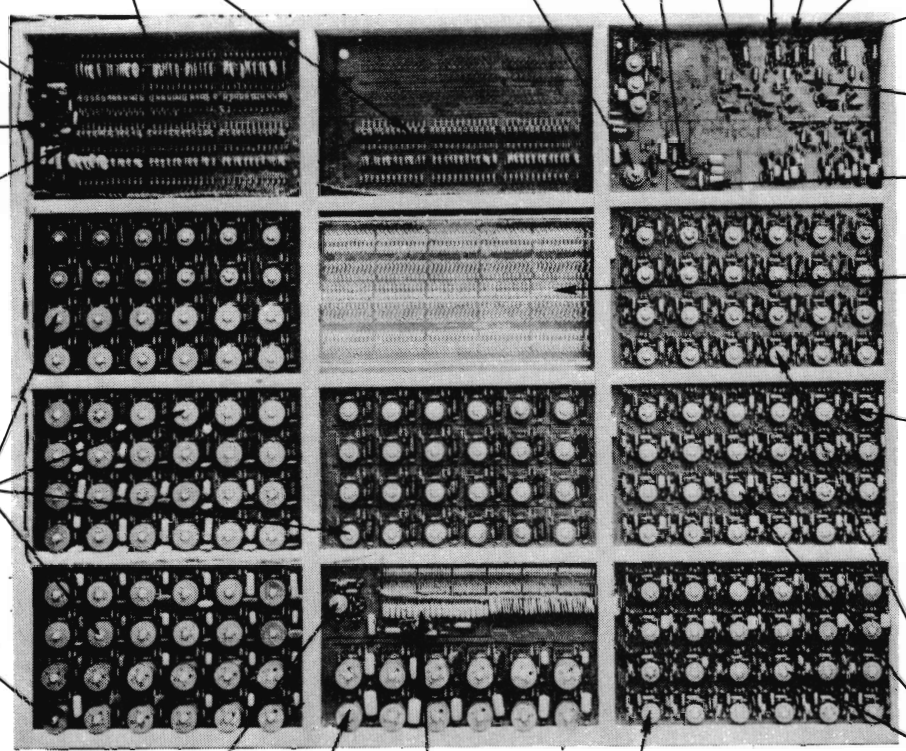



ACTIVITY
AIR SOUND
R120
R1
R28
R29
R101
R320
R301
R501
R520
R601
R620
R720
SWELL TO CHOIR AND CELESTE KEYING INTERCONNECT
R39
R41
CELESTE PRE-AMPLIFIER
CELESTE NOTE 61
NOTE 60
R11
R13
R71
R21
R81
R33
R41
R51
R61
R63
R91
SWELL CELESTE OSCILLATORS
OUTPUT CIRCUITS
OUTPUT CONNECTORS
NOTE 13 (FIRST ONE OF CELESTE GROUP)

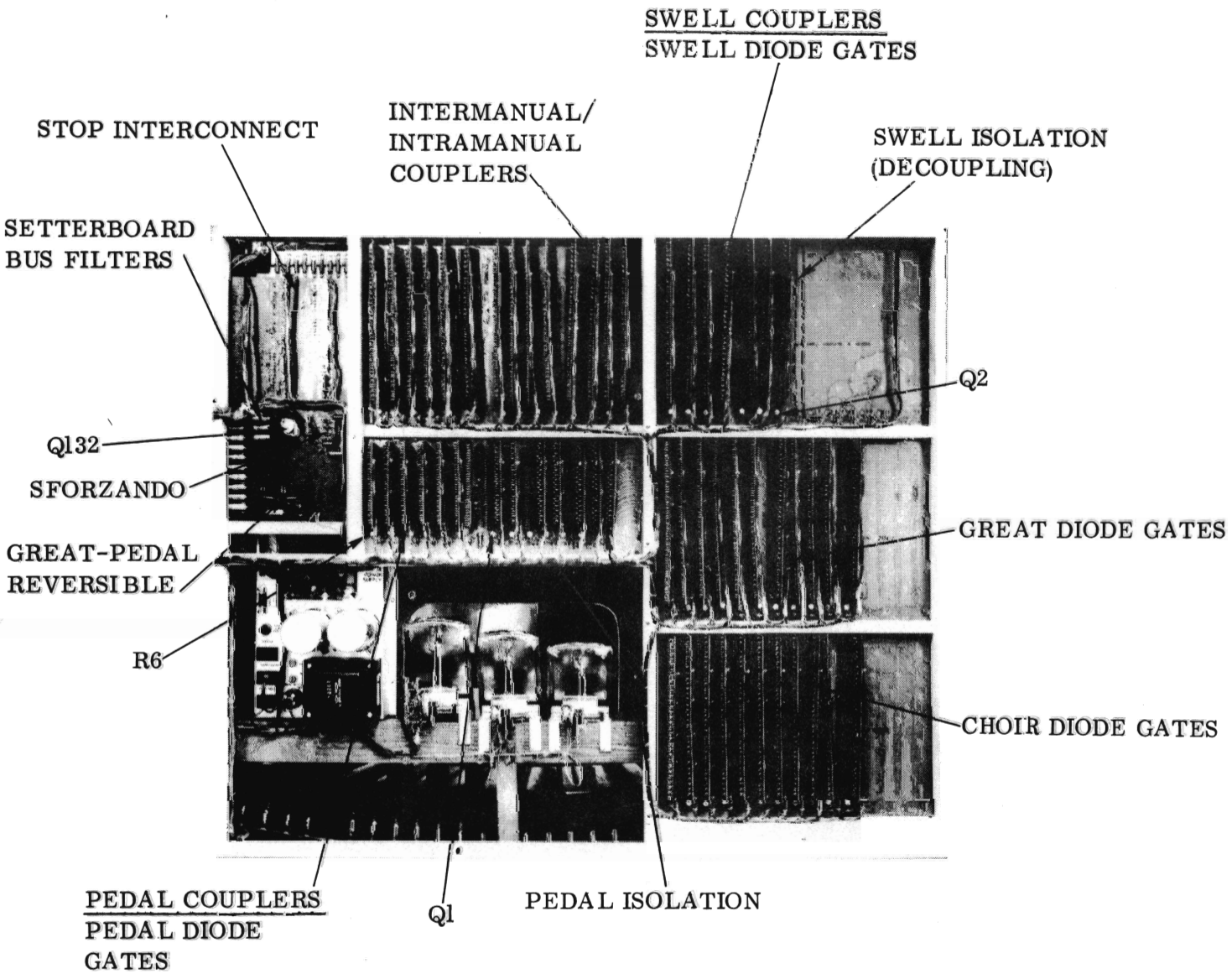
RODGERS SPECIFICATION 660 - RACK #2



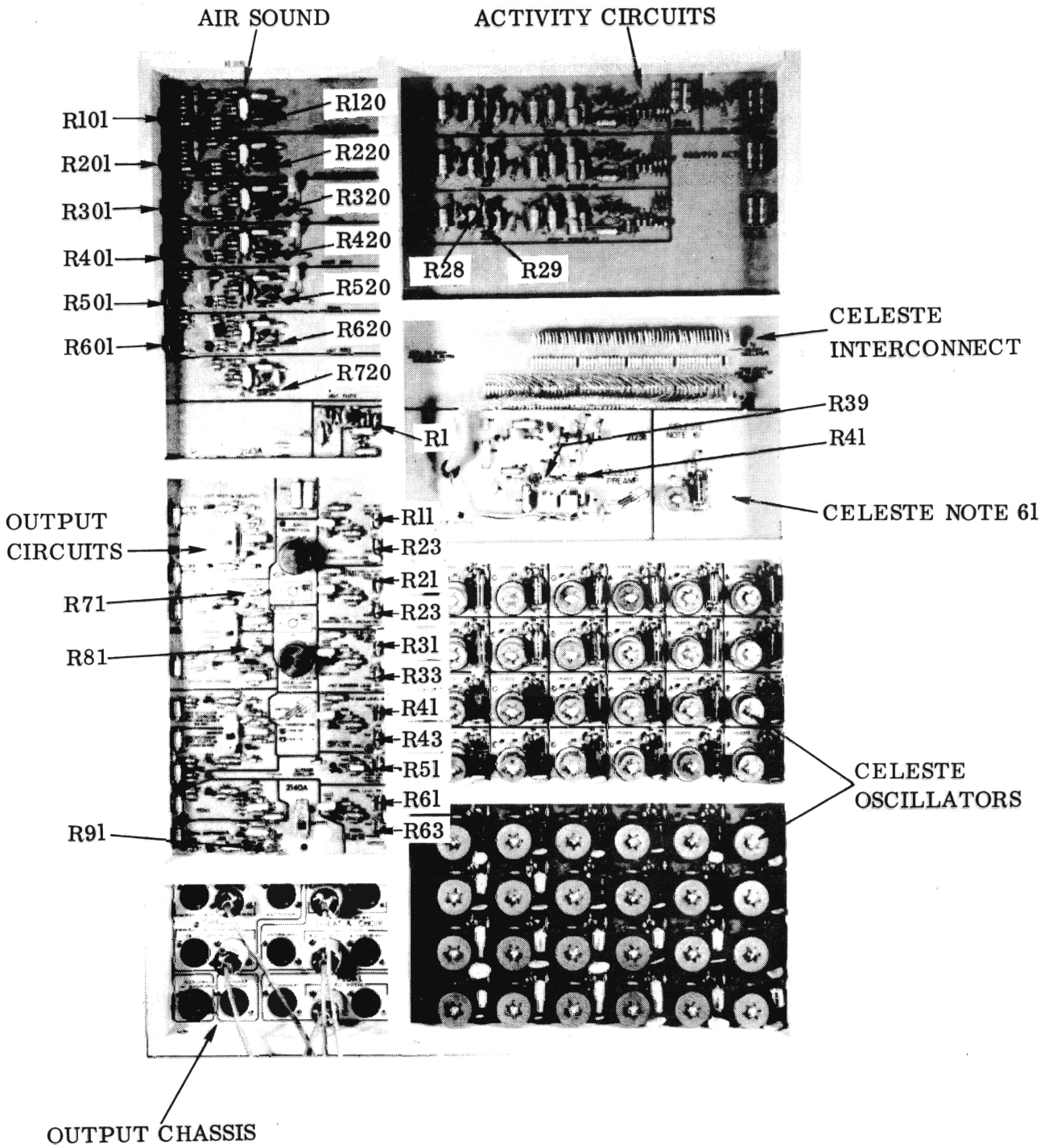
RODGERS SPECIFICATION 660 - RACK #4*



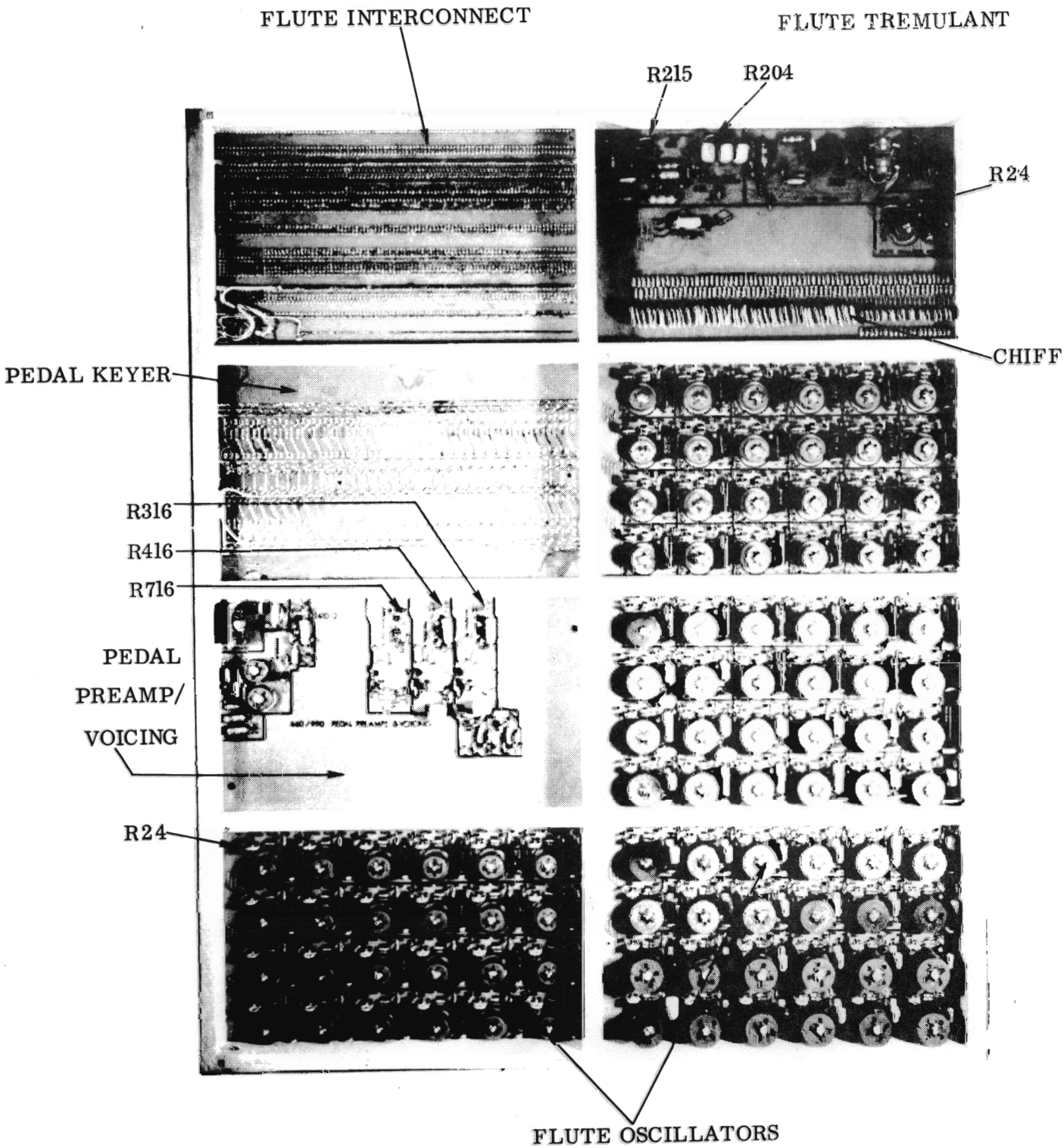
*No Rack #3 on 660

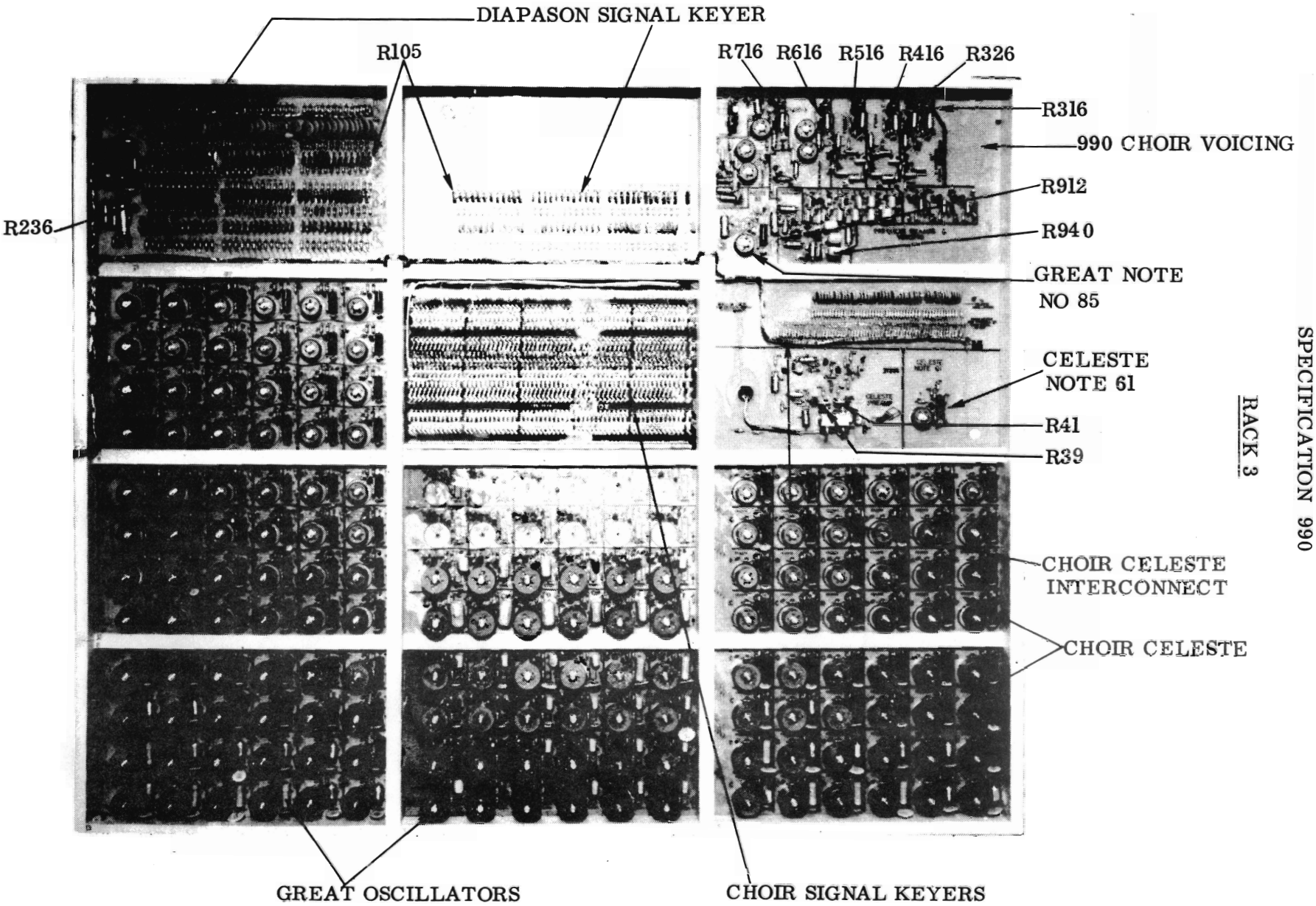

SWELL COUPLERS
SWELL DIODE GATES
STOP INTERCONNECT
INTERMANUAL/
INTRAMANUAL
COUPLERS
SWELL ISOLATION
(DECOUPLING)
SETTERBOARD
BUS FILTERS
Q2
Q132
SFORZANDO
GREAT DIODE GATES
GREAT-PEDAL
REVERSIBLE
R6
CHOIR DIODE GATES
PEDAL COUPLERS
PEDAL DIODE
GATES
Q1
PEDAL ISOLATION

RACK 1

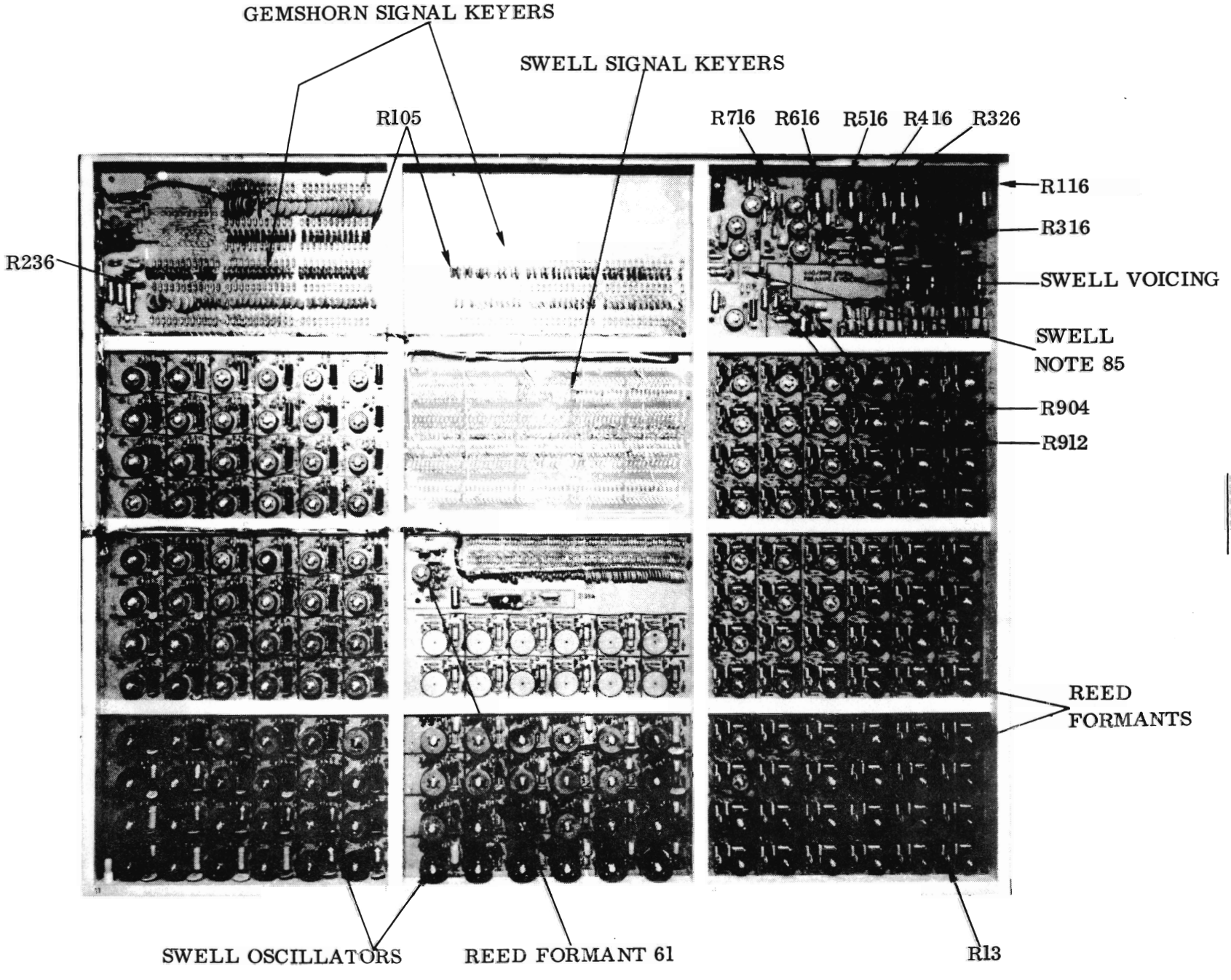

AIR SOUND
ACTIVITY CIRCUITS
R101
R201
R301
R401
R501
R601
R1120
R220
R320
R420
R520
R620
R720
R28
R29
CELESTE
INTERCONNECT
R39
R41
R1
CELESTE NOTE 61
OUTPUT
CIRCUITS
R71
R81
R91
R11
R23
R21
R23
R31
R33
R41
R43
R51
R61
R63
CELESTE
OSCILLATORS
OUTPUT CHASSIS

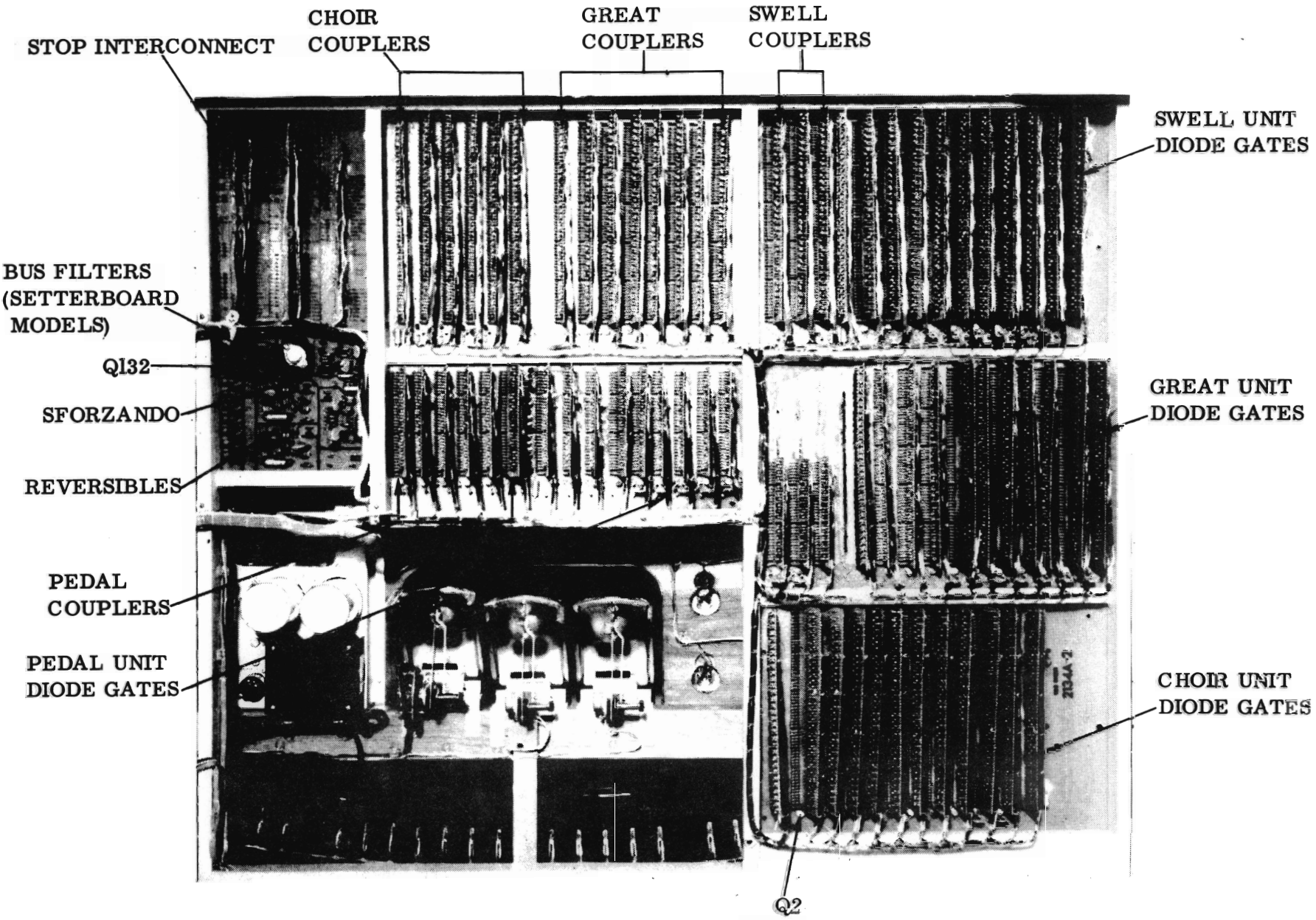
RACK 2


FLUTE INTERCONNECT
FLUTE TREMULANT
R215
R204
R24
CHIFF
PEDAL KEYER
R316
R416
R716
PEDAL
PREAMP/
VOICING
R24
FLUTE OSCILLATORS

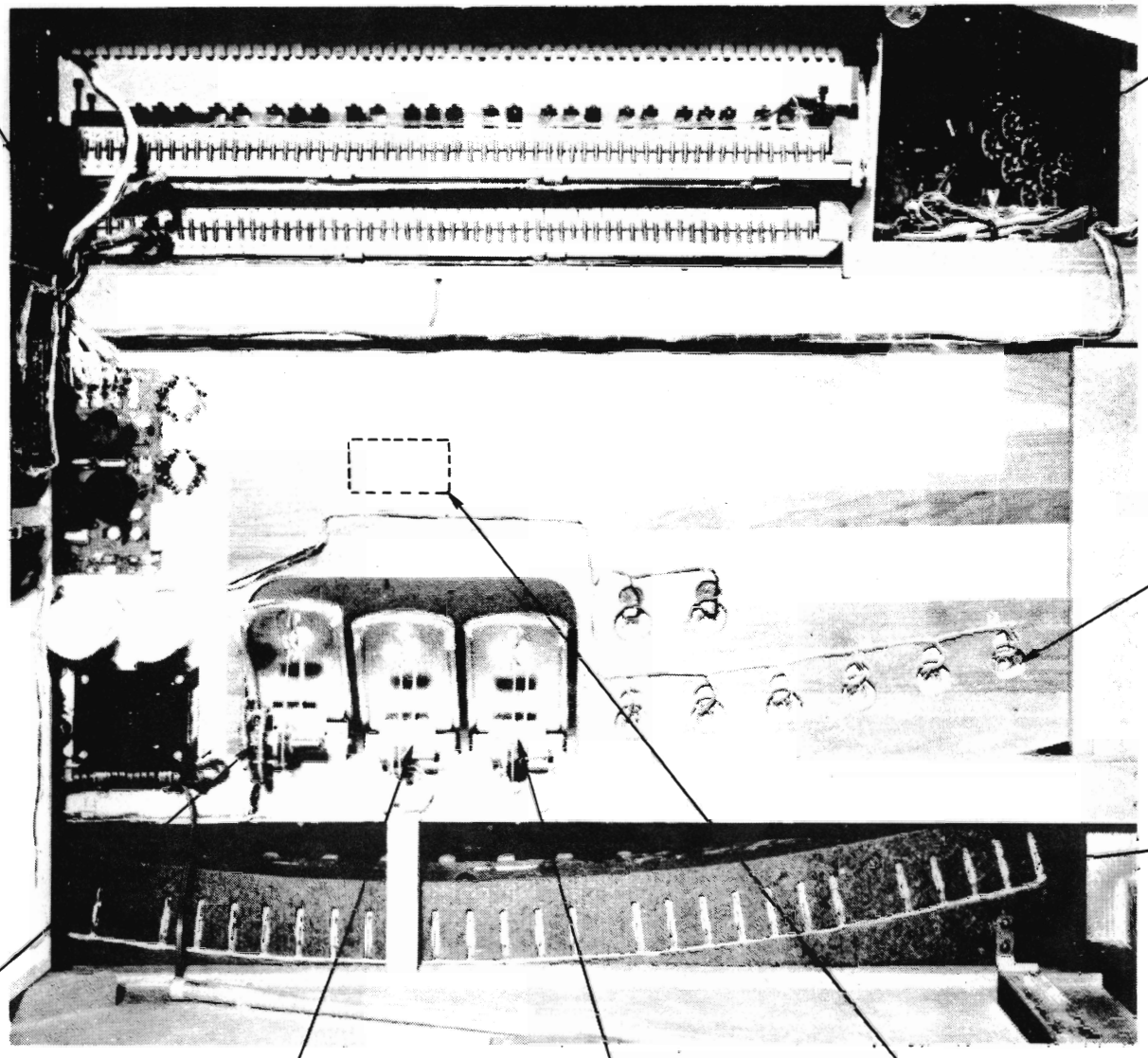

DIAPASON SIGNAL KEYER
R105
R716
R616
R516
R416
R326
R316
990 CHOIR VOICING
R912
R940
R236
GREAT NOTE
NO 85
CELESTE
NOTE 61
R41
R39
CHOIR CELESTE
INTERCONNECT
CHOIR CELESTE
GREAT OSCILLATORS
CHOIR SIGNAL KEYERS

RACK 4


GEMSHORN SIGNAL KEYERS
SWELL SIGNAL KEYERS
R105
R716
R616
R516
R416
R326
R116
R316
R236
SWELL VOICING
SWELL
NOTE 85
R904
R912
REED
FORMANTS
SWELL OSCILLATORS
REED FORMANT 61
R13



(See Trouble-Shooting Guide for enlargement of "slide")


PARTIAL SETTERBOARD
SFORZANDO
REVERSIBLE
STOP INTERCONNECT
(See Rack No. 5
DRAWKNOBS
GENERAL
TOE STUDS
(PISTONS)
PEDAL REED
SWITCH
CRESCENDO
ROTARY
SWITCH
SWELL EXPRESSION
500-OHM POT
GREAT-CHOIR-PEDAL
EXPRESSION
500-OHM POT
SETTERBOARD RELAYS
(FOR GENERAL PISTONS)
NOT ON "CAPTURE MODEL"
SHOWN

SWELL MANUAL

STOP	KEYS	SOURCE	COMMENTS
8' Geigen Diapason	all	Swell Signal Keyer	One set of Diode Gates operates the 8' and 4' Swell Signal Keyers and the Celeste oscillators. These keyers are always on, except when the Swell Unison coupler tab is operated, turning off all Swell voices. If the 4' or 16' Swell to Swell couplers are on, the Swell voices in those footages continue to sound. See drawing 1282A. Each stop tab operates an electronic switch which turns each voice on or off.
8' Rohrflote	all	" " "	
8' Salicional	all	" " "	
8' Oboe	all	" " "	
4' Prestant	all	" " "	
4' Nachthorn	all	" " "	
8' Flute Celeste	all	Celeste oscillators & Swell Signal Keyer	This stop activates the 8' Rohrflote (soft version), as well as the Celeste oscillators.
8' Voix Celeste	all	Celeste oscillators	Celeste oscillators sound alone.
16' Fagotto 8' Trompette 4' Clairon	all	Unit Reed Signal Keyer	These are all the same voice, tonally. Each stop a different set of diode gates, however, to key on the Reed Signal Keyer, and each voice is spaced an octave apart. For example, playing middle C, with the 16' Fagotto stop on, sounds oscillator 13, instead of 25. Top octave of Unit Reed doubles back (Keyer only goes up to No. 61).

GREAT MANUAL

STOP	KEYS	SOURCE	COMMENTS
MIXTURE III	1-25	2' Unit Diapason Signal Keyer 1-1/3' " " " " 1' " " " " --- 26-37 2' Unit Diapason Signal Keyer 1-1/3' " " " " 2-2/3' " " " " --- 38-49 2' Unit Diapason Signal Keyer 4' " " " " 2-2/3' " " " " --- 50-61 2' Unit Diapason Signal Keyer 4' " " " " 5-1/3' " " " " ---	This stop activates the 2' Super Octave Unit Diode Gates, plus two special Diode Gates (used nowhere else). These extra Gates are necessary because different pitch groups are combined for different groups of keys, as shown to the left.
16' Gemshorn	all	Unit Diapason Signal Keyer	Stop operates its own set of Diode Gates (keyed softer).
8' Principal	all	Unit Diapason Signal Keyer	Stop operates its own set of Diode Gates.
8' Bourdon	all	Unit Flute	Stop operates its own set of Diode Gates.
4' Octave	all	Unit Diapason Signal Keyer	Stop operates its own set of Diode Gates.
4' Spitzflote	all	Unit Flute	Stop operates its own set of Diode Gates.

GREAT MANUAL (CONT'D) 660

STOP	KEYS	SOURCE	COMMENTS
2-2/3' Twelfth	all	Unit Diapason Signal Keyer	Manual key actually plays 19 pitches higher than unison pitch; mutation.
2' Super Octave	all	Unit Diapason Signal Keyer	Diode Gates shared with MIXTURE III stop, above.
2' Blockflote	all	Unit Flute	Stop operates its own set of Diode Gates.

CHOIR MANUAL

STOP	KEYS	SOURCE	COMMENTS
8' Viola	all	Unit Diapason Signal Keyer	Shares Diode Gates with 8' Dulciana. Keyed softer than 8' Principal on Great.
8' Gedeckt	all	Unit Flute	Characteristic voice of the Unit Flute Unison pitch. Same voice as 8' Bourdon, but with slight Chiff. Has its own Diode Gates.
8' Quintade	all	Unit Flute	Adds Full Chiff to Unit Flute. (Turns on 8' Gedeckt.)

CHOIR MANUAL (CONT'D) 660

STOP	KEYS	SOURCE	COMMENTS
CARILLON	all	Unit Flute	Operates two separate sets of Diode Gates -- Chime E, which keys four notes above Unison, and Chime F, which keys 29 notes above Unison pitch. Stop also operates Diode Gates of 4' Koppelflote, 2-2/3' Nazard, the 2' Flachflote, and the Long Sustain circuitry.

PEDAL

STOP	KEYS	SOURCE	COMMENTS
32' Contra Violone	all	Unit Diapason Signal Keyer	Lower 15 notes of the Diapason Signal Keyer are fed into s separate preamp, the output of which is combined with the output of the regular preamp on the Output circuit board, through a separate pot.
16' Principal	all	Pedal Signal Keyer	A single set of Diode Gates operates the Pedal Signal Keyer to produce this group of four voices. The stop tab operates an electronic switch to turn each of these voices on or off. The Pedal Signal Keyer itself is always on.
16' Bourdon	all	" " "	
16' Dulciana	all	" " "	
16' Bombarde	all	" " "	

CHOIR MANUAL (CONT'D)

STOP	KEYS	SOURCE	COMMENTS
8' Dulciana	all	Unit Diapason Signal Keyer	Shares Diode Gates with 8' Viola; keyed softer than both 8' Principal and 8' Viola.
4' Principal	all	Unit Diapason Signal Keyer	Has own Diode Gates. Same voice as 8' Principal, but keyed one octave higher.
4' Koppelflote	all	Unit Flute	Has own Diode Gates. Same as Gedeckt, but keyed one octave higher.
4' Quintadena	all	Unit Flute	Adds Full Chiff to Unit Flute. (Turns on 4' Koppelflote.)
2-2/3' Nazard	all	Unit Flute	Keys 19 notes higher than Unison pitch; mutation. Has its own Diode Gates.
2' Flachflote	all	Unit Flute	Same voice as 8' Gedeckt, but keyed two octaves higher. Has own Diode Gates.
1-3/5' Tierce	all	Unit Flute	Keys 28 notes higher than Unison pitch. Notes 58-61 do not sound in this footage.
1' Sifflote	all	Unit Flute	Same voice as 8' Gedeckt, but keyed three octaves higher than Unison pitch. Highest octave on keyboard, notes 50-61 doubles back to notes 38-49.
HARP	all	Unit Flute	Keys 8' Gedeckt Diode Gates, and adds Short Sustain.

PEDAL (CONT'D) 660

STOP	KEYS	SOURCE	COMMENTS
			This Principal is not the same Principal that appears on the Great and Choir manuals; it is a completely separate voice from a different keyer.
16' Lieblich Gedeckt	all	Unit Flute	Same voice as 8' Gedeckt, and at an octave lower in pitch. Has its own Diode Gates.
8' Octave	all	Unit Diapason Signal Keyer	Same voice as 8' Principal. Has its own Diode Gates.
8' Flute	all	Unit Flute	Same voice as 8' Gedeckt. Has its own Diode Gates.
8' Gemshorn	all	Unit Diapason Signal Keyer	Keyed softer than 8' Octave.
4' Choralbass	all	Unit Diapason Signal Keyer	Same voice as 8' Principal, at an octave higher. Has its own Diode Gates.
8' Trompette (SW)	all	Unit Reed Signal Keyer	Same as Swell voice. Has its own Diode Gates.
4' Clairon (SW)	all	Unit Reed Signal Keyer	Same as Swell voice. Has its own Diode Gates.

(NOTE: All Pedal voices are keyed at a lower voltage to produce softer voices. R1 and R2, Drawing 1274, shows the voltage divider that lowers the keying voltages.)

DEVICES OPERATED BY THE VOICE STOPS/990

SWELL MANUAL

STOP	KEYS	SOURCE	COMMENTS
8' Geigen Diapason	all	Swell Signal Keyer	One set of Diode Gates operates the 8' and 4' Swell Signal Keyers and the Celeste oscillators. These keyers are always on, except when the Swell Unison coupler tab is operated, turning off all Swell voices. If the 4' or 16' Swell to Swell couplers are on, the Swell voices in those footages continue to sound. See drawing 1282A. Each stop tab operates an electronic switch which turns each voice on or off.
8' Rohrflote	all	" " "	
8' Salicional	all	" " "	
8' Oboe	all	" " "	
4' Nachthorn	all	" " "	
8' Vox Humana	all	" " "	
16' Violone	all	Unit Gemshorn Signal Keyer	These voices are derived from the same Unit Gemshorn source. The 4' Gemshorn is keyed softer than the 4' Prestant, and both use the same set of Diode Gates and Transistor Switch.
4' Gemshorn	all	" " " "	
4' Prestant	all	" " " "	
2' Doublette	all	" " " "	
Plein Jeu III	1-18	1' Swell Gemshorn S. K. (C) 2/3' " " " (B) 1/2' " " " (A)	A, B, and C denote separate Diode Gate assemblies (slides). All 3 slides are operated by the Plein Jeu III stop, which controls a single Transistor Switch.
	19-30	1' Swell Gemshorn S. K. (C) 2/3' " " " (B) 1-1/3' " " " (A)	
	30-42	1' Swell Gemshorn S. K. (C) 2' " " " (B) 1-1/3' " " " (A)	

Corrected August, 1970

SWELL MANUAL (CONT'D)

STOP	KEYS	SOURCE	COMMENTS
	43-54	2-2/3' Swell Gemshorn S. K. (C) 2' " " " (B) 1-1/3' " " " (A)	
	55-61	2-2/3' Swell Gemshorn S. K. (C) 2' " " " (B) 4' " " " (A)	
8' Flute Celeste II	all	Celeste oscillators & Swell Signal Keyer	This stop activates the 8' Rohrflote (soft version), as well as the Celeste oscillators.
8' Voix Celeste	all	Celeste oscillators	Celeste oscillators sound alone.
16' Fagotto	all	Unit Reed Signal Keyer	These are all the same voice, tonally. Each stop a different set of diode gates, however, to key on the Reed Signal Keyer, and each voice is spaced an octave apart. For example, playing Middle C, with the 16' Fagotto stop on, sounds oscillator 13, instead of 25. Top octave of 4' Clairon doubles back (Keyer only goes up to No. 61).
8' Trompette	all	" " " "	
4' Clairon	all	" " " "	

Corrected, August, 1970

GREAT MANUAL

STOP	KEYS	SOURCE	COMMENTS
MIXTURE III	1-25	2' Unit Diapason Signal Keyer 1-1/3' " " " " 1' " " " "	This stop activates the 2' Super Octave Unit Diode Gates, plus two special Diode Gates (used nowhere else). These extra Gates are necessary because different pitch groups are combined for different groups of keys, as shown to the left.
	26-37	2' Unit Diapason Signal Keyer 1-1/3' " " " " 2-2/3' " " " "	
	38-49	2' Unit Diapason Signal Keyer 4' " " " " 2-2/3' " " " "	
	50-61	2' Unit Diapason Signal Keyer 4' " " " " 5-1/3' " " " "	
16' Gemshorn	all	Unit Diapason Signal Keyer	Stop operates its own set of Diode Gates. (Note that this voice is NOT taken from the Swell Gemshorn)
8' Gemshorn	all	" " " "	Stop operates the 8' Principal Diode Gates.
8' Principal	all	" " " "	Stop operates its own set of Diode Gates.
4' Octave	all	" " " "	Stop operates its own set of Diode Gates.
2-2/3' Twelfth	all	" " " "	Stop operates its own set of Diode Gates.
2' Super Octave	all	" " " "	Stop operates its own set of Diode Gates.
1-1/3' Nineteenth	all	" " " "	Stop operates its own set of Diode Gates.

Corrected, August, 1970

GREAT MANUAL (CONT'D)

STOP	KEYS	SOURCE	COMMENTS
8' Bourdon	all	Unit Flute Signal Keyer	Stop operates its own set of Diode Gates.
4' Spitzflote	all	" " " "	Stop operates its own set of Diode Gates.
2' Blockflote	all	" " " "	Stop operates its own set of Diode Gates.

CHOIR MANUAL

STOP	KEYS	SOURCE	COMMENTS
8' Gedeckt	all	Choir Signal Keyer	These keyers always operate except when the Choir Unison tab is operated, turning off all Choir voices. If a Swell coupler is operated, the coupled voices continue to sound. Each of the stop tabs for these Choir voices turn an electronic switch on and off.
8' Aeoline	all	" " "	
8' Krummhorn	all	" " "	
8' Schalmei	all	" " "	
8' Viola	all	" " "	
8' Viola Celeste	all	Choir Celeste Oscillator	Operated by switching current through an LDR.
8' Unda Maris II	all	Choir Celeste Oscillator, plus 8' Choir Signal Keyer	This stop activates the 8' Gedeckt (soft version) through separate transistor switch, plus the Celeste oscillator.

CHOIR MANUAL (CONT'D)

STOP	KEYS	SOURCE	COMMENTS
8' Quintade	all	Unit Flute	Adds full Chiff to Choir Unit Flute stops.
4' Koppelflote	all	" "	Stop operates its own set of Diode Gates.
4' Quintadena	all	" "	Adds Full Chiff to Choir Unit Flute stops. (Turns on 4' Koppelflote).
2-2/3' Nazard	all	" "	Keys 19 notes higher than Unison pitch. Has its own Diode Gates
2' Flachflote	all	" "	Stop operates its own set of Diode Gates.
1-3/5' Tierce	all	" "	Keys 28 notes higher than Unison pitch. Notes 58-61 do not sound.
1' Sifflote	all	" "	Stop operates its own set of Diode Gates. Highest octave on keyboard, notes 50-61 double back to notes 38-49.
HARP	all	" "	Keys 8' Flute and 4' Koppelflote Diode Gates, and adds Short Sustain.
CARILLON	all	" "	Operates two separate sets of Diode Gates -- Chime E, which keys five notes above Unison, and Chime F, which keys 30 notes above Unison pitch. Stop also operates Diode Gates of 4' Koppelflote, 2-2/3' Nazard, 2' Flachflote, and the Long Sustain circuitry.
4' Principal	all	Unit Diapason Signal Keyer	Stop operates its own set of Diode Gates.

Corrected, August, 1970

DEVICES OPERATED BY THE VOICE STOPS/990

PEDAL

STOP	KEYS	SOURCE	COMMENTS
32' Contra Violone	all	Unit Diapason Signal Keyer	Lower 17 notes of the Diapason Signal Keyer are fed into a separate preamp, the output of which is combined with the output of the Pedal preamp on the Output circuit board, through a separate pot. Stop operates its own set of Diode Gates.
8' Octave	all	" " " "	Same voice as Great 8' Principal. Stop operates its own set of Diode Gates.
4' Choralbass	all	" " " "	Same voice as Great 8' Principal, but at an octave higher. Stop operates its own set of Diode Gates.
Mixture II	all	" " " "	Stop activates 2' and 2-2/3' Diode Gates (slides). There are no breaks in this Mixture.
16' Violone (SW)	all	Unit Gemshorn Signal Keyer	Stop operates its own set of Diode Gates.
8' Gemshorn (SW)	all	" " " "	Stop operates its own set of Diode Gates.
16' Principal*	all	Pedal Signal Keyer	A single set of Diode Gates operates the Pedal Signal Keyer to produce this group of Pedal voices. The stop tab operates an Electronic Switch to turn the individual voices on and off. The Great oscillators provide the signal.
16' Bourdon	all	" " "	
16' Bombarde	all	" " "	

* Not the same Principal that appears on the Great and Choir manuals.

Corrected, August, 1970

DEVICES OPERATED BY THE VOICE STOPS/990

PEDAL (CONT'D)

STOP	KEYS	SOURCE	COMMENTS
16' Lieblich Gedeckt	all	Unit Flute	Stop operates its own set of Diode Gates.
8' Flute	all	" "	Stop operates its own set of Diode Gates.

RODGERS ORGAN COMPANY DRAWING 1282 is an excellent block diagram which shows each group of Diode Gates. The technician can use this drawing along with this Devices Operated section for a thorough understanding of how each voice is produced. ROC Drawing presents the same information, but in organ block diagram form.

TECHNICAL SECTION

GENERAL

The apparent complexity of Rodgers organ circuitry is due primarily to the great amount of component duplication. Each group of components, when considered by itself, however, generally presents no problem to the organ technician.

The ONE-NOTE SCHEMATIC is perhaps the easiest approach to understanding the over-all operation of the organ. This one-note schematic includes typical circuits that exist between a single manual key and the speaker.

Although the oscillator is often considered the "heart" of the organ, it is more convenient to think of the KEYER as the source of the raw tones.

It is also a good idea to think of the Rodgers organ as being four separate organs (in the case of the three-manual instrument) - - a Swell, Great, Choir and Pedal organ. Each manual, including the Pedal, can be considered an organ with its own set of tonal resources, although some of these are available on other manuals through coupling and unifying (explained in full later).

The One-Note system description is followed by a complete circuit description of each section of the organ. The Rodgers Trouble-Shooting Guide, published separately, lists the more common troubles that occasionally occur, and their cure. Each symtom listed in the Trouble-Shooting Guide directs the technician to the appropriate circuit in the organ that should be investigated, along with trouble-shooting techniques that may be used to cure the trouble.

It would be impossible to list every trouble that could occur. For that reason, fairly complete circuit descriptions are included in this manual to enable the technician to analyze the more difficult problem, and devise a suitable cure. Taken one at a time, Rodgers circuits are not difficult to understand. If each description is not fully understood at the moment, enough general information is usually obtained to permit an intelligent approach to finding the trouble in the circuit.

If a trouble is not listed in the guide; or, if after a suitable period of searching, it is not found, additional help may be obtained by writing or calling the Field Service and Quality Assurance Manager, Rodgers Organ Company, Hillsboro, Oregon.

Revised, August, 1970

THE "ONE-NOTE" BLOCK DIAGRAM

THE SWELL SIGNAL KEYER - BASIC APPROACH TO RODGERS ORGAN CIRCUITY

The Swell Signal Keyer Block Diagram shows a typical "straight-through" section of the Specification 660 organ (very similar to this organ). The numbers indicated in this text refer to the encircled numbers that appear next to the blocks that make up the diagram. Each circuit is described in full in the Technical Section that follows this basic explanation.

Assume that Middle C is struck on the Swell Manual. The single contact under the key applies ground to the COUPLER GATE (1) which allows current to flow through the COUPLER CURRENT AMPLIFIER (2) and the ISOLATION CIRCUIT (3). The SWELL/CELESTE INTERCONNECT CIRCUIT (4) divides the current, sending part of it to the Celeste oscillator, and another portion to the SWELL SIGNAL KEYER (5).

Before discussing the purpose of the SWELL SIGNAL KEYER, refer again to the COUPLER GATE. This gate is controlled by a COUPLER SWITCH (6) which turns the gate on or off.

There are other COUPLER SWITCHES and associated COUPLER GATES that are permanently wired to point "A". These can also activate the COUPLER CURRENT AMPLIFIER, and are used for the intermanual and intramanual couplers, explained on page 2 and 5 of the next section (white pages).

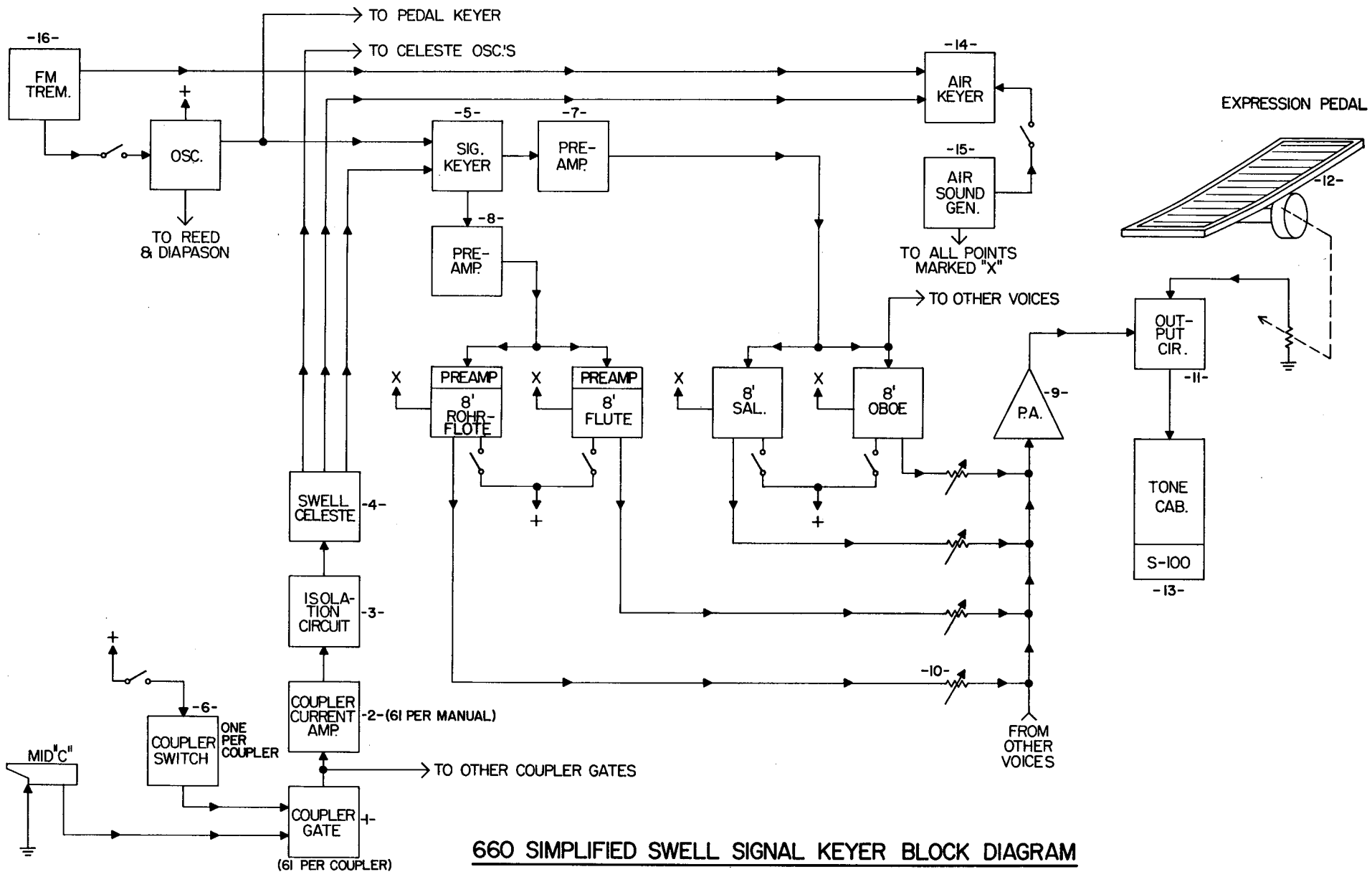
The Celeste oscillator is keyed every time the SWELL SIGNAL KEYER is operated, but the Celeste voice is not heard unless the appropriate tab is depressed.

The MAIN OSCILLATOR (6) (labeled "Swell" on some of the drawings) generates two signals -- a sine wave for the Unit Reed and Diapason Signal Keyers, and a square wave. The latter signal is wired permanently to the SWELL SIGNAL KEYER.

When this keyer is activated by the circuits previously discussed, it generates a pulse for the 8' Salicional, Oboe, etc., and a square wave for the 8' Rohrflute and the 8' Flute Celeste. The pulses are sent through a common preamplifier (7) and introduced to each pertinent voicing circuit. Bear in mind that this description is based on typical operation. Actually, there are other associated circuits involved, explained in full in the section that follows.

The square wave output of the keyer is fed to a wave-shaping circuit (8) and then to individual preamplifiers associated with each voice.

Revised, August, 1970



660 SIMPLIFIED SWELL SIGNAL KEYER BLOCK DIAGRAM

SPECIFICATION 660/990

TECHNICAL CIRCUIT DESCRIPTIONS

The order of circuit descriptions contained in this Technical Section parallels the Simplified One-Note System presented earlier in this manual. Thus, a straight-through explanation is presented that begins with the manual key and ends at the organ speaker system. The text then picks up parallel Keyers and other associated circuits. The circuit diagrams have been arranged in a more or less conventional manner, placing them where the technician would most expect to find them. A numerical table of contents appears at the back of this manual, covering both the Drawings and the individual sections.

The circuit descriptions given here are to be used in conjunction with the Rodgers Trouble-Shooting Guide, published separately. The guide lists the more common problems and their cures, and is kept up to date as more is learned about the field performance of the instrument. The descriptions can be used for general study, also, and the technician is urged to familiarize himself with them before trouble occurs. The descriptions are comprehensive, and were written to help the technician solve the more obscure, difficult problems.

In all of the circuit descriptions contained in this manual, it is assumed that current flow is from negative to positive; i.e., electron flow, as understood by most service technicians. Conventional current flow is not used.

The dotted blue lines appearing on the drawings denote the outlines of separate circuit boards. All circuitry contained within the lines appears on a single board.

TECHNICAL CIRCUIT DESCRIPTIONS

SWELL DIODE GATE AND COUPLER SWITCH

. See ROC Drawing 1379.

When the Swell manual key is played, the bifurcated contacts under the key apply ground to the COUPLER DIODE GATE. If the COUPLER STOP SWITCH connected to the +15-volt supply is off, as shown in the drawing, transistors Q1 and Q2 are biased on. This permits current to flow from ground, through the manual key contacts, through R1, D1, and finally through Q2. A few tenths of a volt is dropped across Q2, which is saturated, and D1. This leaves approximately +11.5 volts appearing at the junction of D1 and D2.

Q5, of the COUPLER CURRENT AMPLIFIER, is normally biased off. R3 and R4 are "floating," and the base of Q5 is at the same potential as the emitter. When the manual key is played, with the COUPLER STOP SWITCH off, the +11.5 volts appearing at the junction of D1-D2 is not sufficient to bias Q5 on. No current, therefore, can flow in the COUPLER CURRENT AMPLIFIER, and no keyers or oscillators, which depend on the current amplifier for their source of current, can operate.

When the COUPLER STOP SWITCH is operated, or turned on, Q1 and Q2 are biased off. When the manual key is played, no clamping voltage is supplied through Q2, and a current path is set up through R1, D2, R3 and R4. Q5 is now biased on, and current is supplied through the low emitter-collector resistance of the transistor. All of the Unit Gates, straight oscillators and signal keyers associated with that current amplifier will now be operated.

D1 isolates each individual COUPLER DIODE GATE from the other 60 gates controlled by that same switch. D2 keeps current from the other couplers out of the COUPLER DIODE GATE.

The principle reason for using transistor switches to control the diode gates is to permit control of the stops when the Sforzando and Crescendo circuits are activated. The UNISON OFF STOP SWITCH does not require a transistor switch inasmuch as turning it on accomplishes the reverse of the regular coupler stop switches. Turning the UNISON OFF STOP SWITCH on prevents the manual keys from activating the diode gates associated with the unison pitches of the organ. The Sforzando and Crescendo circuits do not over-ride the UNISON OFF STOP SWITCH.

SWELL SIGNAL KEYER

. See ROC Drawing 1277

When the Coupler Current Amplifier is turned on, current flows through R1 and D1 of the SWELL KEYING ISOLATION CIRCUIT. This current causes the SWELL SIGNAL KEYER to produce a squarewave and a pulse. There are actually two SWELL SIGNAL KEYERS for each note. One generates an output for the 8' voices, and the other for the 4' voices. (The "Couplers and Keyers" section of the Rodgers Trouble-Shooting Guide explains in detail the physical routing of the keying voltages.)

The SWELL OSCILLATORS run continuously, and provide two different outputs -- a squarewave for the SWELL SIGNAL KEYER, plus a sinewave for the Unit Reed Signal Keyer and the Unit Gemshorn Signal Keyer (discussed under their own headings).

The squarewave is taken from the collector of Q1, and the sinewave is taken from the oscillator coil. The frequency of the oscillator can be varied by rotating the cap of the cup core that contains the oscillator coil. The parallel capacitor that forms the oscillating tank is fixed. The second parallel capacitor, C1, which is partially grounded through D1, is the Tremulant Capacitor, discussed later.

It is not desirable to apply current instantaneously to the SWELL SIGNAL KEYER. The "attack" must be gradual to impart a desired tonal quality to the affected voices. This was accomplished by adding C23, which must charge before the SWELL SIGNAL KEYER can operate.

Figure 1 shows the basic SWELL SIGNAL KEYER. When the Swell manual key is played, the Current Amplifier associated with that key completes the current path to the +12-volt supply. Thus, point A is supplied with a steady +12 volts. Point B will be at about +12 volts also, and will be at approximately zero volts when the transistor saturates. This is due to the extremely low resistance across the oscillator transistor when it is saturated.

When Point B is at +12 volts, both sides of D21 are at the same voltage, and the diode cannot conduct. When Point B is at zero volts, however, D21 is biased in the forward direction and conducts -- "shorting out" the +12 applied by the current amplifier. Point A is therefore at ground potential during the time that the oscillator collector is at ground. Thus, Point A varies from +12 volts to zero volts, and "follows" the squarewave generated at the collector of the oscillator transistor.

D1 is included in the circuit to prevent the premature discharge of C23, the Attack/Decay capacitor. R25 and C25 differentiate the squarewave, and D25 rectifies the pulse.

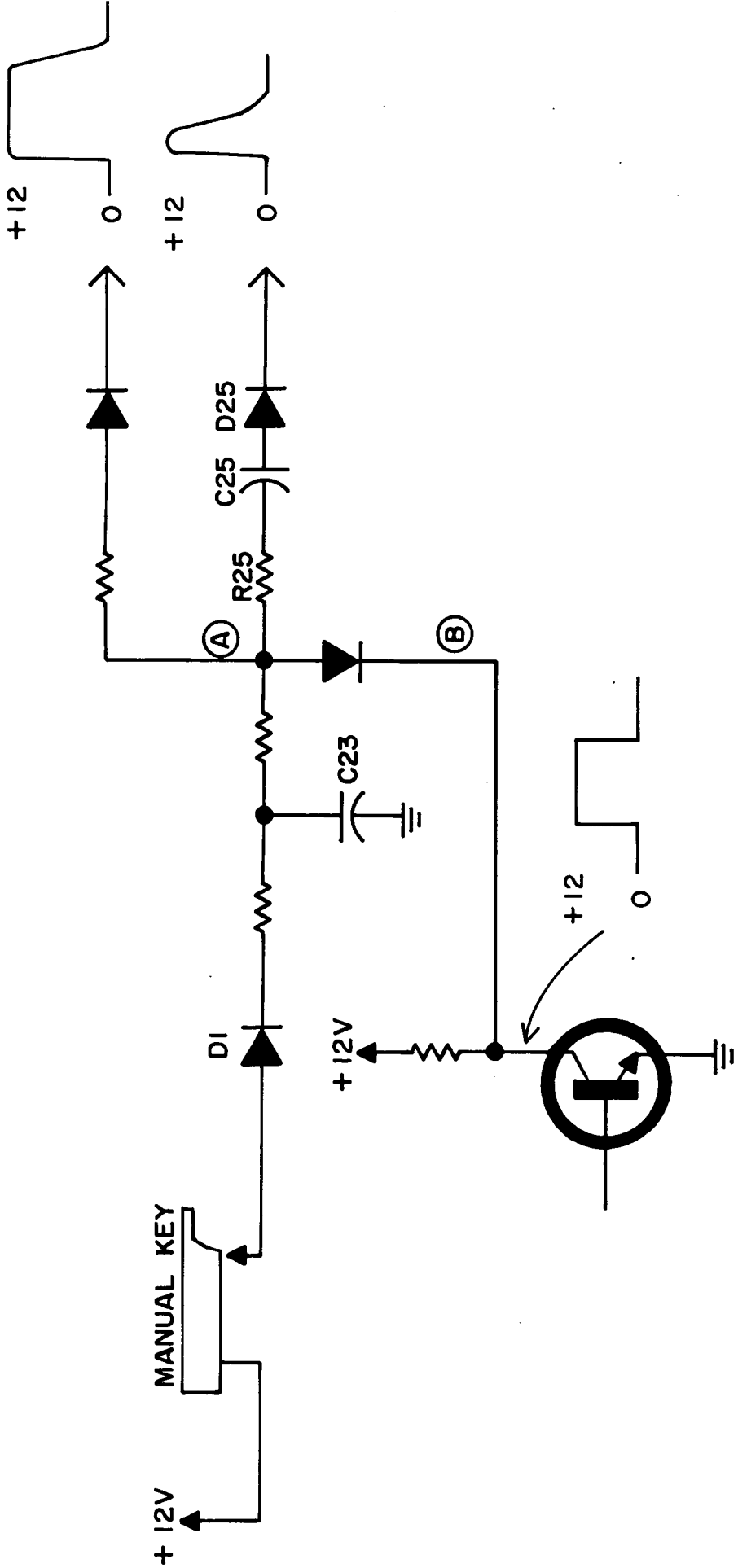


FIG. 1

BLOCK DIAGRAM OF COMPLETE KEYING SYSTEMS

. See ROC Drawing 1282.

The SWELL KEYERS can be operated from several sources besides the single key shown on the diagrams and drawings. It is impractical to show each set of Diode Gates that are associated with each Keyer. A block diagram, however, is given in Drawing 1282, and shows how each keyer can be operated.

The couplers permit the SWELL SIGNAL KEYERS to be operated from several sources, including other keys on the Swell manual and certain keys on the other manuals. There is one current amplifier for each individual key of each manual, including the pedal. The current amplifier can be thought of as an integral part of the circuitry that produces unison pitches, regardless of the fact that a given current amplifier can be activated by gates associated with several other keys.

SWELL FLUTE PREAMP

. See ROC Drawing 1292.

The squarewave outputs of the 4' Swell Signal Keyers are divided into three groups, and processed by similar preamplifiers. The input to each preamp is a squarewave, and the output is the characteristic sinewave of the Nachthorn voice. Each preamp peaks in a different portion of the tonal spectrum, and permits an even scaling of all 73 Nachthorn notes.

The squarewave outputs of the 8' Swell Signal Keyers are divided into four groups to provide approximately equal amplitude outputs to the Rohrflote voicing circuit. The output of the 8' Flute preamps is a sinewave.

SWELL FILTER NETWORK

. See ROC Drawing 1272.

The 41 pulse output of the Swell Signal Keyer is fed directly into a preamp, Q141 and Q142, and then to the 4' PRESTANT voice filtering circuit. The output of the filter is shunted by a dual transistor switch, Q211 and Q212. These normally conduct and shunt the signal to ground. Depressing the 4' PRESTANT stop tab applies +15 volts to the switch, biasing it off, and permitting the signal to appear on the common output collector bus, through pot R216. (Two transistors are used to switch the output in order to provide a lower shunt resistance to ground when on. This lowers the leak-through signal to an inaudible level.)

The 8' pulse is applied to a common preamp, Q161 and Q162, whose output provides signal for four individual voicing filters -- the 8' GEIGEN DIAPASON, 8' SALICIONAL, the 8' OBOE, and the 8' VOX HUMANA. Each of these voices is individually controlled by a transistor switch similar to the one described above.

A typical voicing circuit is made up of various formant-producing components, such as coils, capacitors, etc. The 8' OBOE, for example, consists of a series coil which, in conjunction with C707, controls the amount of higher harmonics in the resultant waveform. C711 and C712, with their two parallel coils, form the tank circuits which control the amount of lower frequencies in the waveform. The output of the filter contains the fundamental and harmonic content of a true OBOE voice.

The 8' Flute Celeste II stop switch controls transistor switch Q321-Q322, which turns on the 8' ROHRFLOTE. This switch is identical to the switch operated by the 8' ROHRFLOTE stop tab, and enables a separate output control to be added to the Rohrflote voice. This second output control provides a softer version of the regular Rohrflote voice to be added to the Celeste voice. The Celeste is turned on by an LDR lamp, controlled by the 8' Flute Celeste II stop switch.

All of the SWELL VOICES are combined on a common bus and applied to a single preamplifier, Q1-3.

OUTPUT CIRCUIT

. See ROC Drawing 1269.

The OUTPUT CIRCUIT permits the distribution of all organ voices to specific output channels. The EXPRESSION PEDALS control LDR lamps which vary the over-all volume of the voice groups.

The SWELL EXPRESSION, the middle shoe on the organ, controls the current through the lamps associated with LDR-15 and LDR-25. The 500-ohm pot is physically located underneath the expression shoe.

LDR-15 forms part of the feedback path between the collector and base of Q18. As the expression shoe is depressed, less current is allowed to flow through the #19 lamp that controls LDR-15. This increases the resistance of the LDR and permits less degenerative feedback to the base. (The output at the collector is 180^{o} out of phase with the input at the base.) This increases the gain of the circuit, and results in an increase of volume.

LDR-25 works exactly the same way, and is also controlled by the #19 lamps that control LDR-15. The SWELL EXPRESSION shoe controls the volume of the UNIT REED, SWELL CELESTE, the 8' and 4' SWELL voices, and the UNIT GEMSHORN.

The SWELL MIXED/SWELL SEPARATE switch, when open, permits the UNIT REED and SWELL CELESTE voices to be expressed by one speaker system, and the 8' and 4' SWELL, plus UNIT GEMSHORN, voices by a separate system.

The two Swell output sockets, SWELL A and SWELL B (plus the other outputs) are located on a metal panel separate from the OUTPUT CIRCUIT board. The UNIT REED and SWELL CELESTE voices are combined into a single channel, and can be expressed separately through their own speaker system. Likewise, the 8' and 4' Swell and UNIT GEMSHORN voices have their own output channel. Both of these channels can be mixed together by the SWELL MIXED/SWELL SEPARATE switch, and fed in to a single speaker system. Either output plug may be used, SWELL A or SWELL B. (See drawing of Output Panel, in back of manual.)

The SWELL MAIN OFF STOP SWITCH, when operated, biases transistor switch Q112-Q122 on, shunting the voice signal to ground. This turns off the SWELL A and SWELL B outputs. The SWELL ANTIPHONAL output, however, is taken from the two Swell channels before the transistor switch. If the SWELL ANTIPHONAL STOP SWITCH is on, the Swell voices will continue to sound through the Antiphonal speaker system.

The principle of operation is the same for the remainder of the organ voices, which are expressed with the second expression shoe (located to the left of the Swell shoe). These include the Pedal voices, also. There are two outputs for the GREAT/CHOIR voices, Channels A and B, plus an Antiphonal channel.

Note that there is a separate input for the 32' Contra-Violone to permit the proper leveling of the lower 32' notes. Only notes 001 through 05 are mixed into this input. The remainder of the Diapason tones are mixed into the regular UNIT DIAPASON input. The PEDAL input is provided by the Pedal Signal Keyer which feeds a series of voice filters in much the same manner as the Swell Voicing system. This keyer is explained in full under its own heading.

The OUTDOOR SPEAKER STOP SWITCH controls the A-C voltage to the S-100 Power Amplifier relay located in the speaker system. This system is physically located in a belfry, or tower, to radiate the CARILLON voice. The level of the CARILLON voice is adjusted by R51. The expression pedal does NOT control the CARILLON volume.

The input to all of the channels is controlled by 20K pots (R12, etc.). This permits proper scaling of all the voice groups on the organ. (See Pink Pages of this manual for correct Voicing procedure.)

CRESCENDO PEDAL

The third expression pedal, the one on the right, is the CRESCENDO PEDAL. It operates a 4-gang shorting-type rotary switch whose contacts parallel selected, progressively louder or higher stops. As the pedal is depressed, these stops are added, one at a time, to build up the organ sound. Three indicator lights signal when the first stop is turned on (MP), mid-point (MF), and last stages of the progression (F). (The FF light is the SFORZANDO, discussed later.)

THE POWER AMPLIFIER

. See ROC Drawing 1200.

The power amplifier, S-100, is located in the Tone Cabinet itself -- not in the organ console. This amplifier is designed especially for the reproduction of organ tones, and incorporates some unique circuitry -- especially that portion that eliminates the "thump" normally produced by the speakers when the amplifier is first turned on.

When the organ is turned on, a controlling voltage is sent to the S-100 which operates the relay, K1. The contacts of K1 apply line voltage to the primary of T1199. The secondary works into a bridge rectifier, D8, D9, D10, and D11, which supplies the D-C voltage for the amplifier. The filtering is accomplished mainly by C15, a large 100-volt, 5,300 microfarad capacitor.

The input stage, Q1, of the S-100 is an emitter-follower which works into amplifier Q2. The output of Q2 is fed to Q5, the driver transistor for the power-output transistor, Q7. The bias for Q2 is held at about +4 volts, and is adjusted by potentiometer, R9. R9 is used to set the collector voltage on Q7 at exactly one-half the collector voltage applied to Q6. The HUM BALANCE circuit is taken from the emitter of Q3, and is a series R-C network that permits feeding a sample of the hum signal to Q3. This sample is taken from ground and is opposite in polarity to the signal riding on the D-C applied to the emitter of Q3.

Extra circuitry was added to the S-100 to eliminate the characteristic "thump" mentioned before, which is caused by turning on the output transistors too quickly (causing the speaker cones to rush forward quickly and "bottoming," producing the thump). The added components are R6 and C5.

When the S-100 is first turned on, C5 has no charge, and Q2 is off. Q3 is therefore off, also. Driver transistor Q5 turns on hard, as does Q7, and all signal components are shorted to ground.

C5 then charges, supplying bias voltage to Q2, which permits it to reach its operating, or "Q" point. Q3 is then turned on, also. Q5 is biased back to its operating, or "Q" point, and Q7 stabilizes to about 38 volts on the collector. As this all happens gradually, no sudden movement of the speaker cone is generated.

RODGERS AIR SOUND

. See ROC Drawing 1283.

NOTE: It would be wise for the technician to first read the Voicing and Adjustments Section of this manual to gain insight into the actual purpose of the AIR SOUND.

The AIR SOUND GENERATOR utilizes the emitter-base diode section of a transistor, Q3, to produce the basic noise for the AIR SOUND. This junction is reverse-biased to its point of Zener breakdown, where considerable "white" noise is generated. R1 adjusts the bias to this exact breakdown point. Q5 and Q7 amplify the noise for parallel distribution to the various circuits that use it.

Referring back a moment to Drawing 1277, it can be seen that the SWELL AIR SOUND, for example, is keyed through the Swell/Celeste Keying Interconnect circuit. Point Y, on Drawing 1283, is where this particular keying voltage is applied. Q306 is the SWELL AIR KEYER transistor, and is controlled by THRESHHOLD ADJUSTMENT, R301. This adjustment prevents the air sound from "leaking" through in a static condition (no keys are depressed), while permitting Air Sound with the playing of a single note, or more. The circuitry provides an additive Air Sound as more voices and notes are played.

The amount of Air Sound to be mixed with each Voicing preamplifier is determined by the setting of R320 and a resistor located in the respective preamplifiers. An extra stage, an emitter-follower, Q321, is provided to give a low impedance source to prevent one voice from leaking into another (for the Swell, Choir, and Pedal filter networks).

When a single key is depressed, the output of the signal keyer, when amplified, is not sufficient to overcome the junction resistance of D113, D112. Thus, the gain of the Air Sound preamp is at its greatest. When two or more Signal Keyers are activated, the combined output, when amplified, is sufficient to cause D312 and D313 to conduct, placing the 22K resistor (R312) across the collector of Q306. This diminishes the Air Sound output to a desired level. R320 provides the over-all leveling adjustment for each Air Sound generator section.

Signal from the Great and Swell Tremulants is mixed with the output of the Air Sound preamplifier. The signal is introduced at the junction of D312 and R312. Although these diodes do not normally conduct when just one note is played, the tremulant signal peaks cause them to partially conduct, thus imparting modulation to the Air Sound.

Mixing the tremulant signal with the Air Sound Generator output gives a "tremolo" effect to the Air Sound that creates the effect of the actual turbulance that occurs in a physical organ pipe.

CELESTE OSCILLATOR (SWELL)

. See ROC Drawing 1277.

When a Swell manual key is played, voltage is applied to the CELESTE OSCILLATOR through the SWELL/CELESTE KEYING INTERCONNECT. The Celeste oscillator produces two waveforms, one taken from the base of the transistor for the VIOLE CELESTE, and the other from the oscillator coil for the FLUTE CELESTE. Each of these voices is controlled by the stop tab which sends current through an LDR lamp (LDR-2, LDR-3). The light-sensitive element of the LDR presents an extremely low resistance when the lamp shines on it and allows output to appear across the leveling pots, R39 and R41. The outputs are fed into a common Celeste preamp circuit, Q1, Q2, and Q3.

When the FLUTE CELESTE II stop switch is depressed, a soft Rohrflote is automatically added to the Celeste voice. The Swell Filter Network Drawing, 1272A, shows the complete stop hook-up.

The constant voltage-drop characteristic of the diode D1 is used to provide a steady D-C bias to the base of all the Swell Celeste oscillator transistors.

The Celeste voices are coupled directly to the Output Circuit. No additional filtering or wave-shaping circuits are used.

CELESTE OSCILLATOR (CHOIR)

The Choir Celeste oscillator, activated from the Choir manual only, is essentially the same oscillator as the Swell. The two outputs, however, are voiced differently. The VIOLA CELESTE is similar to the Swell VOIX CELESTE, but with less higher harmonic roll-off. The UNDA MARIS, like the Swell FLUTE CELESTE, pulls in an accompanying voice, a soft GEDECKT, when activated.

UNIT REED SIGNAL KEYER

. See ROC Drawing 1278.

The collector output of the SWELL OSCILLATOR has already been discussed. Another output, taken from the oscillator coil, provides a sinewave for the UNIT REED SIGNAL KEYER. This Keyer is activated from the Swell and Pedal manuals only. (The word "UNIT" applies to any Keyer that generates voices for more than one manual.)

The drawing shows one DIODE GATE (labeled Diode Keyer Gate on drawing) which is turned on and off by the STOP SWITCH. There are several sets of DIODE GATES that can operate the UNIT REED SIGNAL KEYER. The 16' Fagotto, the 8' Trompette, and the 4' Clairon, for example, are one and the same Reed voice, but played one octave removed from each other. Each has its own set of Diode Keyers. Middle C, with the 8' Trompette tab depressed, sounds the Unison, or normal pitch for that key. With the 16' Fagotto tab down, Middle C plays the same Reed voice, but at an octave lower in pitch. With the 4' Clairon tab down, the same voice sounds at an octave higher. There is no special filtering associated with these Reed voices. (See drawing 1282A for a block representation of all Diode Gate sets that are connected to the UNIT REED SIGNAL KEYER.)

The TRANSISTOR SWITCH, Q1, is normally conducting when the STOP SWITCH is off (open). This places the cathode of D1 almost at ground, permitting current to flow through R1 and through the manual key contact to the +12-volt supply. As the combined resistance of D1 and Q1 during conduction is practically nil, the junction of D1-D2 is at ground. No voltage can be applied to the KEYING INTERCONNECT circuit, and the REED SIGNAL KEYER cannot operate.

When the STOP SWITCH is closed, +15 volts is applied to the base of Q1. The resultant voltage at the base is such that Q1 ceases to conduct, thus removing ground from the junction of D1-D2. Current can now flow through R1, D2, R52, R2, and R3. This turns on transistor Q1 of the REED SIGNAL KEYER, allowing the keyer to process the signal from the oscillator output.

There is an individual REED SIGNAL KEYER for each note, 01 through 61. Each keyer is made up of an individual formant circuit. This permits perfect scaling and leveling of each note on the organ. L1 is a tunable cup-core, and R13 is a leveling pot which sets the output of each REED SIGNAL KEYER.

All outputs of the individual REED SIGNAL KEYERS are ganged together and applied to the UNIT REED PREAMPLIFIER. The output of this preamp is then connected to the Output Circuit, described before (Drawing 1269).

Air Sound is also keyed on with the DIODE GATES, through R51, and mixed into the UNIT REED PREAMP through R21. (The Air Sound is discussed earlier in this manual.)

UNIT REED SIGNAL KEYER - Pedal Diode Gates

. See ROC Drawing 1274.

The Unit Reed Signal Keyer can be activated from the Pedal as well as the Swell keyboard. Depressing a key on the Pedalboard moves the permanent magnet attached to the end of the key into the vicinity of a reed switch, causing the switch (PEDAL KEY CONTACTS) to close. This applies ground to the biasing circuit of Q23, turning it on, thus permitting the application of voltage to the UNIT DIODE GATES. This activates the UNIT REED SIGNAL KEYERS in the same manner as the diode gates associated with the Swell Reed voices.

There are two sets of diode gates -- hence, two voices -- associated with the Pedal Reed. One set is for the 8' Trompette, and the other for the 4' Clairon. These are the same Reed voice, but keyed an octave apart.

The PEDAL KEY CONTACTS also activate the 16' PEDAL SIGNAL KEYER circuits, which are described later under PEDAL SIGNAL KEYER.

UNIT DIAPASON SIGNAL KEYER

. See ROC Drawing 1295.

The DIODE GATE SWITCHING CIRCUIT (labeled "Keyer," etc. on the drawing) is designed to permit the keying of the Diapason voices at three different levels: SOFTEST, SOFT, and LOUD.

When all three control tabs are off (open), only the -12 volts is applied to the base of Q301. Current cannot flow to either the +12 or +15 volts that supply the biasing voltages to Q301. Q301 is therefore saturated, effectively placing its emitter to ground.

When a manual key is depressed, the +12 volts applied to the junction of D311 and D312 in the DIODE GATE is shunted to ground through diode D311 and transistor Q301. No current can flow from the DIAPASON SIGNAL KEYERS.

When the SOFTEST STOP SWITCH is operated, +15 volts is applied to the biasing resistors, R302, R301, R305-R306, and R307, which lead to the regulated -12-volt supply. The -15 volts is not a regulated supply, and in practice, can vary as much as two volts. Diode D301 is connected between junction R301-R302 and the regulated +12-volt supply. The voltages are such that D301 conducts when the SOFTEST STOP SWITCH is operated, clamping junction R301-R302 to the regulated +12 volts (minus the small drop across the diode).

The voltage drops between the +12 voltage at junction R301-R302 and the -12 volt supply biases Q301 in such a manner as to cause the transistor to conduct less heavily. Some voltage now appears at the junction of D311-D312, and a small amount of current can flow from the UNIT DIAPASON SIGNAL KEYER. This permits a soft Diapason voice to be generated.

The SOFT STOP SWITCH operates in the same manner, permitting even less current to flow through Q301. This generates a louder Diapason voice. When the LOUD STOP SWITCH is operated, Q301 is turned completely off, allowing the full +12-volt keying voltage to be available to the UNIT DIAPASON SIGNAL KEYER, producing the loudest Diapason voice.

The GREAT OSCILLATORS run continuously, and provide a constant output taken from the oscillator coils. There are oscillators for notes 001 through 05. These provide signal for the CONTRA VIOLONE Signal Keyers. This 32' voice appears on the Pedal only. The upper notes of the CONTRA VIOLONE are generated by the Great oscillators 06 through 012. The output of these oscillators are connected to the UNIT DIAPASON SIGNAL KEYERS, and are mixed into the output circuit separately (see ROC Drawing 1269).

The third group of GREAT OSCILLATORS supply output for the same type of UNIT DIAPASON SIGNAL KEYERS, and the voices generated are also mixed into the output circuit along with the upper CONTRA VIOLONE notes.

Typically, the output of the GREAT OSCILLATOR is coupled through C102 to the anode side of D101. The cathode side of D101 is biased by the combination of R105, R402, and R403, which are connected to the +12-volt supply. This positive voltage prevents D101 from conducting, and the output from the GREAT OSCILLATOR is not passed on to the UNIT DIAPASON PREAMP.

When the DIODE KEYER GATE is activated by the LOUD STOP SWITCH, the +12-volt keying voltage appears on the anode of D101. This forward-biases

the diode and permits the GREAT OSCILLATOR output to be passed on to the UNIT DIAPASON PREAMP. This biases the diode in such a manner as to permit approximately one-half of the sinewave output of the GREAT OSCILLATOR to be passed on to the UNIT DIAPASON PREAMP.

When the softer switches are operated, less keying voltage is applied to D101, thus requiring the signal from the UNIT DIAPASON to overcome a greater positive bias on the cathode side of D101. As a result, considerably less than half of the oscillator output is passed on to the UNIT DIAPASON PREAMP.

Resistors R402 and R403 provide the biasing voltage for D101. The lower end of R105 is A-C grounded through C403 to maintain a steady bias. The signal keyer output is taken from the 5-K pot, through R104. Each keyer has this individual output leveling control to permit uniform scaling over the entire range of the Diapason voices.

There is always a small capacitive leakage current through a diode. This permits a small passage of signal during "key up" time. A "leakage-signal canceling circuit" therefore has been added. Its effect is adjusted by the LEAK-THROUGH CANCELING ADJUSTMENT. Q204 is the transistor that reverses the polarity of the signal to provide the cancellation, and derives its input through a tiny capacitor formed by the proximity of two of the conductors on the etched circuit board itself. The remainder of the UNIT DIAPASON PREAMP is conventional.

The UNIT DIAPASON SIGNAL KEYER can be activated from the Great, the Choir, and the Pedal manuals (but not the Swell). Each Diapason voice on each manual has its own set of associated DIODE KEYER GATES. There is one DIODE SWITCHING CIRCUIT and a set of Diode Gates for each Diapason voice on each manual.

UNIT FLUTE

. See ROC Drawing 1270.

There are no Signal Keyers associated with the UNIT FLUTE circuits. The UNIT FLUTE OSCILLATORS do not run continuously, but are voltage keyed (as the Celeste Oscillators, described earlier). When the oscillator is keyed (turned on), its output is instantly available to the control circuits located between the oscillator and the UNIT FLUTE PREAMP.

When all the STOP CONTACTS from the Choir are off, the -12 volts applied to the base of Q1 keeps it saturated. When the +12-volt keying source is activated by a manual key, the voltage is effectively grounded through the low resistance of D401 and Q1. No voltage is available at the junction of D401-D402 to bias on the UNIT FLUTE current amplifier Q301.

When a STOP CONTACT is on, (the 8' Gedeckt, for example), +15 volts is applied to the base of Q1, resulting in a net bias of about +3 volts with respect to the +12-volt keying voltage applied when a manual key is held down. The emitter is, therefore, actually negative with respect to the base, and Q1 is biased off. The +12-volt keying voltage is no longer shunted to ground through Q1, but applied to the base of Q301 through D402 and R401. Q301 is biased on, permitting current flow to the UNIT FLUTE OSCILLATOR. The oscillator generates a sinewave which is connected to separate circuits, producing two Flute voice outputs.

The output of the UNIT FLUTE oscillator is split into two parallel branches. Each provides a different Flute voice. The lower branch ("Stopped") which works into R21, is the one normally used for the Flute oscillator voice. This output is controlled by LDR-101. Transistor Q153, with the CARILLON tab off, has no bias on its base and is off. Approximately +12 volts appears on the collector of Q153 which biases Q156 on. This transistor is, therefore, normally on all the time, permitting constant current flow through the #19 lamp associated with LDR-101. The illumination from the lamp lowers the resistance of the element of LDR-101 to a very low value, permitting output to the UNIT FLUTE PREAMP.

Diodes D4 and D5 provide clipping that squares off the positive and negative peaks of the sinewave output of the UNIT FLUTE OSCILLATOR. The amplitude of the squared-waveform is approximately 1.2 volts. The over-all level fed into the preamp is controlled by potentiometer, R24. Each oscillator has this leveling adjustment to permit accurate scaling of the Flute voices.

The output of the upper branch is controlled by LDR-102, and is associated with the CARILLON and HARP circuits, described below.

UNIT FLUTE - CARILLON

. See ROC Drawing 1270.

When the CARILLON stop tab is turned on, +15 volts is applied through several isolation, contact-multiplying diodes to various circuits in the organ. One diode

provides a current path to the base of Q153, turning it on. The current flow in the collector circuit illuminates the #19 lamp, and permits the output of that branch to be applied to the UNIT FLUTE PREAMP. As the collector of Q153 is virtually grounded by saturation, Q156 is biased off. The #19 lamp in its collector circuit is not illuminated, and LDR-101 reverts to its "dark" state, or very high resistance. No output from this branch is passed on to the UNIT FLUTE PREAMP.

NOTE: An option of the Spec. 990 provides for an inhibiting circuit that prevents the modulation of the UNIT FLUTE OSCILLATORS by the UNIT FLUTE TREMULANT. A diode is added, shown by the dotted lines associated with the STOP INTERCONNECT on the drawing. This diode permits the application of +15 volts to Q272 to ground, turning Q274 off. The collector of Q274 removes the effective ground from the bottom of C206, placing it in series with R257. The emitter of Q201 now offers a high resistance to AC, and the phase-shift oscillator cannot operate.

The CARILLON and HARP voices require a sustaining characteristic. This sustain is obtained by charging capacitor C302 on the KEYING INTERCONNECT and SUSTAIN board. Its charge is controlled by the SUSTAIN SWITCH, Q315 and Q316.

With the CARILLON and HARP voice tabs off, -12 volts is applied to the base of Q315 through R312 and R314. This turns Q315 on, placing the emitter at nearly ground potential. The base of Q316 is tied to the -12 volts through R315 which reverse-biases it. This reverse bias keeps Q316 in the off condition. The collector of Q316 is tied to the +12 volts through R317, and remains at that voltage. This reverse-biases D302, placing its cathode (bottom side) at +12 volts. The other end (anode) of the diode (when a manual key is played) is also at approximately +12 volts, and no current can flow through D102. C302, therefore, cannot take on a charge.

Closing the CARILLON stop tab applies +15 volts through R316 to the base of Q316. This forward-biases Q316, turning it on and grounding its collector. When a manual key is depressed, the +12 volts keying is applied to the anode (upper end) of D302 through C302, charging it through D302, Q316, and Q315. Q315 remains on, as before. Q403 is off, and no positive voltage is applied to C302. C302 discharges through R303 and D303 when the key is released.

When the HARP stop tab is closed, +15 volts is applied to R311, R312, and R314, which is tied to the -12-volt supply. Potentiometer R312 sets the bias on Q315, turning it on. Q315 is an emitter-follower, and the voltage on its base will be approximately the voltage seen on the emitter. This controls the voltage applied to the emitter of Q316.

Closing the HARP stop tab also applies forward bias to Q316, through D305 and R316. Q316 is biased on. The collector of Q316 drops (saturates) to almost the same value as its emitter. As the collector is tied to D302, turning potentiometer R315 varies the emitter voltage of Q315, and the collector voltage of Q316. This is the bias applied to D302. C302 can charge only to the actual difference between the keying voltage and the bias on D302. Thus, the SHORT-SUSTAIN LENGTH ADJUST R312 controls the voltage to which C302 can charge, and varies the actual amount of sustain applied to the note (HARP only).

The +15-volt supply shown varies from +13 to perhaps as much as +18 volts in actual practice. The sustain voltage, however, must not vary. Junction R311 and R312 is connected to the regulated +12-volt supply through D306. This assures that the voltage at that point will always be at +12 volts (less the diode drop) when the HARP is turned on.

The other diode circuits turn on the required voices to make up the CARILLON and HARP voices. The CARILLON is composed of the 4' Flute, the 2-2/3' Flute, the 2' Flute, and an "E" and "F" circuit. The "E" and "F" circuits provide certain overtones for the Carillon voice, and is not used for any other voices or Mixtures.

UNIT FLUTE - CHIFF (Patent #3,291,886)

. See ROC Drawing 1270.

The Chiff circuit momentarily adds the Flute pitch 19 notes above the one being played. The Chiffing oscillator is triggered by a pulse generated by the Chiff circuit, and is turned on for an extremely short moment of time.

K501, the Chiff relay, is normally energized by the +15 volts permanently applied to its coil.

The input to the Chiff circuit is taken from the KEYING INTERCONNECT & SUSTAIN board, at the emitter of Q301. When a Choir manual key is played, the keying voltage from Q301 activates the UNIT FLUTE OSCILLATOR. The Chiff output taken from the emitter of Q301 is passed through a differentiating circuit, C502, etc., generating a single pulse. This pulse is applied to the KEYING INTERCONNECT point associated with the oscillator 19 notes higher than the one being keyed from the manual. In other words, the input and output of the Chiff circuit is NOT connected to the same pitch circuit, as shown on the drawing. (It would be difficult to show the actual connection 19 notes higher without greatly enlarging and complicating the drawing.)

With no Chiff stops on (8' Quintade or 4' Quintadena), ground is applied to the four series diodes, D505-06-07-08, through the closed contacts of K501. When the Chiffing pulse is applied to the differentiating circuit, C502, etc., the 4' diodes conduct and ground the input. The total drop across the four diodes is approximately 2.5 volts. This produces a slight, almost inaudible, chiff which is present at all times. (This parallels the true Flutes of the pipe organ; a Chiffing is also present on the true Harp and Carillon, and hence is a desirable component of these voices.

Turning on either the 8' QUINTADE or the 4' QUINTADENA applies +15 volts to the bottom of K501. With this voltage appearing at both ends of the coil, no current can flow in it. Thus, the contacts associated with the relay open. This removes the ground from the diode string and permits the Chiffing signal to form the pulse that temporarily sounds the desired note 19 pitches removed from the fundamental.

The 8' QUINTADE activates the 8' GEDECKT transistor switch; the 4' QUINTADENA activates the 4' KOPPELFLOTE, adding Chiff to these voices.

THE PEDAL SIGNAL KEYER

. See ROC Drawing 1274.

The PEDAL COUPLER CURRENT AMPLIFIER is normally biased off. Depressing a pedal key applies ground to the divider network R21-R22. The resultant voltage drop at junction R21-R22 biases the base of Q23 more negative than the emitter, turning the transistor on.

The signal input to the 16' PEDAL SIGNAL KEYER is derived from the GREAT OSCILLATORS. When the PEDAL COUPLER CURRENT AMPLIFIER is activated, the +12 volts on the emitter of Q23 appears on the collector of that transistor. When the oscillator collector is at zero volts (collector grounded through the saturated oscillator transistor Q1), current flows through Q1, D62, R62, through the PEDAL ISOLATION components, Diode D2 and Resistor R1, and finally through R23.

The anode, or top of D62 is almost at ground potential. When Q1 is cut off during the positive alternation of the oscillator, the voltage at the collector rises to about +7 volts. As the PEDAL AIR SOUND output (Keying Bias; junction of 32 ea. R61) is almost at ground potential, R61 is in shunt with a low resistance. This limits the squarewave output.

The varying voltage on the anode side of D62 (the top end), zero to +7 volts, follows the oscillator output waveform. The emplitude, however, is smaller and somewhat more square (the oscillator squarewave output has rounded leading and trailing edges). When the collector of Q 1 rises above the +7 volts on the anode of D62, the diode stops conducting, and the further rise of the collector produces no greater amplitude at the anode.

The waveform generated at the anode of D62 is split into two parallel branches. The top branch (R63, D63, etc.) feeds the squarewave into the Pedal Filter Network, described below. The bottom branch (R64, etc.) differentiates the squarewave and generates a pulse output for certain voices of the Pedal Filter Network.

C61 imparts a delay to the buildup of the keying voltage at the anode of D62, and sustains the voltage once the pedal key is released. This gives the desired attack and release characteristics to the Pedal voices.

THE PEDAL FILTER NETWORK

. See ROC Drawing 1273.

The squarewave output of the Pedal Signal Keyer is used to create the 16' BOURDON voice. No other voice uses this squarewave. Transistor switch Q312-Q311 is activated by the STOP CONTACT to turn the voice on and off. The -12 volts applied to the bases of these transistors keeps them saturated, shunting the signal to ground. When the STOP CONTACT is closed, the +15 volts adds to the -12 volts in series across R313, R318, and R330. The resultant voltage on the base of Q312 and Q311 turns the transistors off, permitting signal to be fed into the common preamplifier Q1, etc. The 20K pot adjusts the output of the 16' BOURDON voice.

The pulse output of the Pedal Signal Keyer is used to generate two voices -- the 16' PRINCIPAL, and the 16' BOMBARDE. The transistor switches that control the output of these filter circuits are identical to the one already described.

CHOIR

. See ROC Drawing 1294.

The Great Oscillators provide output for the Choir voices on the Specification 990. The CHOIR SIGNAL KEYERS work exactly the same way as do the Swell

Signal Keyers. There are no 4' Choir voices, however, and the output of each oscillator feeds only one signal keyer instead of two. The output of the CHOIR SIGNAL KEYER is divided into two parallel branches, one providing a squarewave and the other, a pulse. The circuit description of the Swell Signal Keyers applies to the Choir keyers as well.

CHOIR FILTER NETWORK

. See ROC Drawing 1275.

The squarewave output of the Choir Signal Keyers, notes 1-10, is applied to preamp Q23. The signal output of this preamp is combined with the output of preamps Q43, Q53, Q63, Q73, and Q83. By splitting the Choir Signal Keyer outputs, a uniform scaling of all notes is made possible over the entire tonal range of the Choir voices.

The signals on the collectors are combined and amplified by Q161-Q162, and fed to the GEDECKT filter. The 8' GEDECKT stop tab controls a transistor switch that turns the voice on or off. The operation of the switch is covered in greater detail in the Swell Filter circuit description.

When the UNDA MARIS stop tab is operated, the Choir Celeste is also turned on. See Drawing 1294.

The emitter outputs are amplified and used to form the KRUMMHORN voice. The pulse out from the Choir Signal Keyers is used to create three Choir voices, the VIOLA, AEOLINE, and the SCHALMEI.

The level of each of the Choir Filter voices is controlled by output pot R316, R416, etc. All of the voices are collected together on a common bus and amplified by Q1, Q2, and Q3. The output of the common preamp is fed directly to the output circuit.

Note that the Air Sound from the Choir Air Sound Keyers is mixed with the Choir voices in the same manner as the Swell circuitry.

UNIT GEMSHORN

. See ROC Drawing 1268.

The signal for the UNIT GEMSHORN is taken from the coil of the SWELL OSCILLATOR. The output is signal-keyed in the same manner as the Unit Diapason. Refer to that section for a complete circuit description of the

UNIT GEMSHORN SIGNAL KEYER. Exceptions will be the absence of the 32' Contra Violone, and only Notes 01-85 are involved. Also, the Gemshorn keyers work into one common preamp.

TREMULANTS - GENERAL

There are three separate Tremulant circuits in the Rodgers Specification 990 organ. One tremulant modulates the SWELL OSCILLATORS and the Swell Celeste oscillators, and thus all the voices derived from them. The second tremulant modulates the UNIT FLUTE OSCILLATORS and its voices, and the third modulates the GREAT OSCILLATORS. Each Tremulant will be discussed in turn.

SWELL TREMULANT

. See ROC Drawing 1277.

To create Vibrato, the steady pitch of the Swell oscillator is made to vary its frequency slightly -- at about a 6-7 Hertz* rate. This frequency-modulating signal is generated with a Phase-Shift Oscillator which uses capacitance and resistance to determine its frequency.

With no Tremulant applied to the Swell oscillator, the junction of D1-C1 is biased at some steady voltage that permits a partial conduction of diode D1. As the oscillator tank goes through its periodic change of polarity, D1 conducts for part of the cycle, and is cut off (back-biased) for the remainder of the cycle. The working frequency of the Swell oscillator depends on the combination of C2, the main tank capacitor, and the percentage of the half cycle that C1 is caused to appear in parallel with it.

When the Tremulant signal adds to the bias, the diode is cut off, and C2 alone determines the frequency of the oscillator. This raises the normal frequency of the tank. When the signal subtracts from the bias, the diode conducts for a longer period of time, thus inserting C2 into the tank circuit during a greater percentage of the positive alternation. This "flattens" or lengthens that half cycle because C2 must also be charged when it suddenly appears across the tank. The result is a "pulling" or lowering of the normal frequency.

* Cycles-per-second

When the SWELL TREMULANT is turned on, +15 volts is applied to the base of Q904, through R922, turning the transistor on. This places the bottom of C906 to ground through the low collector-emitter resistance of Q904, thus providing a low-impedance A-C return to the emitter of the phase-shift transistor Q901. This permits the phase-shift oscillator to function. R904 adjusts the speed of the Tremulant frequency. The output of Q901 is coupled through an emitter-follower, Q908, to the Tremulant preamp, Q903. This stage permits a wide range of FM DEPTH ADJUSTMENT by amplifying the signal taken from the variable pot, R912, through R913. The preamp also permits the mixing of ACTIVITY GENERATOR input No. 3.

The -12 volts applied to the divider resistors, R919 and R917, sets the bias for D1. This bias is applied to D1 through a current-limiting isolation resistor, R1.

UNIT FLUTE TREMULANT

. See ROC Drawing 1270.

The CHOIR TREMULANT stop tab turns on both the UNIT FLUTE TREMULANT and the Choir Tremulant (shown on Drawing 1294).

Note that the FLUTE TREMULANT - LIGHT and the FLUTE TREMULANT - FULL tabs do not exist on the Specification 990. The Tremulant circuit is similar to the Swell Tremulant. Preamplifier Q203, Q204 is de-coupled and permits a 40-volt signal swing.

The ACTIVITY generator input is coupled into the base of Q203 through isolation resistor, R217.

GREAT TREMULANT

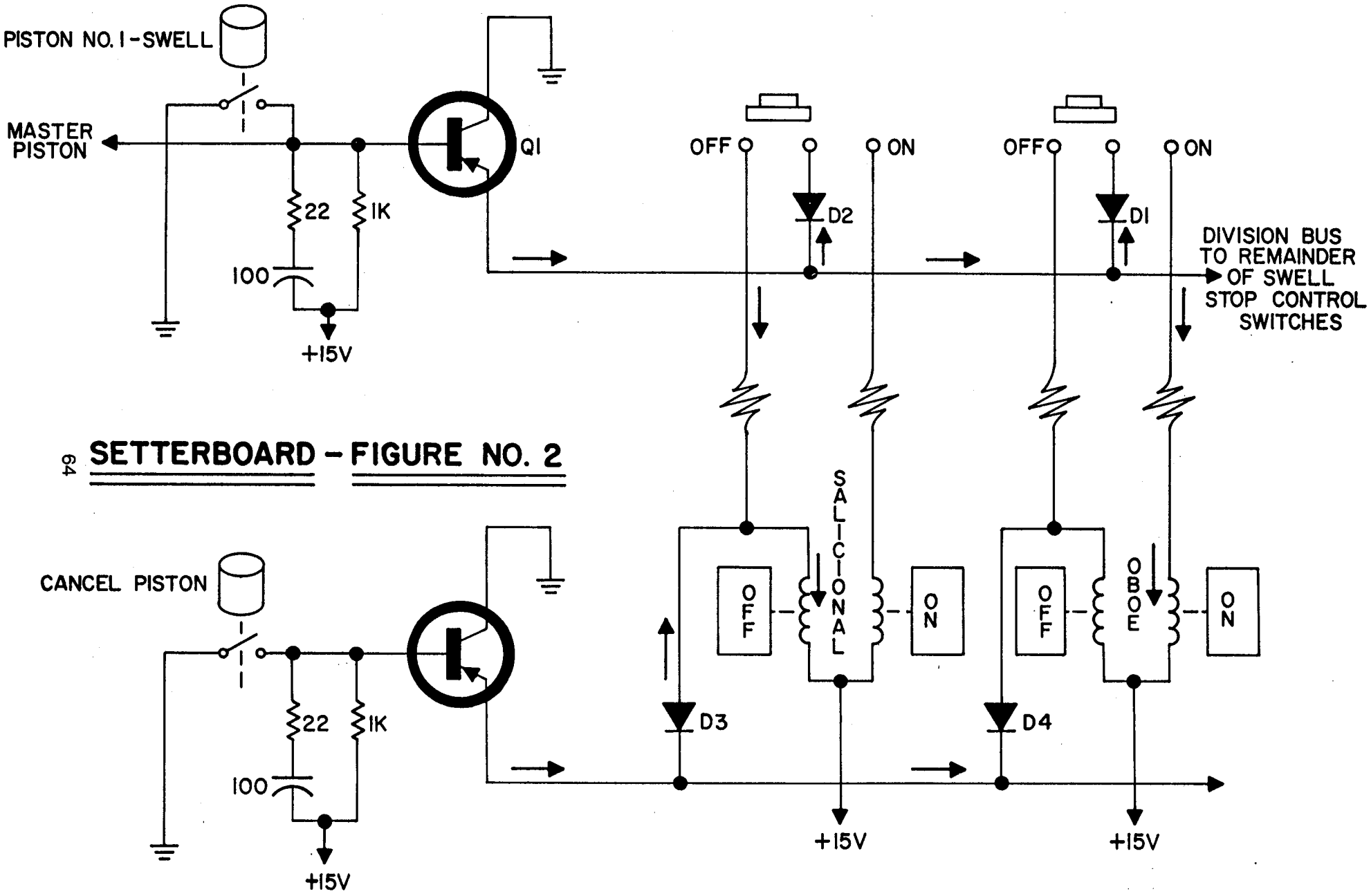
. See ROC Drawing 1294.

This Tremulant circuit is identical to the Swell Tremulant. Refer to the circuit description on page 21 of this section.

COMBINATION ACTION - SETTERBOARD

. ROC Drawing 1216 gives complete detail of the Setterboard. This discussion will use Figure 2 to explain the theory of operation.

SETTERBOARD - FIGURE NO. 2



There are two coils associated with each stop tablet or drawknob assembly. One coil, when energized, turns the stop on, and the other turns the stop off. The setterboard is a complement of switches that determines whether a given stop will remain in the on or the off position when a certain Combination Action Piston is pushed in. The Setterboard is best described by considering each of the pistons that control it.

MANUAL PISTON

There are four pistons for the Swell, four for the Great/Pedal, and four for the Choir. Each divisional piston controls a group of switches on the Setterboard that "programs" a specific manual. Pushing in that piston sets up a desired combination of organ voices (stops) as a given registration for that division.

Assume that Piston No. 1 controls the stops of the Swell manual, and that when the piston is pushed in, it is desired that the OBOE voice be on, and all the other voices off.

The Piston applies ground to the base of Q1, removing the +15 volts from its base and grounding it. At the same time, +15 volts is always applied to the emitter of Q1 through either the off or the on coil of the stop associated with the voices of the Swell manual. Q1 conducts and the stop either moves to, or remains in, the off or the on position, depending on where the associated switch was set. In the case of the OBOE in Figure 2, for example, the +15 volts has a path through the on coil, through diode D1 to the emitter of Q1. In the case of the Salicional voice, current is directed through the off coil, through D2, to the emitter of Q1, causing this voice to remain in, or move to, the OFF position.

Diodes D1 and D2 prevent voltage from one division bus from activating voices of another division bus.

The 22-ohm-100 mfd series combination that appears in the base circuit of Q1 is a noise filter to eliminate transient clicks, etc.

GENERAL PISTONS

. See ROC Drawing 1216.

On Setterboard organs, a MASTER piston operates three manual pistons at one time -- one corresponding to the Swell manual, one to the Great/Pedal

manuals, and the third to the Choir manual. Operating the MASTER piston, therefore, calls up a registration involving the whole organ. The number on each MASTER piston is matched to the number on the manual pistons that it controls. In other words, MASTER piston 1 operates Swell piston 1, Great/ Pedal piston 1, and Choir piston 1. Only numbers appear on the MASTER piston. The four toe studs which parallel the MASTER pistons, are labeled MASTER. The toe studs and the MASTER pistons accomplish the same thing.

On organs with the Rodgers Computer Capture Combination Action, these pistons are GENERALS rather than Masters. Each one is completely independent of the individual manual pistons. When a GENERAL is activated, it calls up a registration involving all the organ manuals, but no manual piston is operated. This is explained in detail in the section on the Computer Capture system. (Salmon colored pages).

MAIN CANCEL PISTON

The Main Cancel Piston directs current through the off coils of all stops, returning them to the off position. Diodes D3, D4, associated with the cancel bus, prevents the application of voltage to the off coil when other individual manual pistons are pushed in.

ACTIVITY CIRCUIT

. See ROC Drawing 1281.

The ACTIVITY CIRCUIT causes an intentional random detuning of the affected oscillators, a random modulation of the Air Sound (besides the regular Tremulant modulation at a 7-Hertz rate), and in some cases, more directly affects the higher harmonics of certain voices. This randomness lends authenticity to the over-all organ sound. (See the voicing section of this manual for a discussion of the use and adjustment of the Activity).

The heart of the activity generator is the set of three electrolytic capacitors, C7, C9, and C11, which are connected in reverse polarity. The +12 volts is applied to the negative terminals of the capacitors. This causes the capacitors to break down, creating a low-leakage path to ground. The 10K resistors, R8, R10, and R12, limit this leakage current. The capacitors tend to heal themselves immediately after breakdown, and then quickly break down again. Thus, each capacitor undergoes a sporadic breakdown and recharge action. This occurs at a random rate, and during the breaking down and healing process, the capacitor generates noise. Three capacitors are used to create an even more random noise source, and to ensure reliability should one of the capacitors fail. The voltage source to Q3 is very carefully controlled by a voltage-regulating circuit (QØ).

Revised, August, 1970

The three capacitor outputs are coupled by 100K resistors to emitter-follower Q3. This low-impedance output works into R15 and a roll-off capacitor C15 to eliminate the high frequencies. The remaining low-frequency portion of the noise signal is greatly amplified through Q4, Q5, and Q6. The output of this portion of the circuit is limited to about 3-4 Hertz. Q7 limits the signal to about 1.5 volts by the insertion of a full-wave clipping circuit, D4, 5, 6, 7. Q7 amplifies the input from Q6, and when the output on the collector tends to rise above 1.5 volts, the limiter diodes break down, clamping the output to 1.5 volts.

The output of Q7 is divided into two circuits, the level of each determined by pots R28 and R29. Output R28 is fed into the Tremulant circuits to impart a random modulation of the Tremulant signal.

Output R29 is further amplified and split into two identical channels, "E" and "F." Each of these outputs goes to a different group of five Diapason notes. There are two more ACTIVITY GENERATORS identical to the one shown on Drawing 1281B. This provides a separate source of Activity or randomness to the separate groups of Diapason Signal Keyers.

Point "E," for example, is connected into certain UNIT DIAPASON SIGNAL KEYERS (See Drawing 1268). This causes a random variation of the amplitude and harmonic content of the rectified sinewave output of the UNIT DIAPASON SIGNAL KEYER.

When the CARILLON or HARP voice is turned on, the ACTIVITY INHIBIT circuit prevents the Activity Circuit from operating. The +15 volts applied to the base of Q2 turns the transistor on, and effectively grounds the collector of Q3 through Q1 and QØ.

SFORZANDO

. See ROC Drawing 1271.

The Sforzando turns on a predetermined number of stops, and its circuitry is operated by either a manual piston or toe piston (stud). Pushing in the piston turns the Sforzando on, and pushing it in again turns it off.

When the piston is activated, -12 volts is applied to the biasing network R108-R110. A negative potential, applied through R109, triggers the Schmidt circuit Q109, Q112, which provides a sharp pulse output. This pulse is applied to the multivibrator, Q102, Q106, turning Q106 off and Q102 on. This allows Q107 to conduct and activate those stops associated with the Sforzando circuit.

The pulsing circuit, C101-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 Sforzando from operating until a piston or stud is depressed.

The output of the Schmidt trigger, Q109 and Q112, is applied to both collectors of the multibrator. This increases the reliability of the flip-flop function of the circuit.

REVERSIBLE PISTON

. See ROC Drawing 1280.

The Reversible Piston is associated with certain coupler stop tabs, permitting the Great to Pedal couplers to be turned on or off.

The piston applies ground to the SCR control circuit, completed through S1, located on the stop magnet of 8' coupler. S1 is either in the on or off position (shown on in the drawing). If the reversible circuit allowed the coupler tablet to remain in the off position, S1 would provide a path for the triggering network of SCR Q7. Turning on SCR Q7 applies current to the on coil of the coupler tablet, moving it down, or to the on position. Switch S1 is now moved to the other position, providing a path for the triggering of SCR Q1.

The next time the reversible piston is depressed, Q1 fires and supplies current to the off coil. This moves the coupler back again to the off position, etc.

The series network R1-C1 prevents firing of the SCR's by any fast-rise transients that might be produced by the sudden application of voltage across the SCR.

D11 controls the off coils of other couplers so that both 16' and 4' couplers, for example, will be cancelled at the same time.

TYPE IV REGULATED POWER SUPPLY

. See ROC Drawing 1192

The Type IV Power Supply furnishes six separate voltages for the organ, two of them regulated.

See ROC Drawing 1418
The Type VIII Power Supply was used in later models 990 only.

The +15-volt output is supplied by separate windings that work into diodes D5 and D6. C20 and C21 provide the filtering. This circuit is designed to handle a peak load of nearly 80 amps, which is several times the load drawn normally by the circuitry requiring +15 volts. No practical method of fusing this circuit exists. (F1 fuses the entire supply, however.)

The 20 vac supply is taken across one-half of the main power transformer winding.

The main transformer winding also provides a non-regulated +30-volt and a -30-volt output, plus the two regulated plus and minus supplies for the 12-volt circuits. Each of these, and the 20 vac output, is protected by a bi-metal circuit breaker which signals an over-load condition by shunting current through a parallel lamp built into the breaker. The organ must be turned off for several seconds to reset these circuit breakers.

The +12-volt supply is electronically-regulated over a wide variation of load-current requirements. To understand the theory of operation, assume that the load on the +12-volt supply decreases. This causes an increase in the positive voltage dropped across the fixed divider network, R7, R8, and R9. The voltage at the wiper of potentiometer R8 increases, also. This applies a more positive bias to the base of Q3, whose emitter is held at a fixed voltage, determined by the 6.2-volt reference Zener diode D7. This increase in bias causes an increase in current through resistors R2 and R4. The increased drop across R2 and R4 makes the base of Q2 more negative (less positive).

At the same instant, the emitter of Q2 has become more positive due to the original rise across the +12-volt supply, so Q2 draws less current. This drop in current through Q2, R1, and R3, biases the base of Q1 more positive, decreasing the current through Q1. The greater voltage drop across Q1 lowers the voltage at the +12-volt supply point, counteracting the rise that caused the regulating cycle to begin in the first place. All of this occurs simultaneously.

The -12-volt supply works the same way, except that the emitter of Q4 is returned directly to ground instead of through a reference diode. None is needed because the +12-volt supply provides an accurate reference through the divider network, R15, etc.

Diode D8 is connected across the +12-volt supply to protect it in case a negative voltage should be shorted to it. D9 similarly protects the -12-volt supply from the positive voltage. R1 and R11 are series resistors that limit the current to the regulated supplies in case of a short circuit. They also reduce the power dissipation in the series regulator transistors, Q1 and Q6.

THE RODGERS COUPLER SYSTEM

Each organ manual, or division, has its own group of voices. By the addition of COUPLING circuits, a manual can utilize the voices belonging to another manual, thus gaining variety and versatility. The coupler itself is a simple electronic switch.

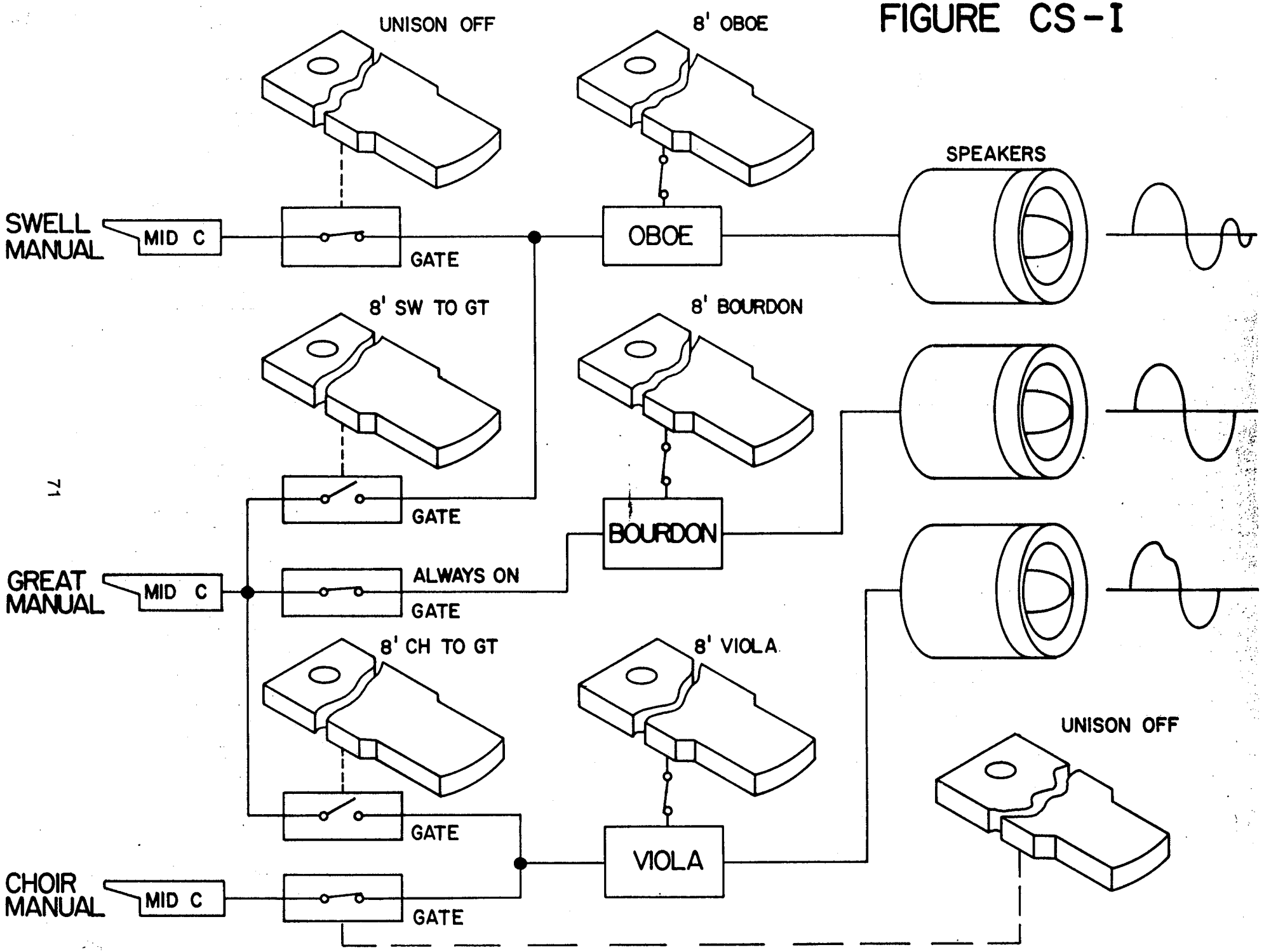
Refer to Figure CS-1. Assume that the organist plays Middle C on the Great manual. A Gate associated with this key starts a sequence of events that causes the BOURDON voice to sound. (Assume that the stop tabs for the voices of Figure CS-1 are "On.") If he depresses the 8' SWELL TO GREAT tab, the Middle C key that he holds down actuates a Gate that bypasses the one normally associated with the Middle C of the Swell manual. This causes the Swell OBOE to sound in addition to the BOURDON. Thus, a Swell OBOE is coupled to the Great manual.

Likewise, by depressing the 8' CHOIR TO GREAT tab, he can reach into the Choir manual voices and get the VIOLA, as shown, or any other Choir voices which the organist might have set up previously.

The couplers described thus far are called INTERMANUAL couplers -- they couple voices from one manual to another. There are also INTRAMANUAL couplers that couple entirely within a given division. These are used to couple a note an octave higher (the 4' pitch), or a note an octave lower (the 16' pitch) to the note being played. For example, if the 4' SWELL TO SWELL coupler tab is depressed, and the Middle C of the Swell manual played, the next higher C note will sound along with the Middle C. If the 16' SWELL TO SWELL coupler is used, it connects the next lower C to the Middle C. This permits the playing of a complete octave with one finger. With both 4' and 16' couplers on, one finger can accomplish what would be impossible on a piano -- the sounding of three octaves with one hand. Drawing No. 1282 shows all the coupling combinations available on the Specification 660 organ.

When the Middle C key of the Great manual is played, as shown in the figure, it actuates the associated Gate, which causes a tone to be produced, if a stop tab is on. There is no way to stop this gate from operating. This is not true of the Middle C of the Swell and Choir manuals, however. The Gates that are associated with these keys can be turned off by the use of UNISON OFF tabs. Unison is the "normal" pitch on the organ; and, in the case of the 8' voices, is the same pitch that would be heard on a piano when the corresponding key is struck, such as Middle C. The use of the UNISON OFF tab does not prevent the Unison pitches associated with that manual from being coupled to another manual. The intermanual couplers bypass the UNISON OFF controls. Each coupler has its own set of Gates which substitute for the Gates normally used to key the voices associated with a given manual.

FIGURE CS-I


UNISON OFF
8' OBOE
SPEAKERS
SWELL MANUAL
MID C
GATE
OBOE
8' SW TO GT
8' BOURDON
GATE
BOURDON
GREAT MANUAL
MID C
ALWAYS ON
GATE
8' CH TO GT
8' VIOLA
UNISON OFF
GATE
VIOLA
CHOIR MANUAL
MID C
GATE

HOW TO USE THE RODGERS COMPUTER CAPTURE COMBINATION ACTION

The Computer-Capture is an extremely versatile and reliable combination action. Ordinarily, four MANUAL PISTONS are provided for each division, including pedal. Each of these is programmed separately. There are also six GENERAL PISTONS, each of which contains its own individual registration. The GENERAL PISTON activates all organ divisions independently, rather than collect the separate MANUAL PISTONS, as is the case with most combination actions. The organist, therefore, is provided the capability of setting up no fewer than 10 complete registrations for each division–any of which can be instantly changed with a simple touch of a button.

TO CAPTURE A NEW COMBINATION OF STOPS

Manually set up a new registration. Depress the SET PISTON and hold it in. Then depress an appropriate PISTON to incorporate the stops that you have set up. If the registration involves more than one division, you can either program each division separately with MANUAL PISTONS, or select a GENERAL PISTON that retains the registration of the entire organ. The pistons need be held in for only an instant.

TO CALL UP THE NEW REGISTRATION

Depress only the PISTON involved. Do not depress the SET PISTON again.

TO CANCEL ALL STOP TABS

To return all stops to the OFF position, depress the GENERAL CANCEL PISTON. This will not destroy any registrations set up previously. (Some of the larger custom organs have cancel pistons for each division.)

HOLD AND SET

Some older combination actions were of the Hold and Set variety. This is, stops were physically held in the new position while the mechanical action set itself for the change. The Rodgers Computer Combination Action can be used in the same way, if desired. To make a minor change to an existing registration, physically hold the stop in the new position and depress the PISTON that called up that registration. Or, the change in the registration may be recorded as explained above, using both the SET PISTON and the appropriate PISTON.

THE RODGERS COMPUTER-CAPTURE COMBINATION ACTION

How The Core Stores Information

A Ferrite Magnetic Core can store information. It can be made to store a YES or a NO . . . an ON or an OFF . . .or, more commonly, a "1" or a "0."

The storing is accomplished by threading a wire through the center of the core and then applying a current pulse to the wire. This DRIVE pulse magnetizes the core, with its magnetic field oriented in one direction. The core, after receiving this pulse, is left in either a "1" or a "0" state, depending on which it is arbitrarily called.

If another pulse is applied to this same wire, but of opposite polarity, the core will be magnetized in the other direction. That is to say, the north and south poles within the magnetic core will change places and the magnetic field will assume the opposite polarity. If the first state is called "1," this second, or reverse state would be "0." Thus, a core retains either the digit "1," or "0," depending upon the polarity of the pulse that was last applied to it. These two digits are all that is necessary for the operation of a binary counting system, similar to that used in most modern computers.

The pulse that magnetizes the core is called a WRITE pulse. If a full WRITE pulse is sent through all the cores, each will assume the same polarity– a "1" state, arbitrarily. In order to have a memory system, some means must be provided to leave some of the cores in the "1" state, and some of them in the "0" state.

Refer now to Figure 1. Lines A, B, and C are called WORDS, and in this case, consist of three DIGITS each. The DIGITS are lines 1, 2, and 3. If a half-pulse is applied to line A, or WORD A, the cores will not switch. No "writing"–or "storage"–or "memorization"– has taken place within the cores.

If it is desired to store a "1" in core 1-A, the switch in the DIGIT line associated with that core (DIGIT line number 1) is set to the ON position. This time, when the half-pulse is applied to the WORD line, a similar half-pulse is applied to the DIGIT line. These separate pulses add their amplitudes as they coincidentally pass through core 1-A. This creates a full pulse and the core switches to the "1" state. No other core in the group of nine–called a memory plane– is affected.

In practice, the WORD line is associated with a settable, or pre-set, PISTON. Each DIGIT line runs to an on-off switch (S-1) associated with each stop. When the piston associated with WORD line A is depressed, the three cores in that WORD will be left in the "1" or "0" state, depending upon the position of the

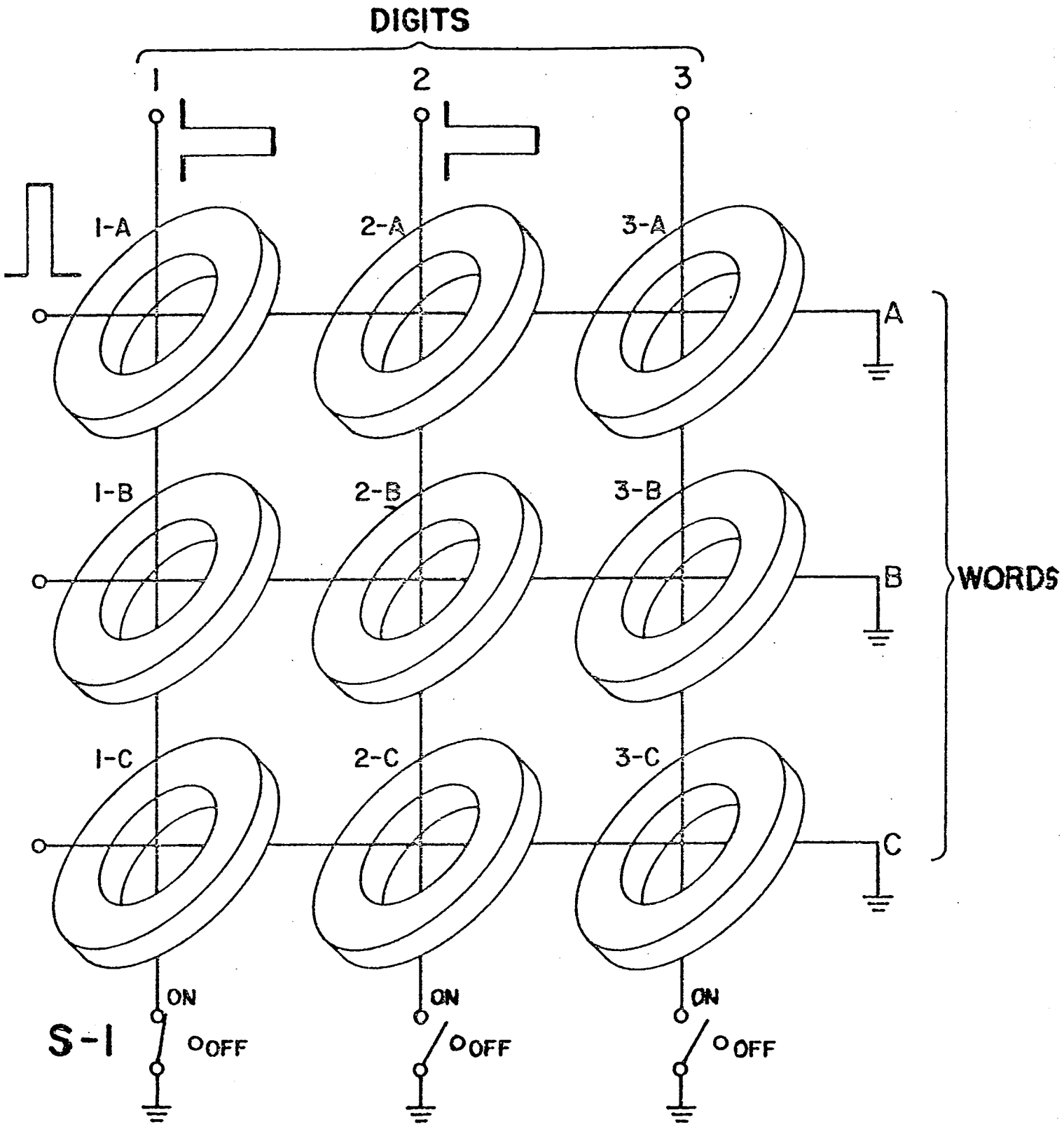

DIGITS
1
2
3
1-A
2-A
3-A
A
1-B
2-B
3-B
B
WORDS
1-C
2-C
3-C
C
ON
OFF
S-1
ON
OFF
ON
OFF

FIGURE I

switch on the particular stops associated with that word. Thus, each WORD consists of three stops, or DIGITS.

The same three stops can be programmed, as previously explained, from two other positions, or pistons. These could be located on the same or another manual. These two pistons apply pulses to WORD lines B and C. In the actual combination action, a WORD consists of many more stops than the three shown in Figure 1, and are associated with 3 or more pistons each. The operation is the same, however. Each piston pulses a WORD line and each DIGIT line determines if there will be coincidence of half-pulses in the cores associated with that particular line.

How The Core Reads Out Its Information

Another wire is threaded through the memory cores, parallel to the WORD line. A READ pulse is then applied to this wire from a direction opposite to that of the previous WRITE pulse. Its polarity is such that it will switch the magnetic field of any core that was resting in the "1" state.

When a core switches, its magnetic field collapses to zero, then builds up to full strength in the opposite direction, or polarity. If the lines of force of this rapidly-changing field are allowed to cut across a conductor, a secondary pulse will be induced into the conductor. Therefore, a fourth wire is threaded through the cores to "pick up" this secondary pulse. This is the SENSE wire. It senses all switches from the "1" states of the cores that it passes through. If a core had a "0" stored previously, the READ pulse would merely tend to re-magnetize that core in the same direction as before. There would be no switching of the core and no pulse would be induced in the SENSE wire. The SENSE wires run parallel to the DIGIT wire described before. As described later, both are DIGIT lines.

If the SENSE line associated with a particular core reads out a pulse, the stop coil associated with that core moves to the ON position. In the absence of a pulse, the coil moves to the OFF position. If a stop is already in the required ON or OFF position, it merely remains there. The ON or OFF coil is still energized, however.

Inspection of the actual memory planes of the combination action will show more than four wires threaded through each core. The "extra" lines are actually the two DIGIT lines, doubled back upon themselves several times for extra sensitivity.

How Previously - Memorized Registrations Are Called Up

The following explanation of the computer-capture combination action requires the use of a block diagram B-1. The numbers in parentheses correspond to the numbers printed in red on the block diagram.

The organist can choose from at least 4 settable, or pre-set, pistons per manual. He may choose, instead one of the general pistons. In any case, the following circuit description is applicable.

Depressing the SETTABLE piston (1) grounds the timing circuits through the darlington current switch (21) and starts the cycle of events. The SCR Power Gate (2) applies power through another darlington switch (3) to the SCR Digit Sense circuits (4) and the Digit Sense Inhibit circuit (5). Operation of these circuits will be explained later as they are activated.

After the SCR Power Gate operates, the Piston Pulse Generator (6) produces a pulse which is amplified by the READ Driver Amplifier (7). This pulse is sent down the READ wire threaded through the center of each memory core (8) on that line.

If a core was previously left in the "1" state, it reverses its field, or switches, to the "0" state. This reversal of field around the core causes a pulse to be induced in the Digit line that passes through its center at right angles to the READ wire. This pulse is amplified by Q18 (9) and triggers an SCR, Q19 (10). SCR Q19 permits current to be applied to the ON coil (11) of the stop associated with that digit wire.

If the memory core was previously left in the "0" state, the READ pulse causes no reversal of the magnetic field. No pulse, therefore, appears on the associated digit wire, and no power is applied to that ON coil.

A few milliseconds after the ON coil has been energized, the Cancel Pulse Generator (12) produces a pulse which is amplified by the Cancel Pulse Amplifier (13). This turns on SCR Q25 (14), which applies power to the OFF COIL (15) of the stop mechanism.

Unless some sort of protective circuit were to be activated when a stop is being moved to the ON position, the cancel pulse circuitry would tend to keep it in the OFF position. Therefore, when the ON coil is activated, a portion of the ON coil voltage is fed from SCR Q19 to SCR Q25, through a clamping diode (16). This disables SCR Q25 which then cannot send current to the OFF coil associated with the same stop.

The Cancel Pulse Generator output pulse is also used to trigger another SCR, Q301 (17) which turns on Q305 (18). It, in turn, turns Q308 (19) off. When Q308 does not conduct, Q18 (9) is disabled. This prevents stray pulses, or other interference, from triggering SCR Q19 and applying power to the ON coil when it is not desired.

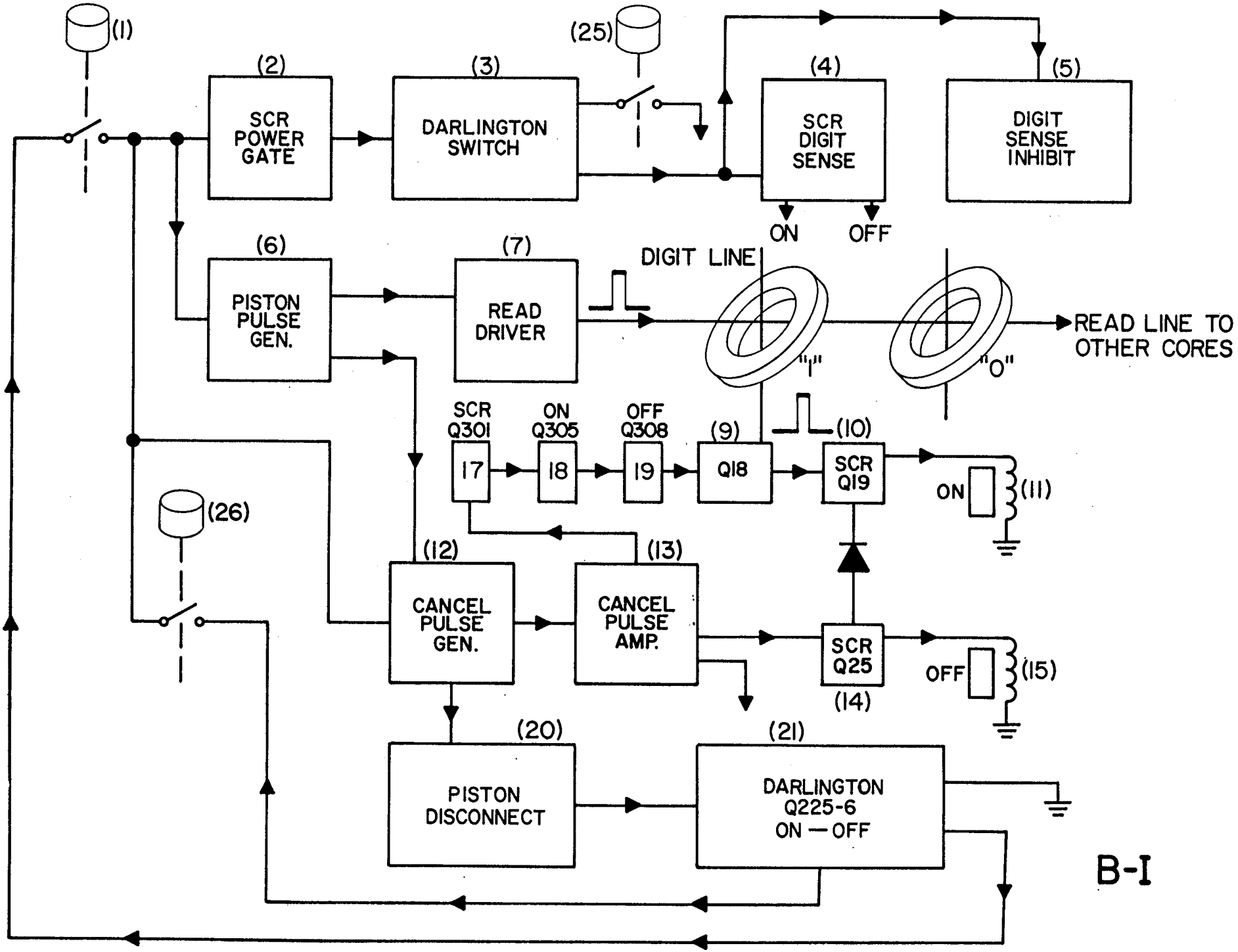
The Cancel Pulse Generator also activates the Piston Disconnect circuit (20), causing it to change its output voltage level. This occurs a few milliseconds after the Cancel Pulse Generator has applied power to the appropriate OFF coils. The changed output voltage level from the Piston Disconnect disables the darlington circuit (21) and removes ground from the Settable Piston (1). This prevents the activating of another piston pulse generator by accidentally hitting a second settable piston. (If this were to happen, the two registrations would mix in a haphazard way, and portions of both would wind up being set up on the stops. Then this new, unwanted registration would be set up on both pistons, the old registrations being destroyed.)

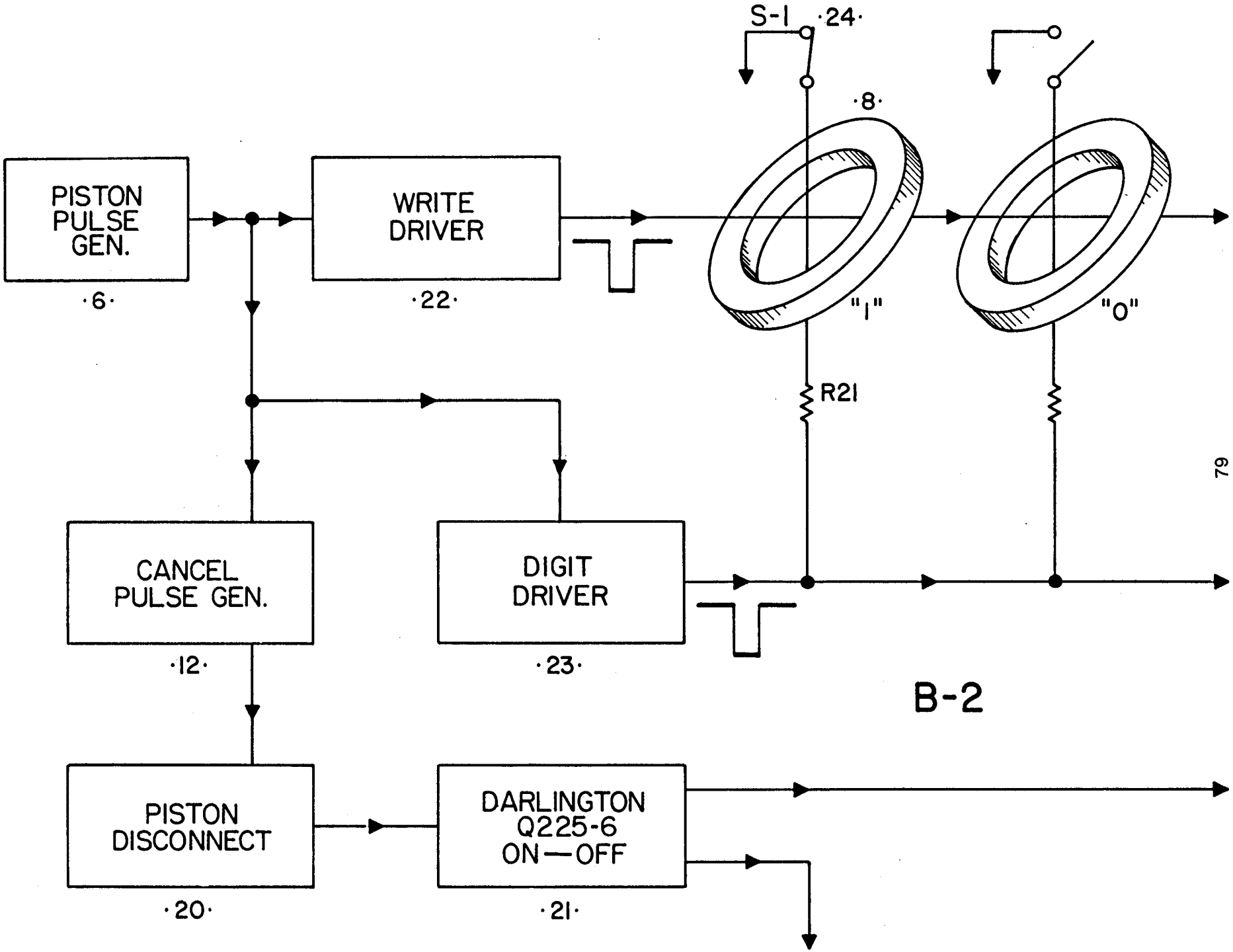
Shortly after the above sequence of events, the stop mechanisms will have moved to their required positions. The SCR Power Gate then reverts to its original state, removing power from the DIGIT Sense SCR's, which in turn remove power from the ON and OFF coils.

(Refer now to Block Diagram B-2, along with B-1)

The Piston Pulse Generator (6) reverts to its original state. In doing so, it generates a WRITE pulse which is amplified by the WRITE Driver (22). The output of the driver is fed into the WRITE wire also threaded through the same row of memory cores that contains the READ wire. (Recall that the READ wire carries the pulse that switches the cores from the "1" to the "0" state.) This WRITE pulse is sent through the cores in the opposite direction. Its amplitude alone will not switch the cores.

The WRITE pulse is also fed into another circuit, the DIGIT Driver (23). It amplifies the pulse and applies it to a bus that branches off through each individual memory core (8) associated with each stop. Each of these branches, or DIGIT lines, is isolated from the WRITE line by a 330-ohm resistor, R21. If the stop associated with a particular memory core is in the ON position, a switch (S-1) (24) grounds the DIGIT wire that passes through that core. This allows the WRITE pulse to pass through every core on that DIGIT wire. This WRITE pulse does not have sufficient amplitude to switch the cores, either. When the first WRITE pulse, which is associated with the "WORD," coincides with the second WRITE pulse, which is associated with the DIGIT, their combined amplitudes switch that particular memory core to the "1" state. Thus, re-programming is accomplished. This same core caused the stop to move to the ON position when it reads out its previous "1" state. The stop in turn now re-programs the core to the same "1" state, thus preserving its share of the total registration.


(1)
(2)
SCR POWER GATE
(3)
DARLINGTON SWITCH
(25)
(4)
SCR DIGIT SENSE
(5)
DIGIT SENSE INHIBIT
ON
OFF
(6)
PISTON PULSE GEN.
(7)
READ DRIVER
DIGIT LINE
"1"
"0"
READ LINE TO OTHER CORES
SCR Q301
ON Q305
OFF Q308
(9)
(10)
17
18
19
Q18
SCR Q19
ON
(11)
(26)
(12)
(13)
CANCEL PULSE GEN.
CANCEL PULSE AMP.
SCR Q25
(14)
OFF
(15)
(20)
(21)
PISTON DISCONNECT
DARLINGTON Q225-6 ON — OFF
B-I
78


S-1
·24·
·8·
PISTON PULSE GEN.
·6·
WRITE DRIVER
·22·
"1"
"0"
R21
CANCEL PULSE GEN.
·12·
DIGIT DRIVER
·23·
PISTON DISCONNECT
·20·
DARLINGTON Q225-6 ON—OFF
·21·
79

B-2

One by one, the Piston Pulse Generator, the Cancel Pulse Generator, and the Piston Disconnect circuits return to their resting state. Ground is again applied to the Settable Piston (1) through the darlington circuit (21). The system is now ready to go through the entire sequence of events all over again. If the piston is still depressed, it will do so. The total time lapse for each complete cycle is a little over half a second.

How The System Memorizes A New Registration

The Set Piston (25) is depressed, applying ground to the darlington switch (3). This disables it, preventing power from being applied to the SCR Digit Sense (4) and Digit Sense Inhibit (5) circuits. The SETTABLE piston (1) is depressed next.

The READ pulse put out by the Piston Pulse Generator is applied to the READ line that passes through the memory cores (8), as explained before. Each core switches to the "0" state. As no power is supplied through the sense SCR's (4), no stop coil is energized. At this point, the cores have no memory (all are in the "0" state).

The re-programming, as explained earlier, DOES take place, however. Each stop will be in its required position, as per the new registration. Those that are in the ON position allow a "1" to be memorized by the core associated with that stop. The "1" state, of course, moves that stop to the ON position whenever that registration is called up in the future, etc.

How The Cancel Piston Operates

The Cancel Piston (26) is depressed. This activates the Cancel Pulse Generator (12) and the SCR Power Gate (2). The SCR Power Gate reacts first, applying power to the SCR DIGIT Sense and DIGIT Sense Inhibit circuits (4 and 5).

The Cancel Pulse Generator produces a pulse which is amplified (13) and used to trigger SCR Q25 (14). This moves all stops to the OFF position. The Piston Pulse Generator (6) does not become activated (note that it is isolated by the back-biased Diode D2, in schematic 1298).

The ON coils are prevented from operating on stray pulses by the SCR Digit Sense Inhibit circuit (5), as previously explained.

Output from the Cancel Pulse Generator activates the Piston Disconnect circuit. This disconnects the cancel piston, causing all circuits to begin returning to their original state. The stop mechanisms complete their move to the OFF positions (except those already in the OFF position, of course). Power is then removed from the coils as the SCR Power Gate returns to its resting state.

Corrected, August, 1970

SUGGESTION

When the over-all operation is understood, it is suggested that the description that accompanies the block diagrams be read again. This time, however, substitute the two schematics for the block diagrams to gain familiarity with the actual circuits involved.

Hold And Set Operations

If the organist desires to make minor changes to a registration, he can change a particular stop by physically holding the stop in the new position, either ON or OFF, and depressing the Settable Piston (1).

However, as the combination action automatically goes through a re-programming cycle each time a Settable Piston is depressed, there is no reason why even minor changes should not be incorporated by using the SET Piston (25). This operation was explained previously under the section dealing with memorizing new registrations.

General Pistons

A general piston does NOT activate other settable pistons, as on most organs. This permits a much greater versatility and expanded choice of pre-set registrations. These general pistons are not shown on the block diagrams or the schematic drawings. Their function, however, is no different from that of the individual settable pistons, except that memory planes for all three manuals and pedal are activated at one time, rather than just one manual.

Power Supply

The core characteristics vary rapidly with even minor temperature changes. Drive-current requirements therefore change with different room temperatures. To provide the amount necessary, the power supply is designed to supply an output voltage that varies inversely with temperature. Regardless of the output voltage supplied by the power supply, it is regulated at that voltage. In other words, load variations do not change the voltage output of the supply. Only the Thermistor, which is a temperature-sensing device in the power supply, causes the output voltage to vary. This output voltage varies inversely with temperature. The chart on schematic 1298 indicates the output voltage versus the room temperature.

Corrected, August, 1970

PRELIMINARY FIELD TROUBLE-SHOOTING GUIDE
FOR
CORE CAPTURE SYSTEM

1. One stop does not cancel (or turn OFF when set off).

   SCR Q-25 for that stop is probably defective.
   R-26 open.
   R-24 open.
   R-42 open.

2. One whole division does not cancel.

   Q-40 and/or Q-41 defective (on divisional core board).
   R-40 open.

3. One division does not cancel from its cancel piston but does cancel with general cancel.

   Divisional cancel Schmitt defective.
   Q-206 defective (in divisional cancel).
   Q-208 defective (in divisional cancel).

4. General cancel inoperative (all divisions).

   Defective General Cancel Schmitt.
   Q-206 defective (in general cancel).
   Q-208 defective (in general cancel).

5. One division does not move OFF when set off (one piston only).

   Open diode D1 on the Schmitt for that piston.

6. One division does not move OFF when set off (all pistons of that division).

   Defective Q-201 (in division cancel).

7. No stops will move to the OFF position when set off (one general piston).

   Open diode D1 on the Schmitt for that piston.

8. No stops will move to the OFF position when set off (all general pistons).

   Defective Q-201 (in general cancel).

9. One stop moves to the OFF position when any piston is depressed.

Shorted diode 24 (for that stop).
Shorted SCR Q 25 (for that stop).

10. One division cancels whenever any piston is depressed.

Q-41 defective (in that division).
Q-40 defective (in that division).
Q-208 defective (in that division).
Shorted diode D24 (for one or more stops in that division).

11. All stops in one division do not set ON for one piston (General Piston).

Defective Q-10 (for that piston on that core board).
Defective Q-29 (for that piston on that core board).
R-12 changed value (for that piston on that core board).
open diode D-12 (for that piston on that core board).

12. All stops do not set ON one General Piston.

Defective Q-111 (for that General piston).
Defective Q-112 (for that General piston).
Defective Q-110 (for that General piston).
Defective Q-113 (for that General piston).
Defective Schmitt (for that General piston).

13. All stops in one division do not set ON for one piston in that division.

Defective Schmitt for that piston.
Defective Q-111 for that piston.
Defective Q-112 for that piston.
Defective Q-10 for that piston (located on core board).
Defective Q-29 for that piston (located on core board).
R-12 has changed value for that piston (on core board).
Open D12 for that piston on core board.

14. One stop does not set ON more than one piston.

Defective Q-18 for that stop (located on the core board).
Defective R-21 for that stop (located on the core board).
Defective Q-19 for that stop (located on the core board).
Stop contact or (open diode on drawknob).

15. One stop does not set ON (one piston only).

Defective core: Before attempting to replace core, replace the following:

Q-18 on that stop Q-29 on that piston.
SCR Q-19 on that stop Q-10 on that piston.
R-20 on that stop R-12 on that piston.
R-18 on that stop R-28 on that piston.
R-19 on that stop.
R-21 on that stop.
Connect the spare cores to that stop.
Replace core only if the spare cores are already in use.

16. One stop always turns ON when any piston is depressed.

Shorted Q-18.
Open base lead to Q-18 (broken wire from base of transistor through the cores).
Shorted SCR Q-19.

17. All stops in one division do not set ON.

Defective Q-14.
Defective Q-17.
Defective Q-301.
Defective Q-305.
Defective Q-308.

18. All stops in one division do not operate either ON or OFF.

Defective Q-156 (for that division).
Defective Q-157 (for that division).
Circuitry: D2 in the cancel for that division (Circuit board with Schmitts).
Q-201 in the cancel for that division.
Cancel Schmitt for that division.

19. All stops do not operate either ON or OFF.

Defective SCR power Schmitt.
Q-151.
Q-152.

Piston disconnect Schmitt.
Q-225.
Q-226.

20. All pistons do not repeat.

Defective Piston disconnect Schmitt.
Q-221.

21. Pistons in one division do not repeat.

D1 on the cancel Schmitt for that division.

LIGHTED CAPTURE SYSTEM OPTION - schematic 1396

While the Lighted Capture System is much the same as the Computer Capture Combination Action, 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 'O' 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 an 'O' is stored in the core. Thus the SETTABLE PISTON is reprogrammed 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 brighness for all of the stops on the stopboard. R41 is adjustable by means of a knob on the stopboard.

GREAT TO PEDAL REVERSIBLE OPTION
(note: Setterboard no longer available)

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 990; 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 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.

LIGHTED REVERSIBLE - schematic 1401

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. 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.

EXPRESSION INDICATOR - schematic 1405

The Expression Indicators provide a reference point so the organist can preset 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 its schematic. 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. As the Crescendo pedal is pressed, the switch contacts add progressively louder stops to the selected voices. 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.

TIMESHARED
COUPLER SYSTEM - schematic 1379

Time has been divided into 10 microsecond segments with a 2 microsecond space between them. These time segments (slots) are actually used in groups of four. The first slot of the four is used for the Swell keys, the second for the Great keys, the third for the Choir, and the fourth for the Pedal. The operation of each of the time slots is identical.

Using the Great time slot as an example: keying voltage (ground) is applied to the key contacts for 10 microseconds out of every 48 (every 4th time slot). The other side of the contacts are connected to 61 keying busses through diodes. (The other three keyboards are also connected to these same 61 busses through diodes of their own.) These busses are connected to 4 diode gates (61 notes each). They are: 8' Swell, 8' Great, 8' Choir, and 4' Swell (49 notes). During this Great time slot, the 8' Great diode gate (Coupler) is turned on to allow the Great keying voltage to reach the Great Coupler Current Amplifier. This circuit inverts the keying voltage (changes it to +12 VDC), and includes a capacitor to store the keying voltage during the other three time slots until the Great keys once again have keying voltage applied to them. The other 8' Couplers (diode gates) are turned on when their respective keyboards have keying voltage on them. The Pedal "Coupler" does not turn off as it is connected to the Pedal keys ahead of the diodes, and thus never "sees" any keying voltage except that of the Pedal.

Turning on the 8' Swell Coupler during the Great time slot allows the Great keys to play the Swell stops by keying the Swell Coupler Current Amplifier. Other inter-manual couplers operate in a similar manner and include: 8' Swell to Choir, 8' Choir to Great, 8' Great to Pedal, 8' Swell to Pedal, and 8' Choir to Pedal. The 4' Swell to Swell also operates the same way except that it is turned on only during the Swell time slot. These inter- and intra-manual couplers require that a stop tab be depressed for them to operate.

Electronically the system consists of a circuit to delay the application of +12 VDC to parts of the system while providing a fast rise time to insure that the circuits start properly. This delayed voltage is applied to the clock circuit, which consists of a free running multivibrator, a differentiating circuit to provide a narrow pulse, and a power gating circuit that advances the ring counter part of the time slot generator. There are four time slots, each consisting of a single stage of the ring counter and the transistors that gate the power to the keyboards. The outputs of the keyboards are connected to the transposer (described below) then to their individual Coupler Current Amplifiers for each division. Coupler switch circuits operate these diode gates and in turn are controlled by the various Coupler Gates that synchronize them with the appropriate time slots. The outputs of the Diode Gate Assemblies (Couplers) are applied to the Coupler

Current Amplifiers. These Coupler Current Amplifiers include capacitors to store the input keying voltage between the time slot pulses. The output of the Coupler Current Amplifiers is DC, and is used to key some signal keyers directly and others via Diode Gates (Unified Voices).

The coupler system as described is called "Time Division Multiplexing" or "Time Sharing." If you are interested in more information about multiplexing, we suggest that you refer to the Howard Sams publication #20051, ABC's of Telemetry, by Alan Andrews. In particular, refer to pages 15, 16, 49 to 60, 89, and 90.

TRANSPOSER - schematic 1404

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.

TROUBLE SHOOTING:

Organs With Transposer

ORGAN DOES NOT PLAY ON ANY KEYBOARD -- first check for the obvious such as: is the organ plugged in? are the fuses good? do the voltages measure correctly at the power supply.

If all of these are okay, then proceed as follows. Turn on several stops and hold a chord. Push the transposer pistons one at a time. If the organ sounds on one or more of the transposer pistons, the trouble is in the Normal transposer circuitry. Check the following in the transposer: Q57, Q59 and the associated circuits. If the organ does not sound on any transposer pitch, the problem is in the Time Sharing Section.

Proceed as follows: Turn off the organ. Attach an oscilloscope to the Collector of Q156 and the Delayed +12. Turn the organ on. There should be a slight delay and then this point will jump to +12. (This voltage starts the Clock and must be +12.) If the voltage does not rise, check the Delayed +12 section. If this point is +12, check the Collector of Q167 for the Clock pulses. If the Clock is running, the problem is probably caused by a faulty transistor (Q171 or Q173) in one of the Time slots, or by D 180 - C 180.

ONE KEYBOARD IS DEAD -- OR -- PLAYS ON ALL MANUALS:
Q176 or Q178 in the Time slot or Q196 (Divisional Switch).

SAME KEY DEAD ON ALL KEYBOARDS -- Q3 in the Transposer Current Amplifier bad.

ONE DEAD KEY ONLY ON ONE MANUAL -- Q188 in the manual's Current Amplifier or D198 in the Divisional Diode gate.

ONE KEY DEAD ON ALL KEYBOARDS ON ONLY ONE TRANSPOSER PITCH --open output diode in the diode gate for that transposer pitch.

ONE DEAD NOTE APPEARS ON ALL TRANSPOSER POSITIONS EXCEPT ONE --

Example: "O" Transposer key 49 is okay
#1 Sharp transistor is dead on key #48
#1 Flat transposer is dead on key #50
#2 Sharp transposer is dead on key #47
#2 Flat transposer is dead on key #51

etc.

There is probably a shorted series diode on the transposer (normal) "O" diode gate #49.

ONE TRANSPOSER POSITION WILL NOT PLAY WHEN ONLY ONE KEY IS DEPRESSED, BUT WILL PLAY NORMALLY WHEN MORE THAN ONE KEY IS DEPRESSED --

On that transposer position one key will play normally. The clamp diode for that key in that transposer diode gate is shorted.

CAPTURE SYSTEM CORE POSITIONS FOR 990-C/D

Digits	Stop Name (Great)
1.	Spare Cores
2.	16' Gemshorn
3.	8' Principal
4.	8' Bourdon
5.	8'Gemshorn
6.	4' Octave
7.	4' Spitzflote
8.	2-2/3' Twelfth
9.	2' Super Octave
10.	2' Blockflote
11.	Mixture III
12.	4' Great to Great
13.	Spare Cores
14.	Spare Cores

Number of Stops = 11
Number of Spare Cores = 3
Number of Divisional Pistons = 4
Number of General Pistons = 6

Digits	Stop Name (Swell)
1.	Spare Cores
2.	16' Violone
3.	8' Geigen Diapason
4.	8' Rohrflote
5.	8' Salicional
6.	8' Voix Celeste
7.	8' Flute Celeste II
8.	4' Prestant
9.	4' Nachthorn
10.	4' Gemshorn
11.	2' Doublette
12.	Plein Jeu III
13.	16' Fagotto
14.	8' Trompette
15.	8' Oboe
16.	8' Vox Humana
17.	4' Clairon
18.	Tremulant
19.	16' Swell to Swell
20.	Swell Unison Off
21.	4' Swell to Swell
22.	Spare Cores
23.	Spare Cores

Number of Stops = 20
Number of Spare Cores = 3
Number of Divisional Pistons = 4
Number of General Pistons = 6

CAPTURE SYSTEM CORE POSITIONS FOR 990-C/D

Digits	Stop Name (Pedal)
1.	Spare Cores
2.	32' Contra Violone
3.	16' Principal
4.	16' Bourdon
5.	16' Lieblich Gedeckt
6.	16' Violone (Sw)
7.	8' Octave
8.	8' Flute
9.	8' Gemshorn (Sw)
10.	4' Choralbass
11.	Mixture II
12.	16' Bombarde
13.	8' Trompette (Sw)
14.	4' Clairon (Sw)
15.	Spare Cores
16.	Spare Cores

Number of Stops = 13
Number of Spare Cores = 3
Number of Divisional Pistons = 4
Number of General Pistons = 6

Digits	Stop Name (Choir)
1.	Spare Cores
2.	8' Viola
3.	8' Viola Celeste
4.	8' Gedeckt
5.	8' Quintade
6.	8' Unda Maris II
7.	8' Aeoline
8.	4' Principal
9.	4' Koppelflote
10.	4' Quintadena
11.	2-2/3' Nazard
12.	2' Flachflote
13.	1-3/5' Tierce
14.	1-1/3' Nineteenth
15.	1' Sifflote
16.	8' Krummhorn
17.	8' Schalmei
18.	Harp
19.	Carillon
20.	Tremulant
21.	16' Choir to Choir
22.	Choir Unsion Off
23.	4' Choir to Choir
24.	Spare Cores
25.	Spare Cores

Number of Stops = 22
Number of Spare Cores = 3
Number of Divisional Pistons = 4
Number of General Pistons = 6

CAPTURE SYSTEM CORE POSITIONS FOR 990-C/D

Digits	Stop Name (General)
1.	Spare Cores
2.	Swell Main Off
3.	Swell Antiphonal On
4.	8' Great to Pedal
5.	4' Great to Pedal
6.	8' Swell to Pedal
7.	4' Swell to Pedal
8.	8 Choir to Pedal
9.	4' Choir to Pedal
10.	16' Swell to Great
11.	8' Swell to Great
12.	4' Swell to Great
13.	16' Choir to Great
14.	8' Choir to Great
15.	4' Choir to Great
16.	16' Swell to Choir
17.	8' Swell to Choir
18.	4' Swell to Choir
19.	GT/CH Main Off
20.	GT/CH Antiphonal On
21.	Spare Cores
22.	Spare Cores

Number of Stops = 19
Number of Spare Cores = 3
Number of General Pistons = 6

LIST OF SCHEMATICS AND DRAWING OF RODGERS MODELS

SPECIFICATION 660/990

TITLE	DRAWING NUMBER
KEYING CHART	1243
660 BLOCK DIAGRAM	1291A
990 BLOCK DIAGRAM	1265A
660/990 KEYING BLOCK DIAGRAM	1282B
COUPLER SYSTEM	1379F
TRANSPOSER	1404A
660/990 UNIT DIAPASON	1295I
660/990 UNIT FLUTE	1270P
660/990 UNIT REED	1278I
990 UNIT GEMSHORN	1268I
660/990 SWELL	1277J
990 CHOIR	1294H
660/990 PEDAL	1274D
660/990 SWELL FILTER NETWORK	1272F
660/990 SWELL FLUTE PREAMP	1292A
990 CHOIR FILTER NETWORK	1275I
660/990 PEDAL FILTER NETWORK	1273D
660/990 OUTPUT CIRCUIT	1269J
EXPRESSION INDICATOR	1405A
SETTERBOARD COMBINATION ACTION	1216D
LIGHTED CAPTURE SYSTEM	1396F
CAPTURE SYSTEM (also see dwg. 1298Q)	1297H
CAPTURE SYSTEM (see dwg. 1297H)	1298Q)
LIGHTED REVERSIBLE	1401C
SILICON SFORZANDO (TUTTI)	1271I
REVERSIBLE FOR NPN ORGANS	1280C
660/990 AIR SOUND	1283E
ACTIVITY GENERATOR	1281D

LIST OF SCHEMATICS AND DRAWING OF RODGERS MODELS

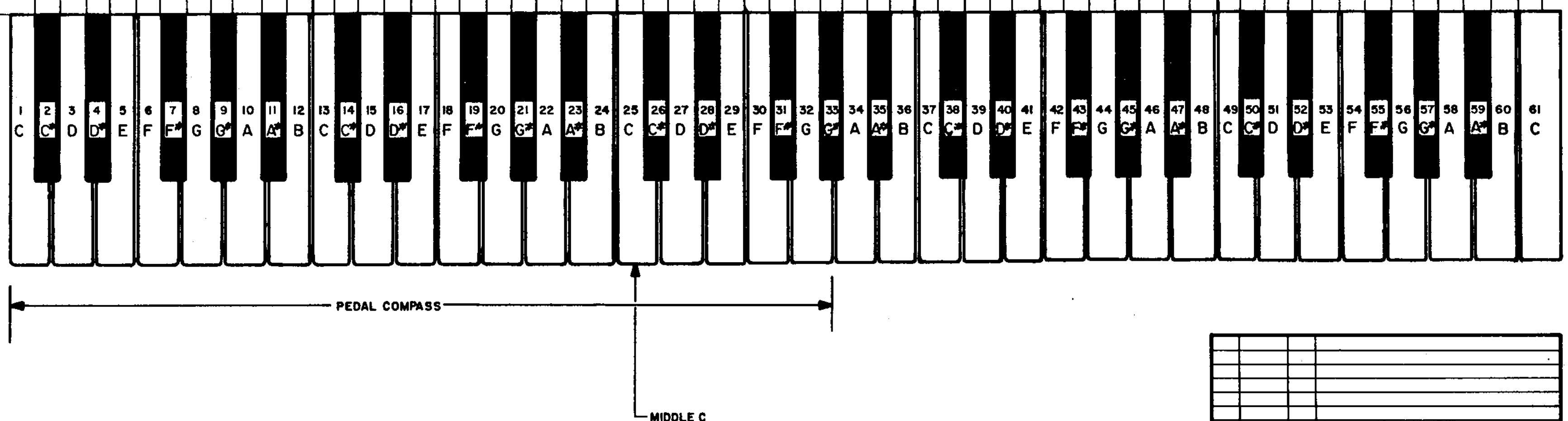
SPECIFICATION 660/990

TITLE	DRAWING NUMBER
TYPE VIII POWER SUPPLY	1418I
TYPE IV SERIES REGULATED POWER SUPPLY	1192K
TYPE IV SERIES REGULATED POWER SUPPLY	1192M
S100B AMPLIFIER	1200G
S101 AMPLIFIER	1200P
W2 SPEAKER SYSTEM	1179
W3 SPEAKER SYSTEM	1246A
W6 100U SPEAKER SYSTEM	1314A
M13 SPEAKER SYSTEM	1247C

PEDAL CHOIR OPTION

32'	001	002	003	004	005	006	007	008	009	0010	011	012	01	02	03	04	05	06	07	08	09	010	011	012	1	2	3	4	5	6
32' RES.	08	09	010	011	012	1	2	3	4	5	6	7	01	02	03	04	05	06	07	08	09	010	011	012	1	2	3	4	5	6
16'	01	02	03	04	05	06	07	08	09	010	011	012	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
8'	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
CHIME MIN. (D#)	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
CHIME MAJ. (E)	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
5-1/3'	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	30	32	33	34	35	36	37
4'	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
4'	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	34	35	36	37	38	39	40	41	42
2-2/3'	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
2'-A	25	26	27	28	29	30	31	32	33	34	35	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
2'-B	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
1-3/5'	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
CHIME "F"	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
1-1/3'	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
1'	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
4/5'	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
A MIXTURE	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	38	39	40	41	42	43	44	45	46	47	48	49
B MIXTURE	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
FLEMISH (D#)	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

32'	7	8																													
32' RES.	7	8																													
16'	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
8'	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
CHIME MIN. (D#)	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
CHIME MAJ. (E)	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
5-1/3'	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
4'	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
4'	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	50	51	52	53	54	55	56	57	58	59	60	61
2-2/3'	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
2'-A	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
2'-B	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	62	63	64	65	66	67	68	69	70	71	72	73
1-3/5'	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				
CHIME "F"	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					
1-1/3'	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85							
1'	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85												
4/5'	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85																
A MIXTURE	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
B MIXTURE	62	63	64	65	66	67	68	69	70	71	72	73	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
FLEMISH (D#)	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	69	70	71	72	73	74	75



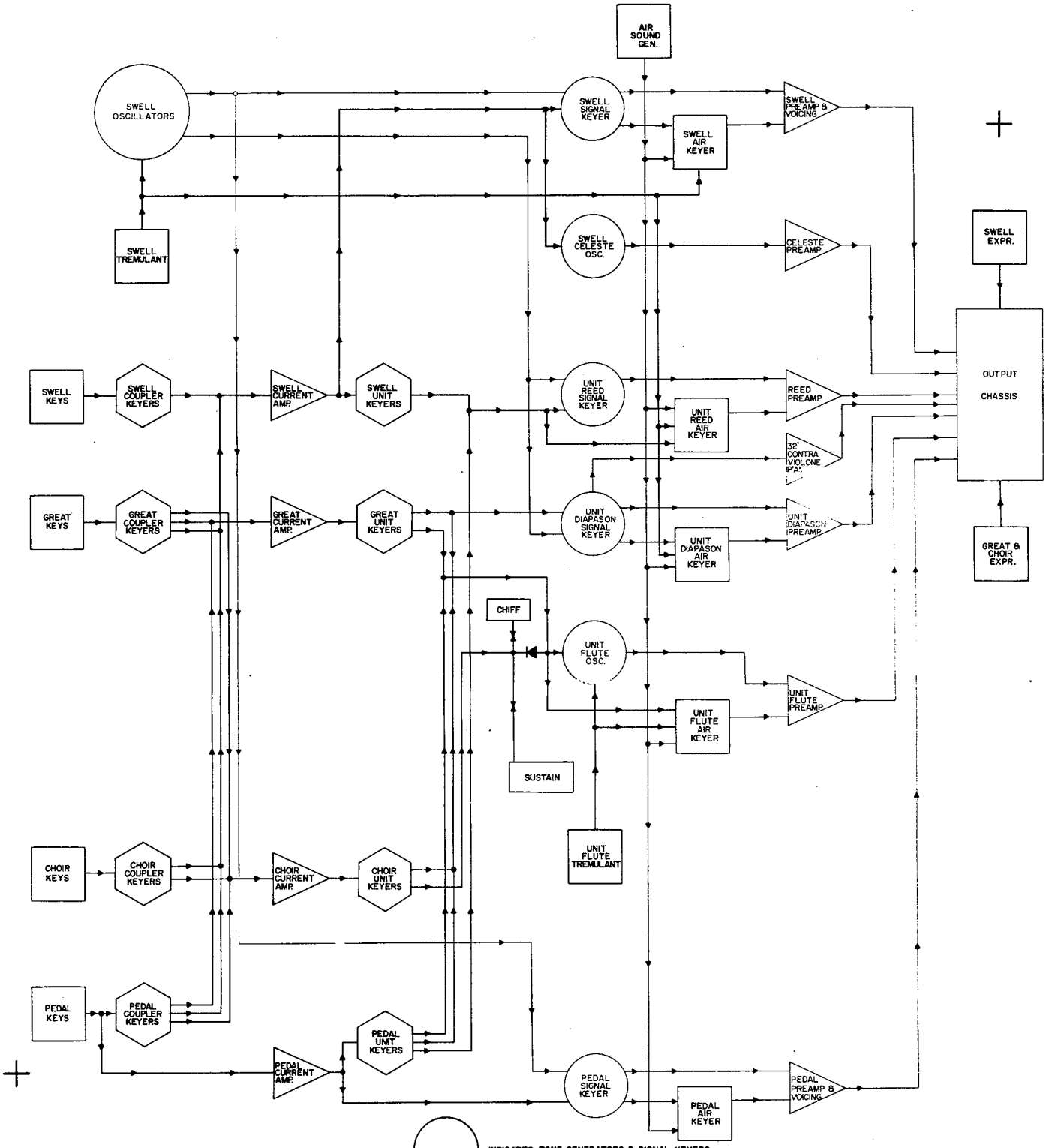
LTR	DATE	BY	DESCRIPTION

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
GS	11-15-65	42		1243

TITLE KEYING CHART



BLACK – INDICATES D.C. KEYING, CONTROLS, ETC.
BLUE – INDICATES AUDIO
RED – INDICATES AIR SOUND

– INDICATES TONE GENERATORS & SIGNAL KEYERS

– INDICATES D.C. KEYERS
– INDICATES COUPLER KEYERS & UNIT KEYERS

– INDICATES AMPLIFIERS & PREAMPS

– INDICATES OTHER DEVICES

DWG. 1291A RED
DWG. 1291A BLUE

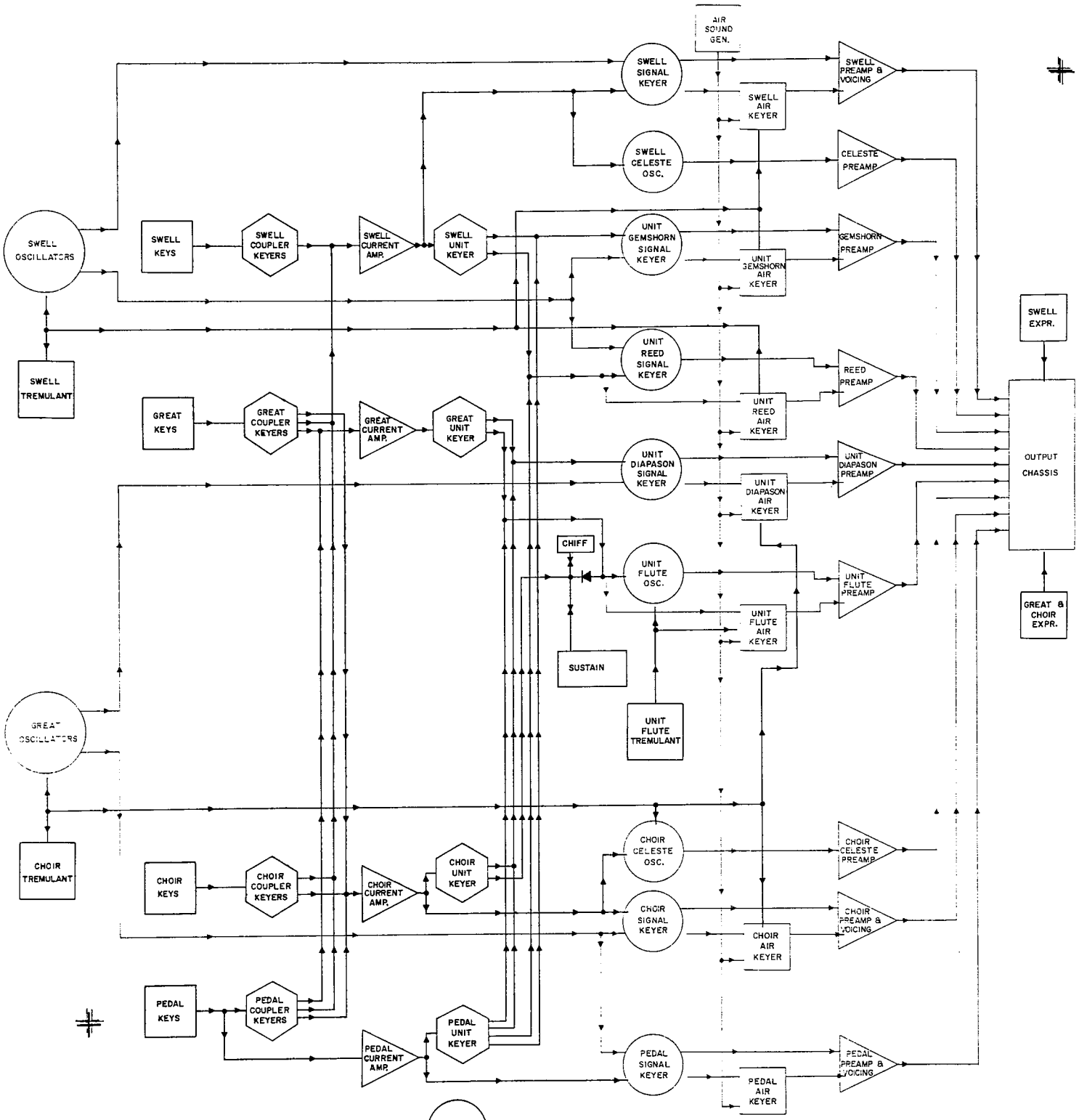
LTR	DATE	BY	DESCRIPTION
A	2-25-69	GM	ADDITIONS

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	6-6-68	30	660	1291A

TITLE: 660 BLOCK DIAGRAM



— INDICATES TONE GENERATORS & SIGNAL KEYERS

— INDICATES D.C. KEYERS — COUPLER KEYERS & UNIT KEYERS

— INDICATES AMPLIFIERS & PREAMPS

— INDICATES OTHER DEVICES

RED — INDICATES AIR SOUND
BLUE — INDICATES AUDIO SIGNAL
BLACK — INDICATES D.C. KEYING, CONTROLS, ETC.

DWG. 1265A RED
DWG. 1265A BLUE

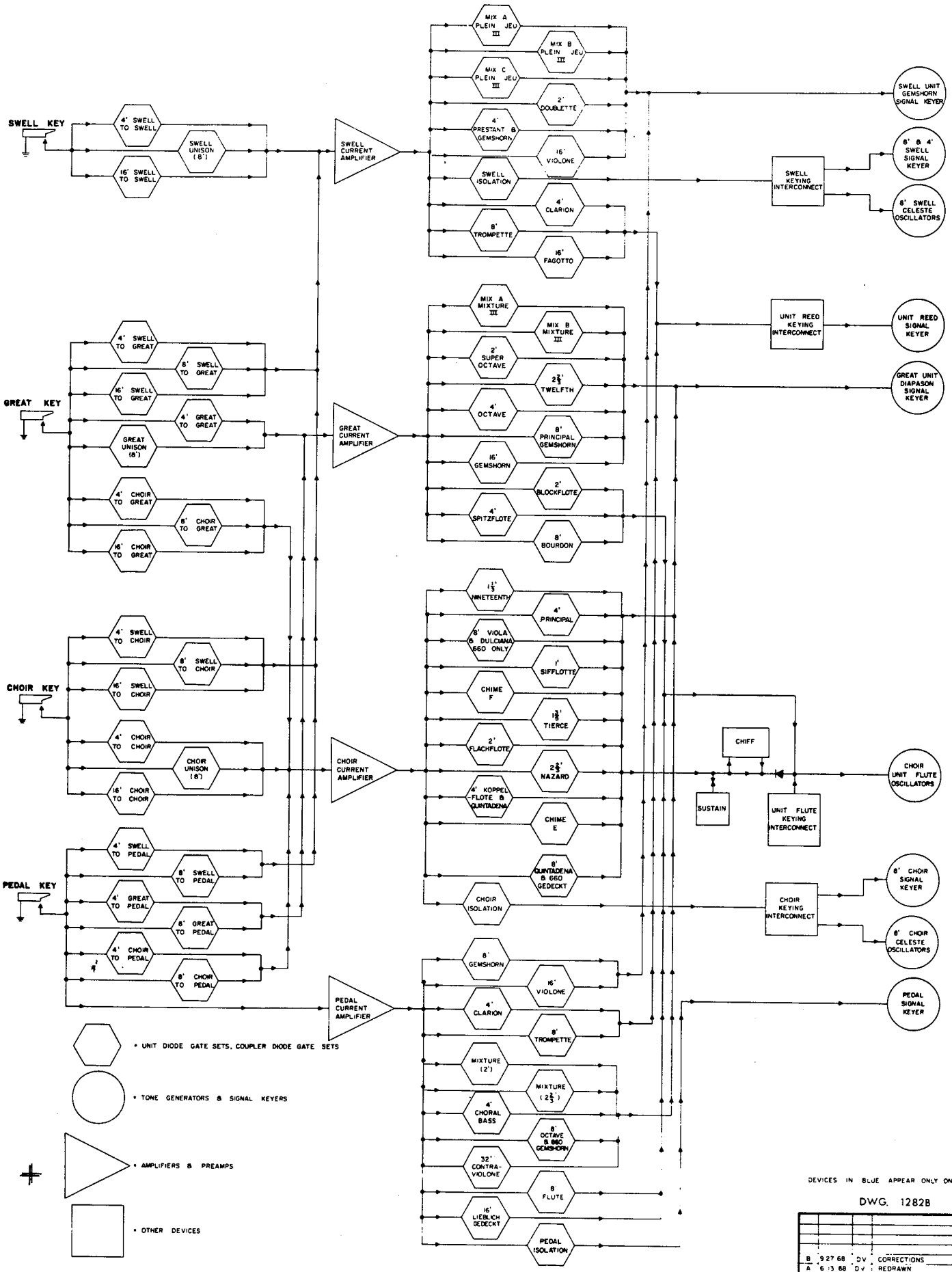
LTR	DATE	BY	DESCRIPTION
A	6-20-68	WU	REVISED FOR 990 MODELS

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	1-23-68	30		1265A

TITLE: 990 BLOCK DIAGRAM



DEVICES IN BLUE APPEAR ONLY ON 990

DWG. 1282B

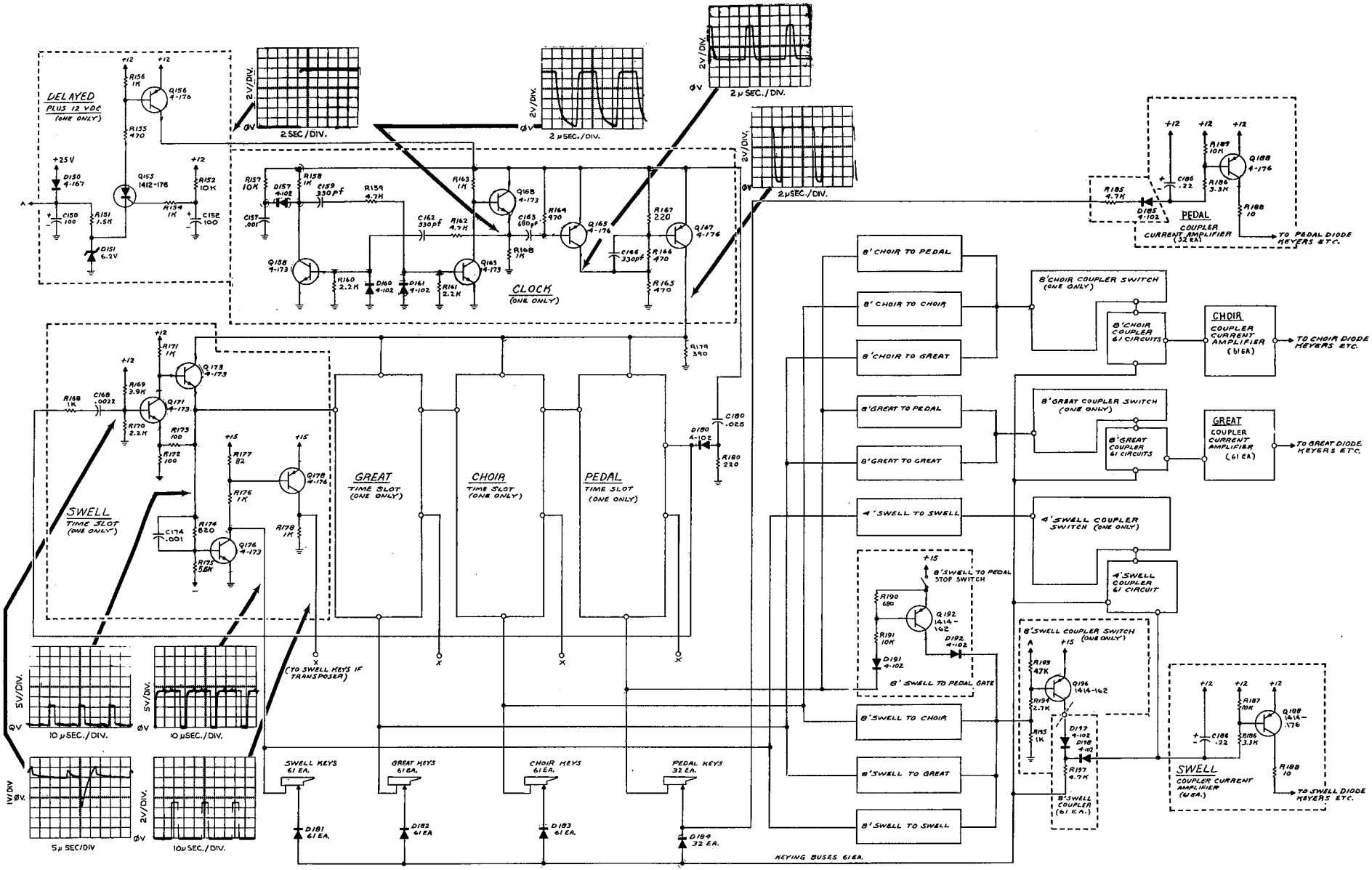
B	9 27 68	DV	CORRECTIONS
A	6 13 68	DV	REDRAWN
NO.	DATE	BY	DESCRIPTION

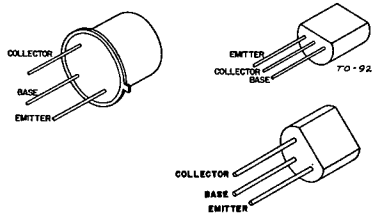
REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
DMV	6 13 68	25		1282B

660/990 KEYING BLOCK DIAGRAM





NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
B NATIONAL C E	TO-92 E B C	C B E	APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

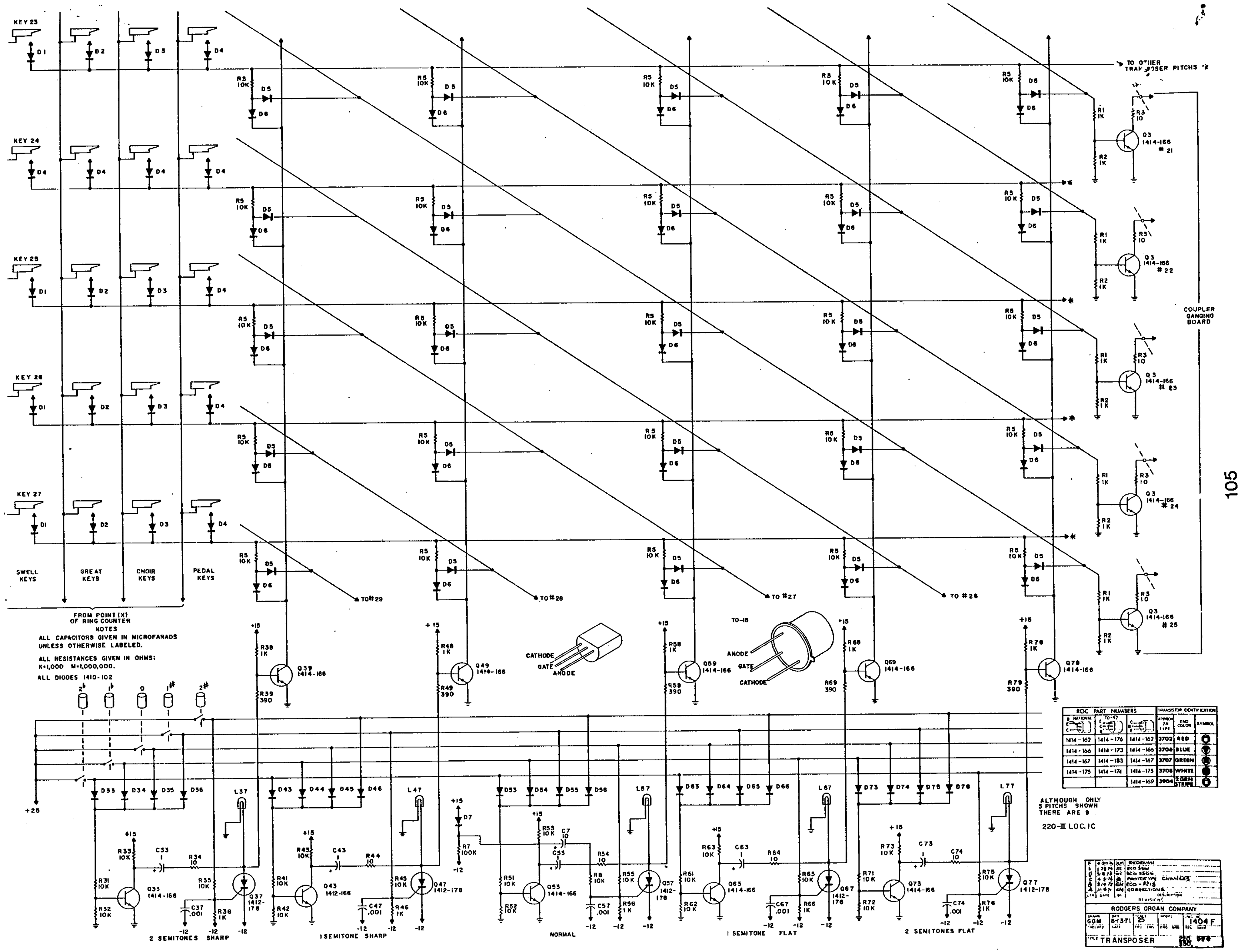
LTR	DATE	BY	DESCRIPTION
F	5-15-77	LY	ECO 4825
E	3-1-76	LY	ECO 4250
D	6-11-73	BT	ECO-3481
C	5-15-72	GM	ECO-3258
B	3-14-72	GM	ECO-3216-3220
A	11-8-71	GM	ECO'S-3161-3170-3158-3165

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
J.D.W.	5-18-71	25	330	1379 F
CHECKED	DATE	PRJ. ENG.	ENG. MRG.	REL. DATE

TITLE COUPLER SYSTEM



NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ALL DIODES 1410-102

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
NATIONAL	TO-97		APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 ORN STRIPE	

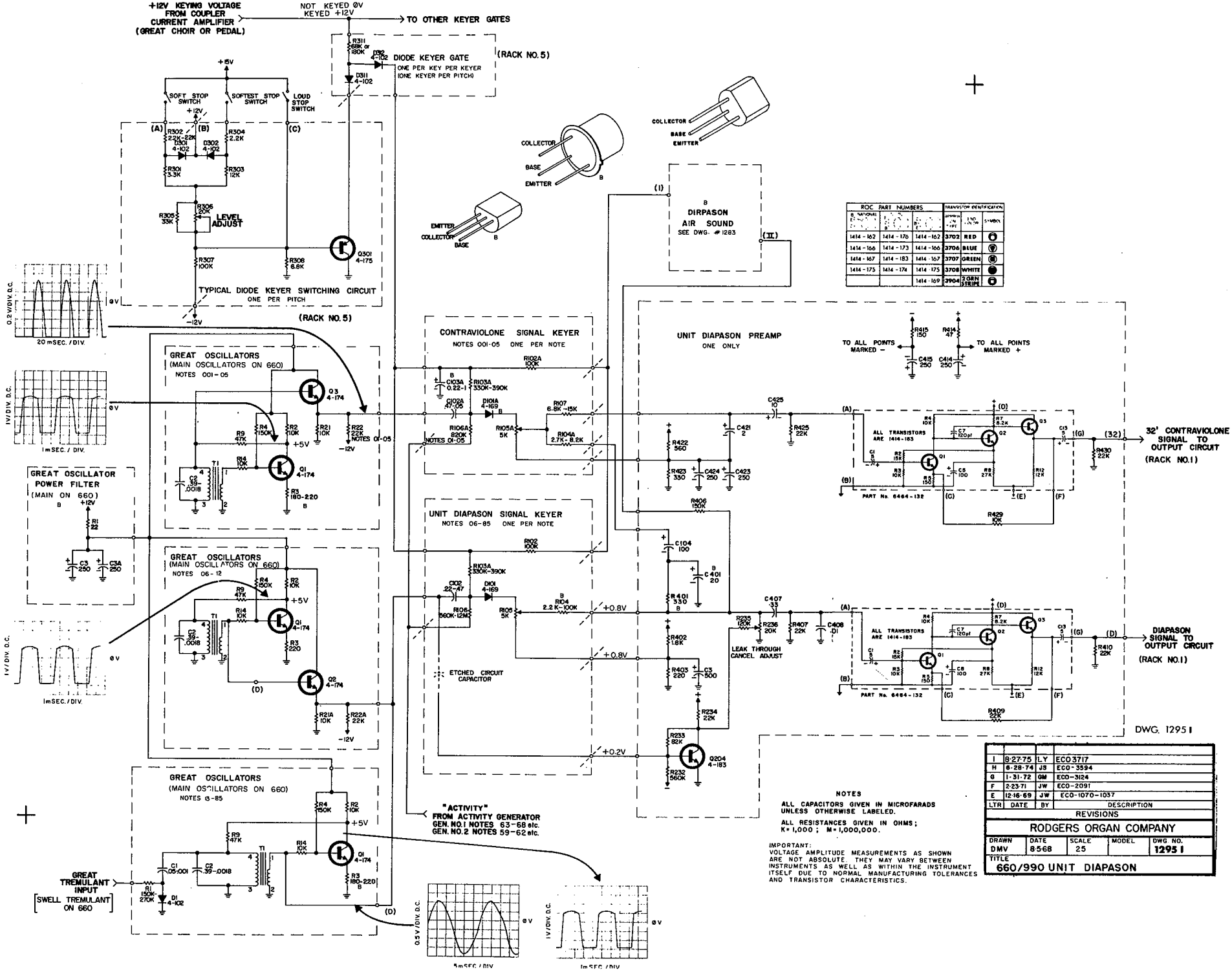
ALTHOUGH ONLY 5 PITCHS SHOWN THERE ARE 9

220-II LOC. IC

RODGERS ORGAN COMPANY

DRAWN GGM DATE 8-13-71 SCALE 25 1404 F

TITLE TRANSPOSER 220 330



ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
A NATIONAL	B		JEDEC NO.	EIA NO.	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

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.

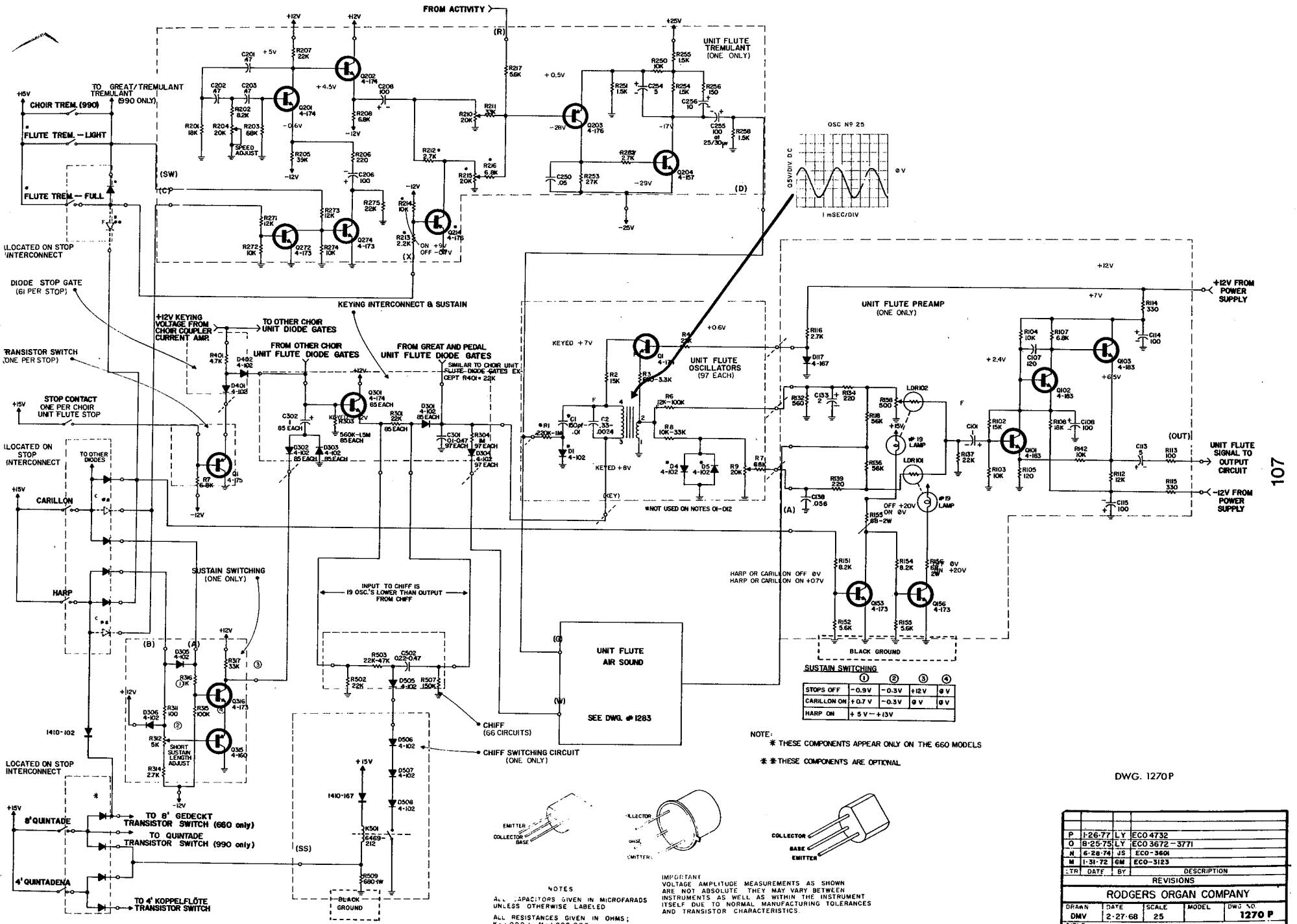
DWG. 12951

LTR	DATE	BY	DESCRIPTION
			REVISIONS
I	9-27-75	LY	ECO 3717
H	6-28-74	JS	ECO-3594
G	1-31-72	GM	ECO-3124
F	2-23-71	JW	ECO-2091
E	12-16-69	JW	ECO-1070-1037

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
DMV	8-5-68	25		12951

TITLE
660/990 UNIT DIAPASON



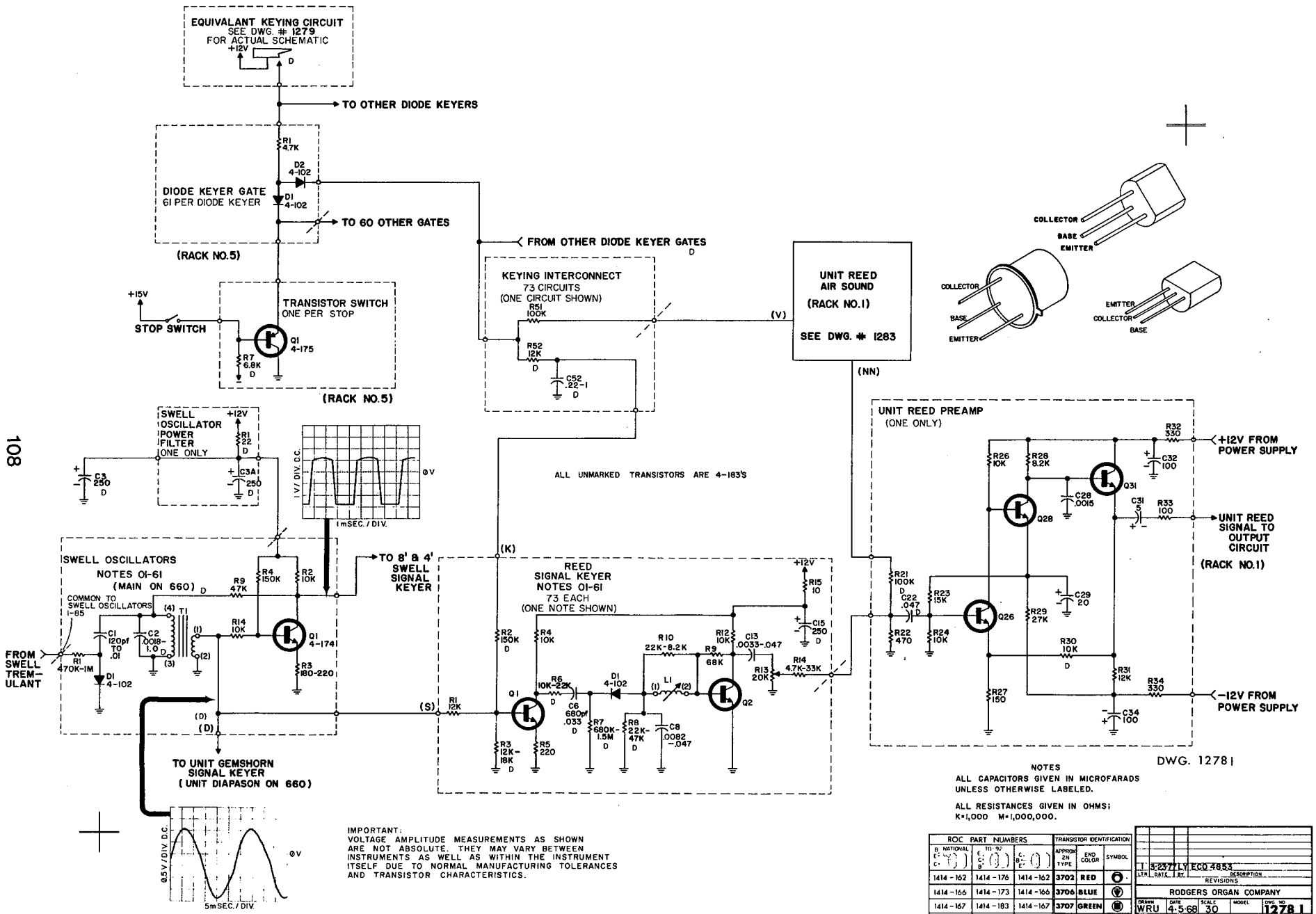
P	1-26-77	LY	ECO 4732
O	8-25-75	LY	ECO 3672-3771
N	6-28-74	JS	ECO-3601
M	1-31-72	GM	ECO-3123
TR	DATE	BY	DESCRIPTION

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
DMV	2-27-68	25		1270 P

TITLE: 660/990 UNIT FLUTE



DWG. 12781

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.

NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

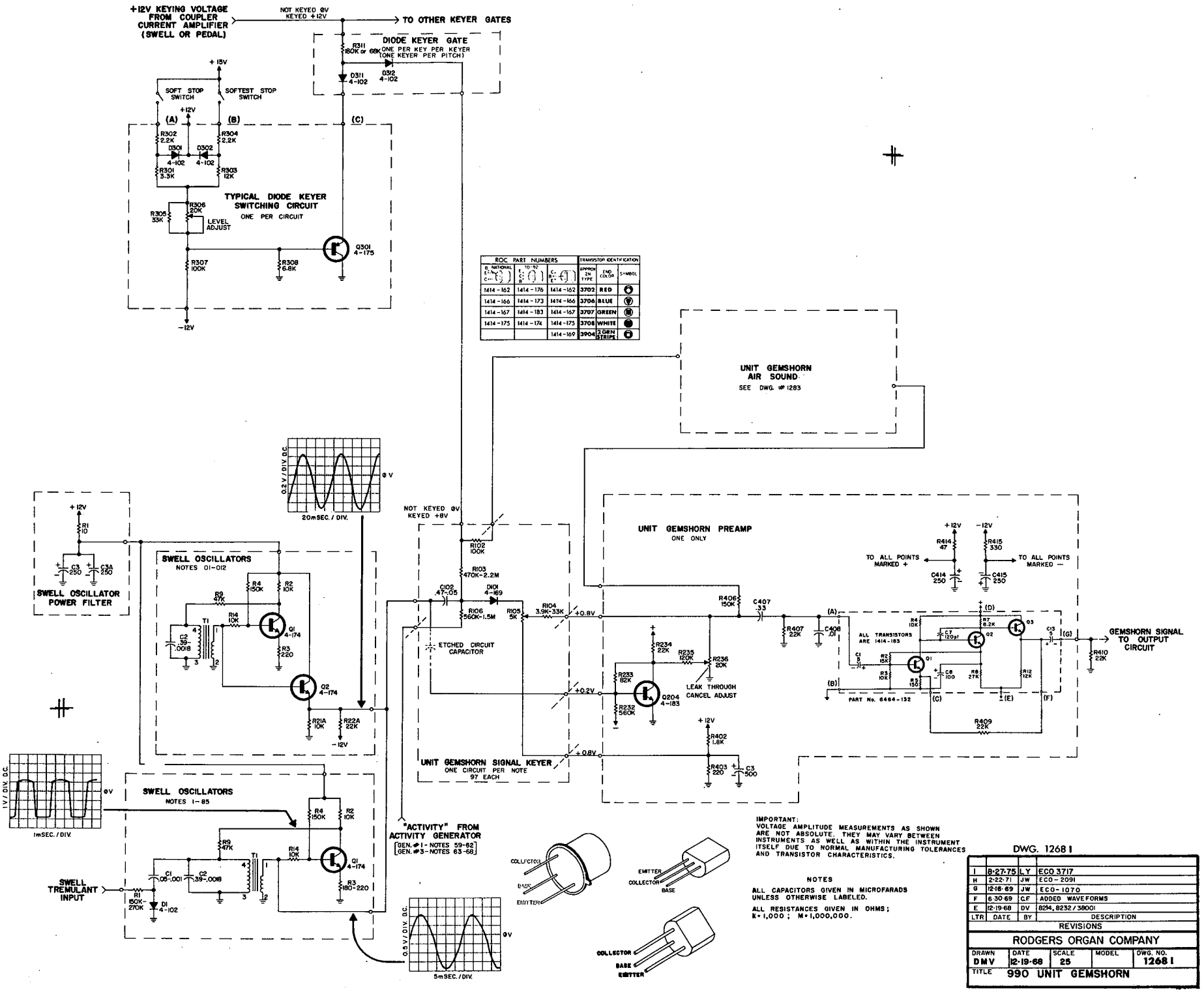
ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
B, NATIONAL E: C: B:	TO-92 E: C: B:	C: B: E:	APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

LTR	DATE	BY	DESCRIPTION
			REVISIONS
I	5-27-71	LY	ECO 4853

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO
WRU	4-5-68	30		1278 I
CHECKED	DATE	PRJ ENG	ENG MNG	REL DATE

TITLE 660/990 UNIT REED



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.

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

DWG. 12681

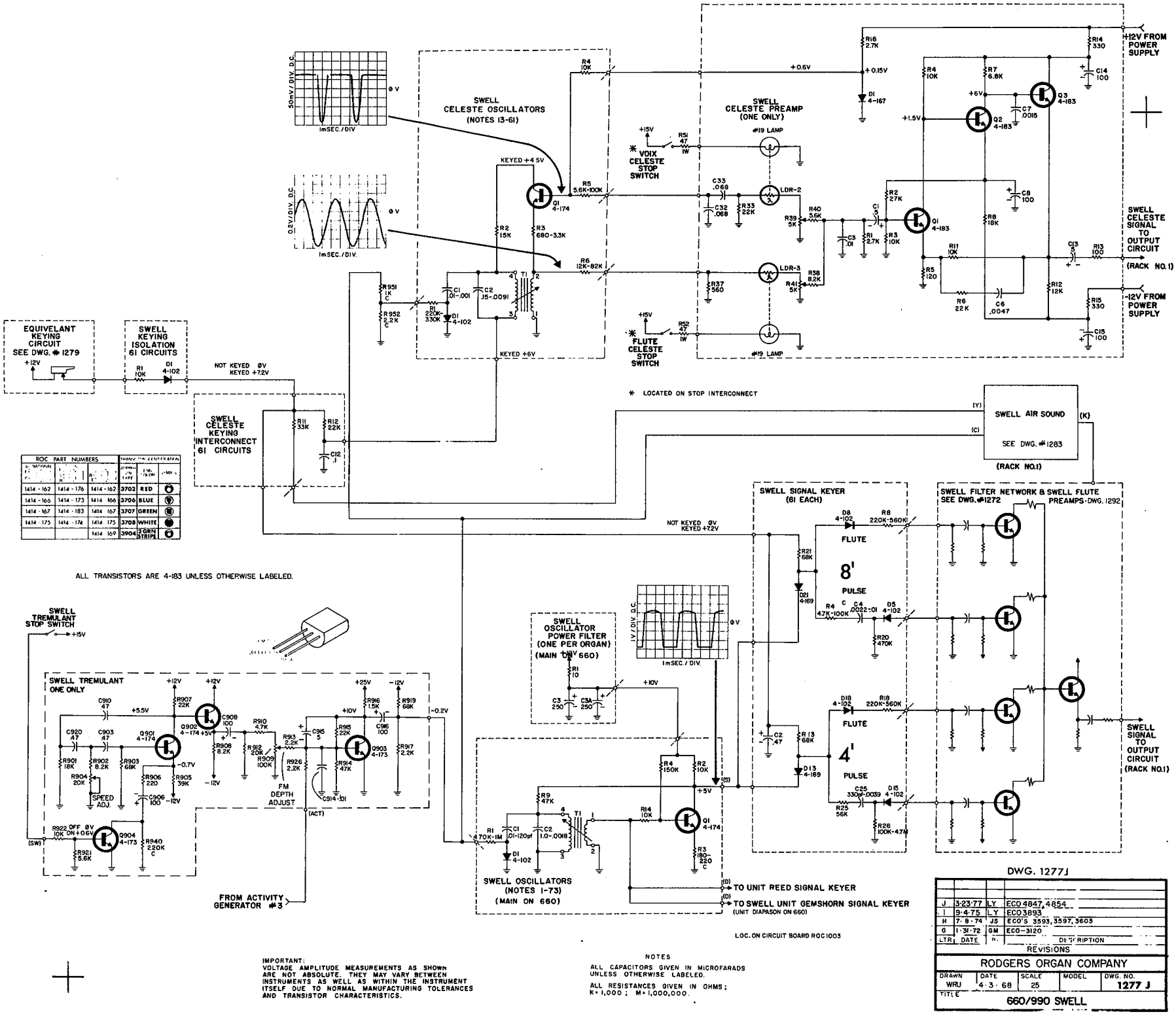
I	8-27-75	LY	ECO 3717
H	2-22-71	JW	ECO - 2091
G	12-16-69	JW	ECO - 1070
F	6-30-69	C.F	ADDED WAVEFORMS
E	12-19-68	DV	8234, 8232 / 38001
LTR	DATE	BY	DESCRIPTION

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	12-19-68	25		12681

TITLE 990 UNIT GEMSHORN



110

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.

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

DWG. 1277J

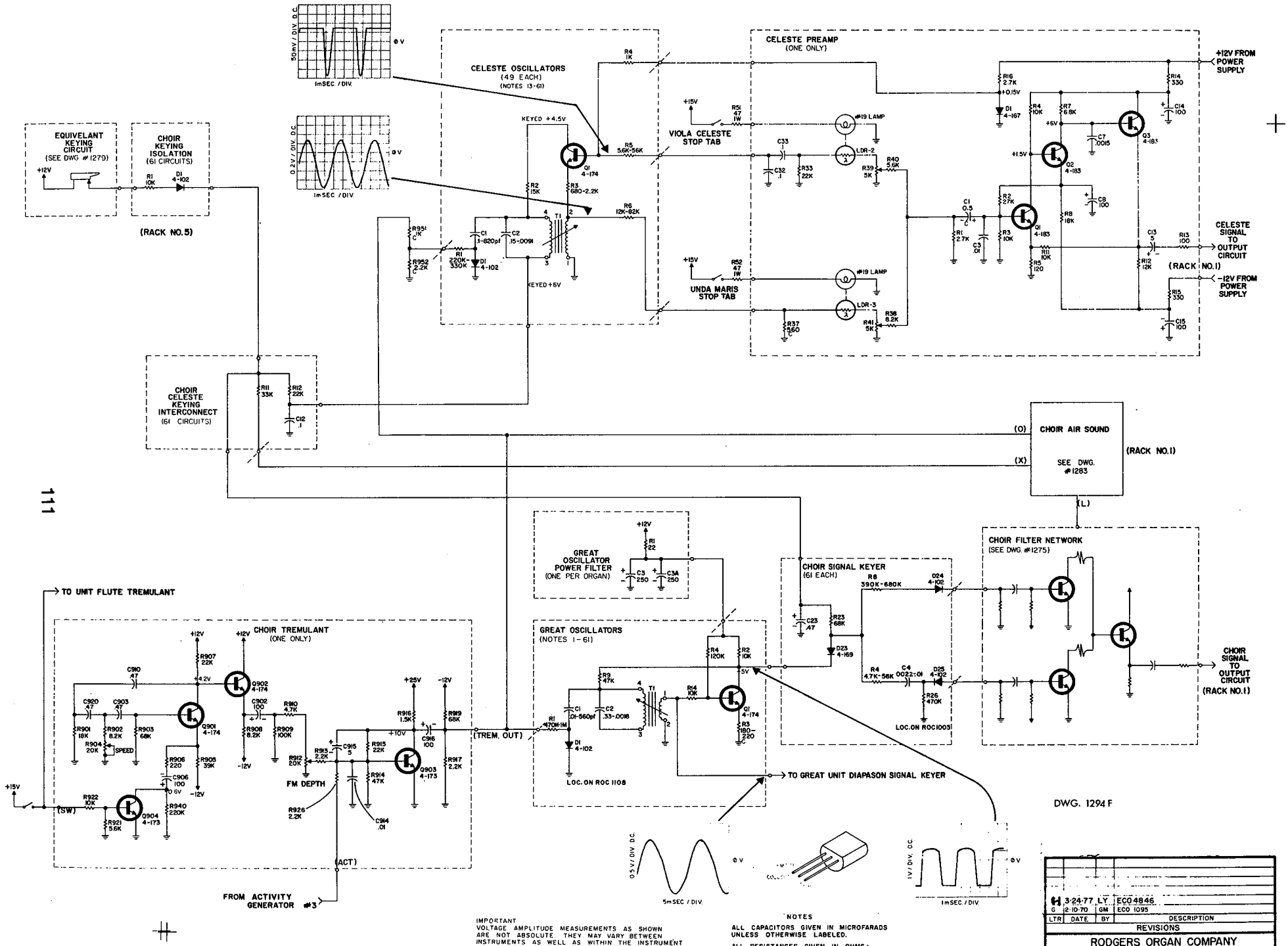
LTR	DATE	BY	DESCRIPTION
J	3-23-77	LY	ECO 4847, 4854
I	9-4-75	LY	ECO 3893
H	7-8-74	JS	ECO'S 3593, 3597, 3603
G	1-31-72	GM	ECO-3120

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRJ	4-3-68	25		1277 J

TITLE: 660/990 SWELL



111

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.

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

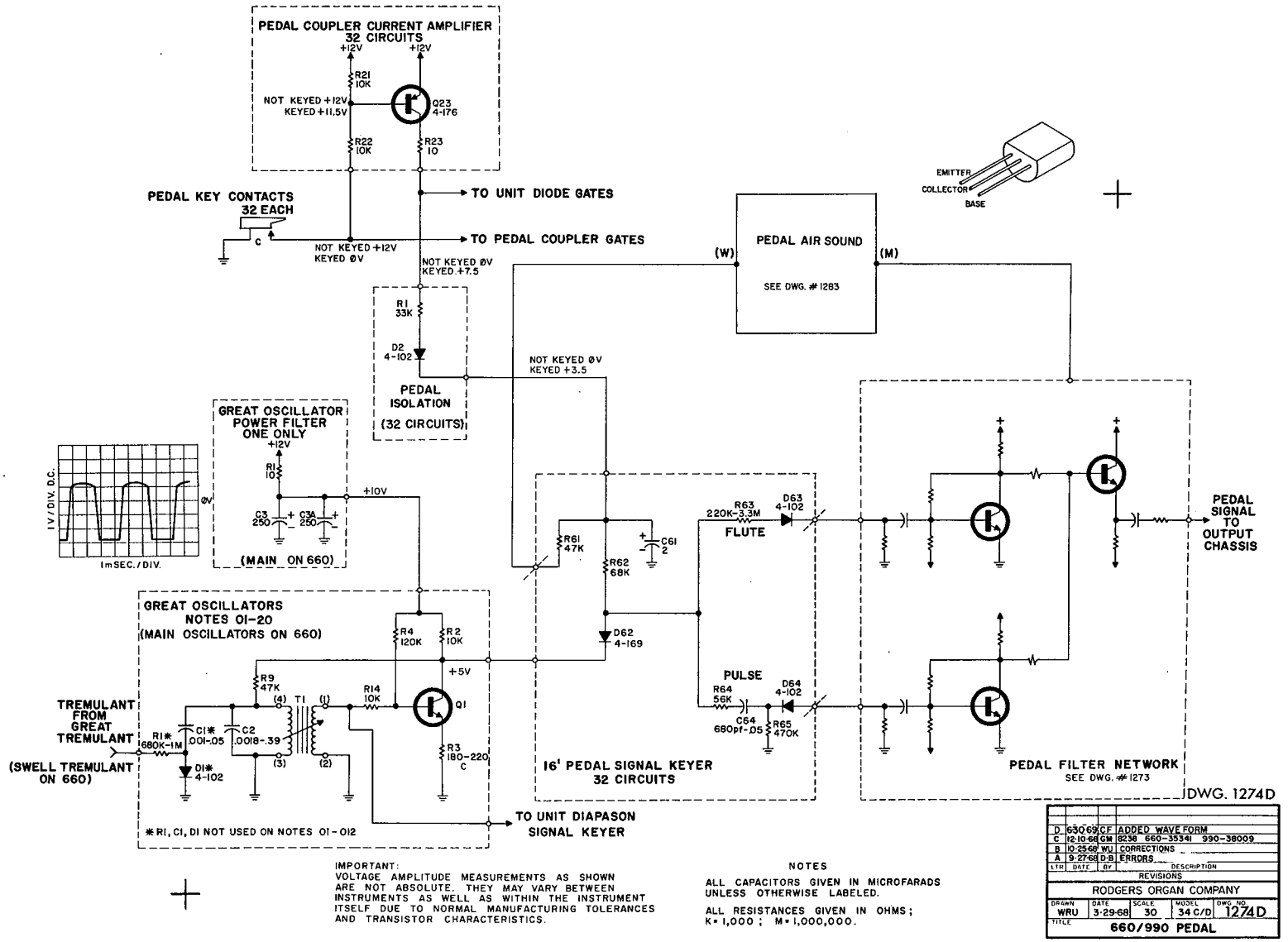
LTR	DATE	BY	DESCRIPTION
H	3-24-77	LY	ECO 4846
G	2-10-70	GM	ECO 1095

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	7-31-68	25	990	1294 H

TITLE: 990 CHOIR



DWG. 1274D

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.

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

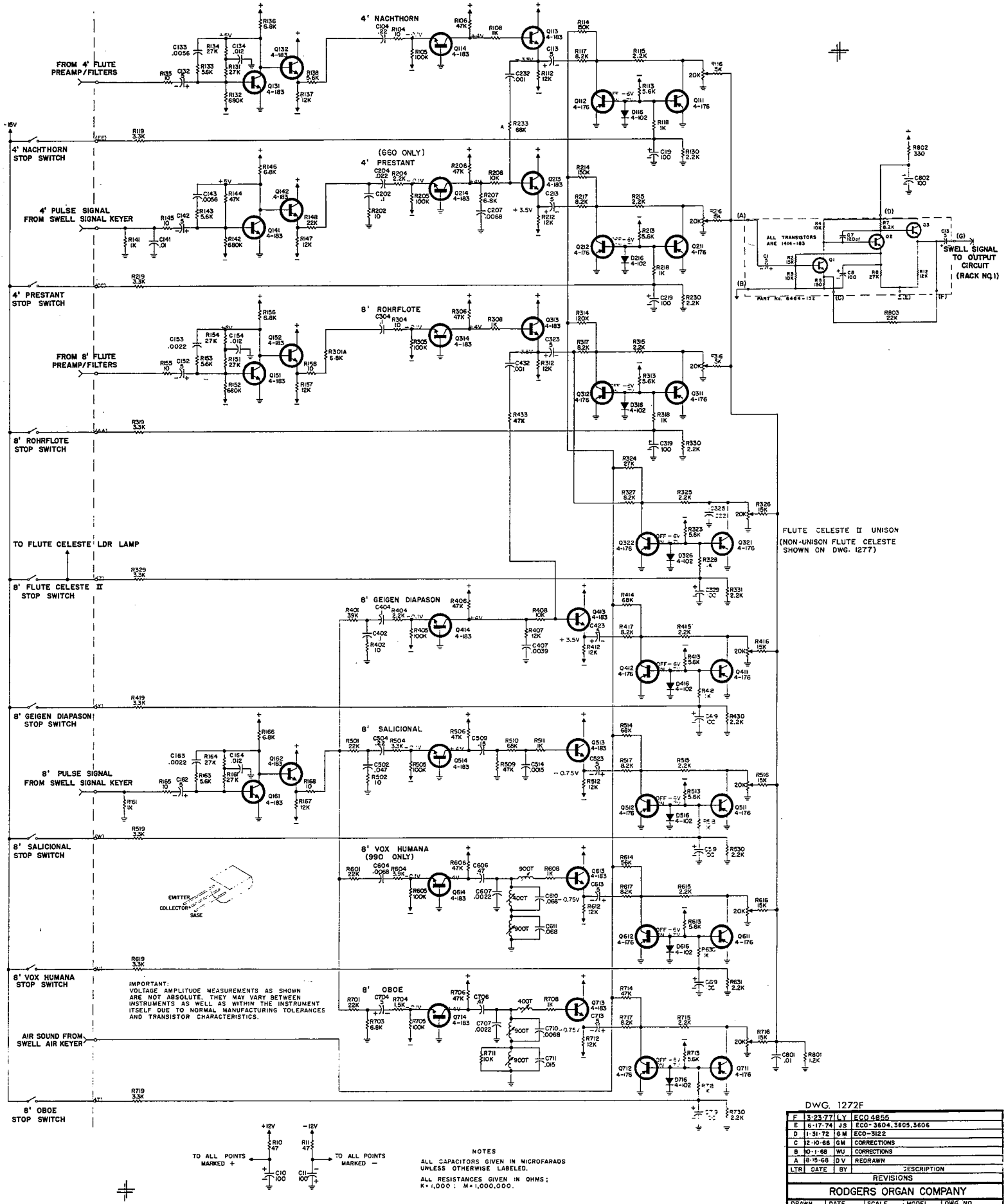
LTR	DATE	BY	DESCRIPTION
D	6-30-69	CF	ADDED WAVE FORM
C	12-10-68	GW	8238 660-35341 990-38009
B	10-25-68	WU	CORRECTIONS
A	9-27-68	DB	ERRORS

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	3-29-68	30	34 C/D	1274D

TITLE: 660/990 PEDAL



DWG. 1272F

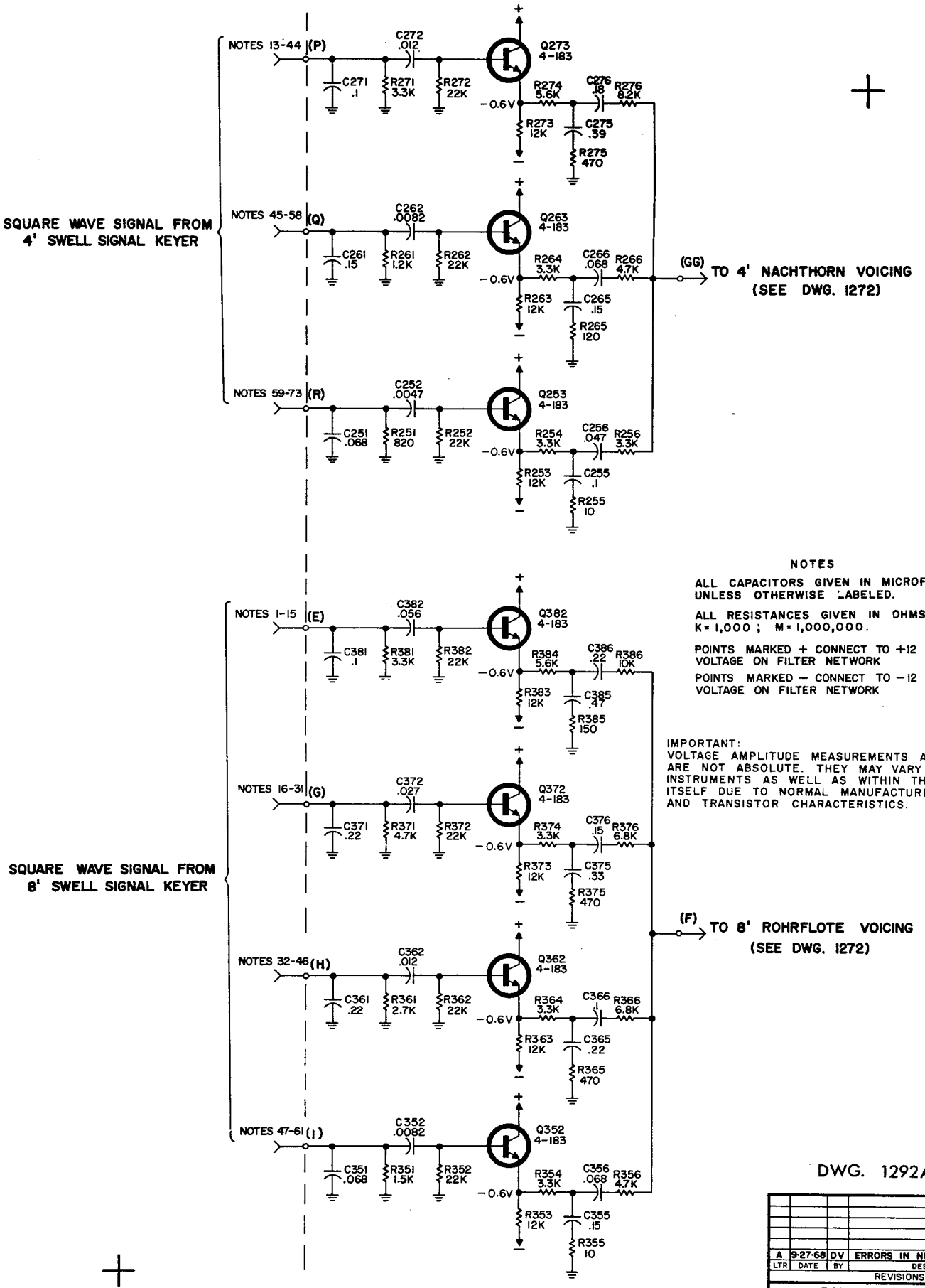
LTR	DATE	BY	DESCRIPTION
F	3-23-77	LY	ECO 4855
E	6-17-74	JS	ECO-3604, 3605, 3606
D	1-31-72	GM	ECO-3122
C	12-10-68	GM	CORRECTIONS
B	10-1-68	WU	CORRECTIONS
A	8-15-68	DV	REDRAWN

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	8-15-68	25		1272F

TITLE 660/990 SWELL FILTER NETWORK



NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

POINTS MARKED + CONNECT TO +12 DECOUPLED VOLTAGE ON FILTER NETWORK

POINTS MARKED − CONNECT TO −12 DECOUPLED VOLTAGE ON FILTER NETWORK

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. 1292A

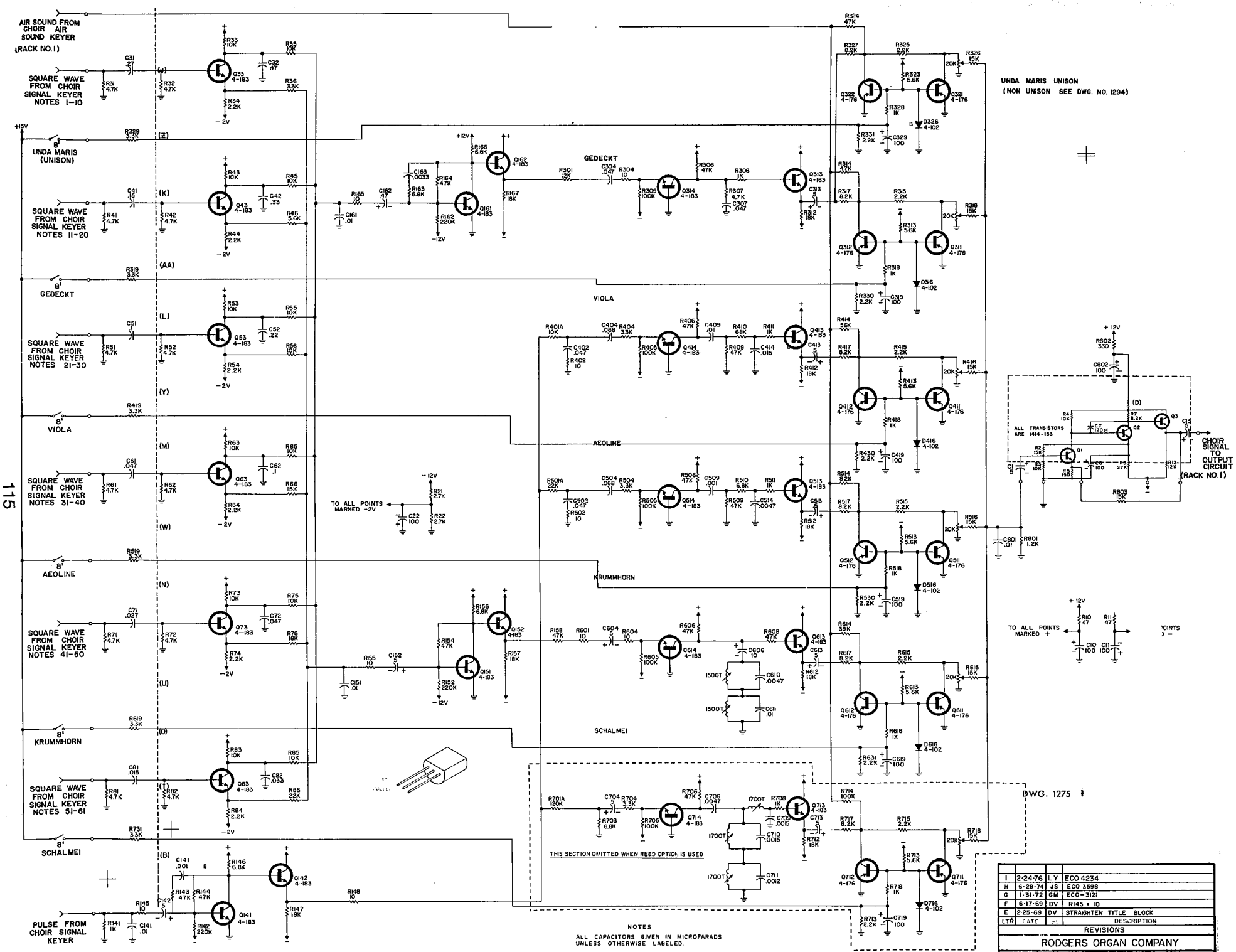
LTR	DATE	BY	DESCRIPTION
A	9-27-68	DV	ERRORS IN NUMBERS

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	8-16-68	40		1292A

TITLE: 660/990 SWELL FLUTE PREAMP



NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

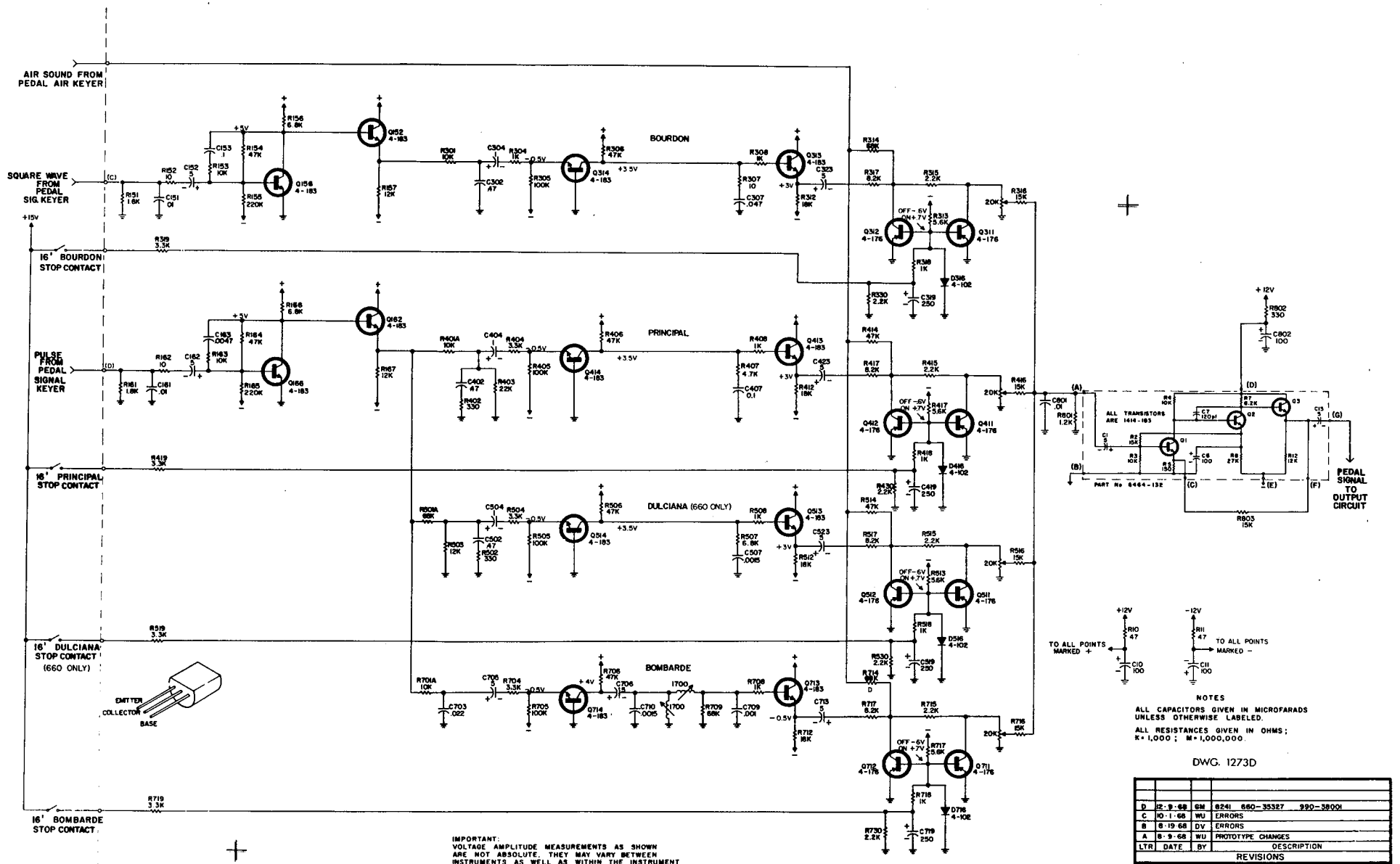
LTR	DATE	BY	DESCRIPTION
I	2-24-76	LY	ECO 4234
H	6-28-74	JS	ECO 3598
G	1-31-72	GM	ECO-3121
F	6-17-69	DV	R145 = 10
E	2-25-69	DV	STRAIGHTEN TITLE BLOCK

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
WRU	7-17-68	25	990	1275 I

TITLE: 990 CHOIR FILTER NETWORK



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.

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

DWG. 1273D

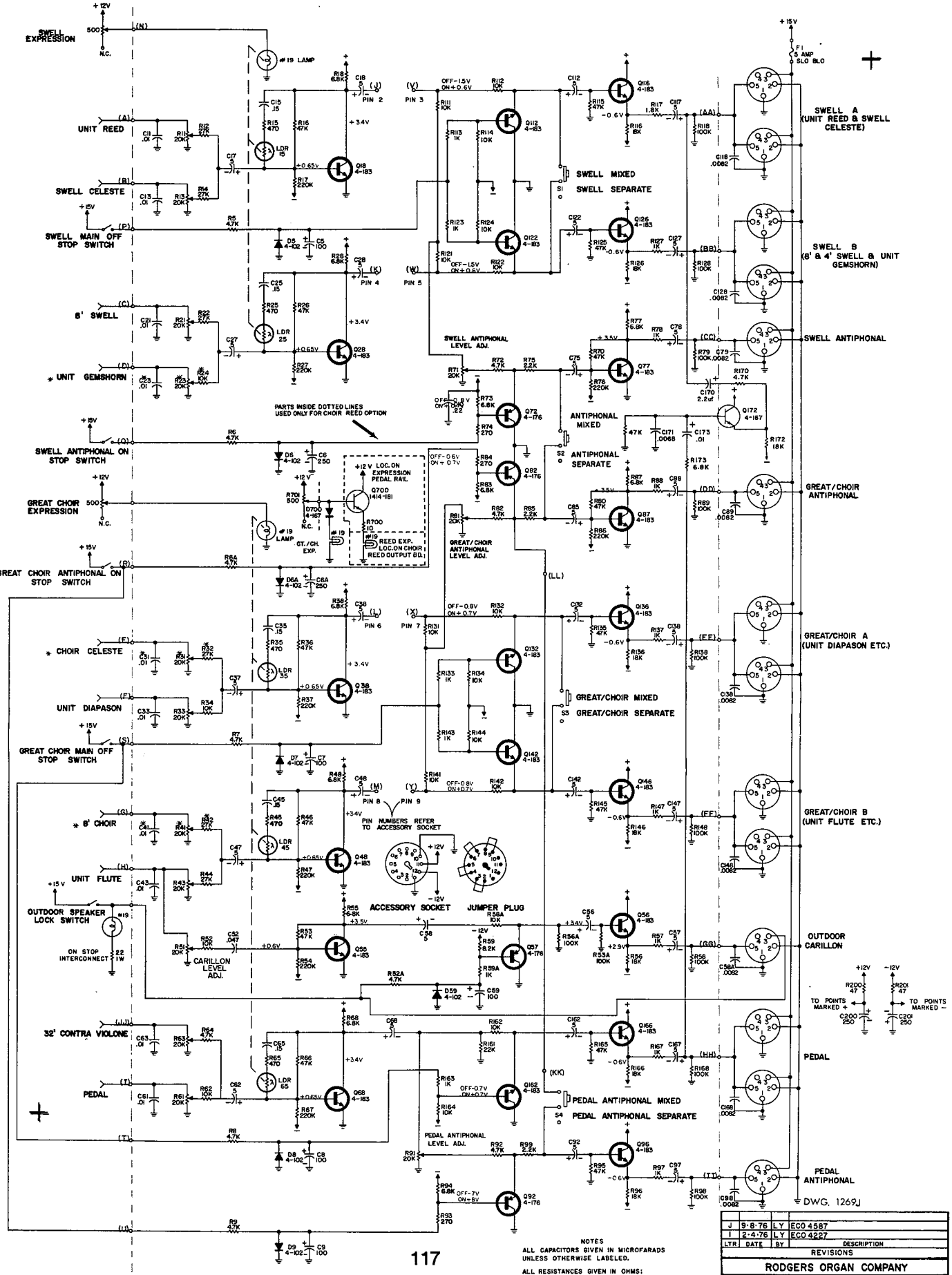
LTR	DATE	BY	DESCRIPTION
D	12-9-68	GM	8241 660-35327 990-38001
C	10-1-68	WU	ERRORS
B	8-19-68	DV	ERRORS
A	8-9-68	WU	PROTOTYPE CHANGES

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	3-22-68	25		1273D

TITLE
660/990 PEDAL FILTER NETWORK



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

* USED ON 990 ONLY

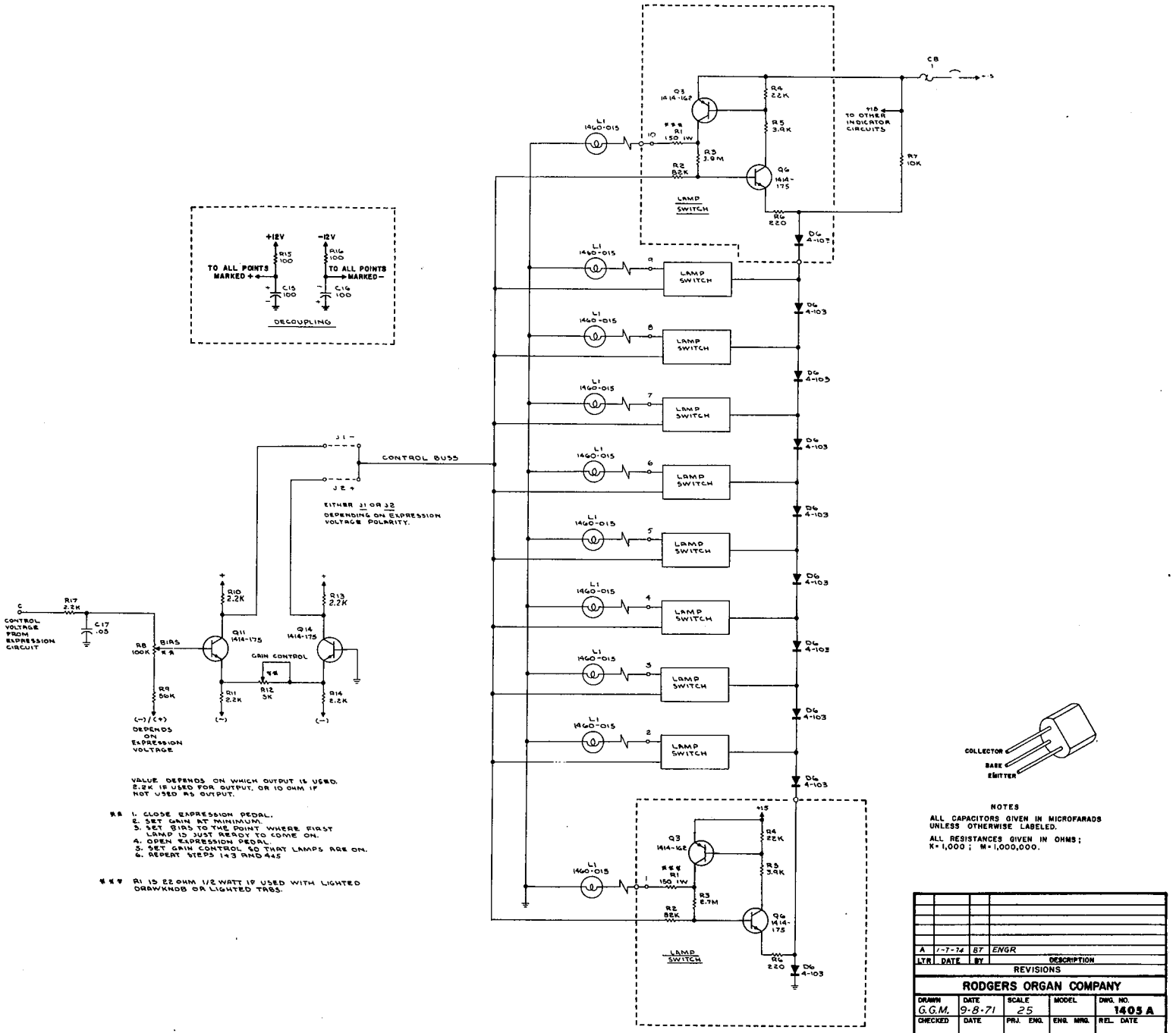
LTR	DATE	BY	DESCRIPTION
J	9-8-76	LY	ECO 4587
I	2-4-76	LY	ECO 4227

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	6-28-68	25		1269J

TITLE 660/990 OUTPUT CIRCUIT



VALUE DEPENDS ON WHICH OUTPUT IS USED. 2.2K IF USED FOR OUTPUT, OR 10 OHM IF NOT USED AS OUTPUT.

** 1. CLOSE EXPRESSION PEDAL.
2. SET GAIN AT MINIMUM.
3. SET BIAS TO THE POINT WHERE FIRST LAMP IS JUST READY TO COME ON.
4. OPEN EXPRESSION PEDAL.
5. SET GAIN CONTROL SO THAT LAMPS ARE ON.
6. REPEAT STEPS 1 & 3 AND 4 & 5

*** R1 IS 22 OHM 1/2 WATT IF USED WITH LIGHTED DRAWKNOB OR LIGHTED TABS.

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

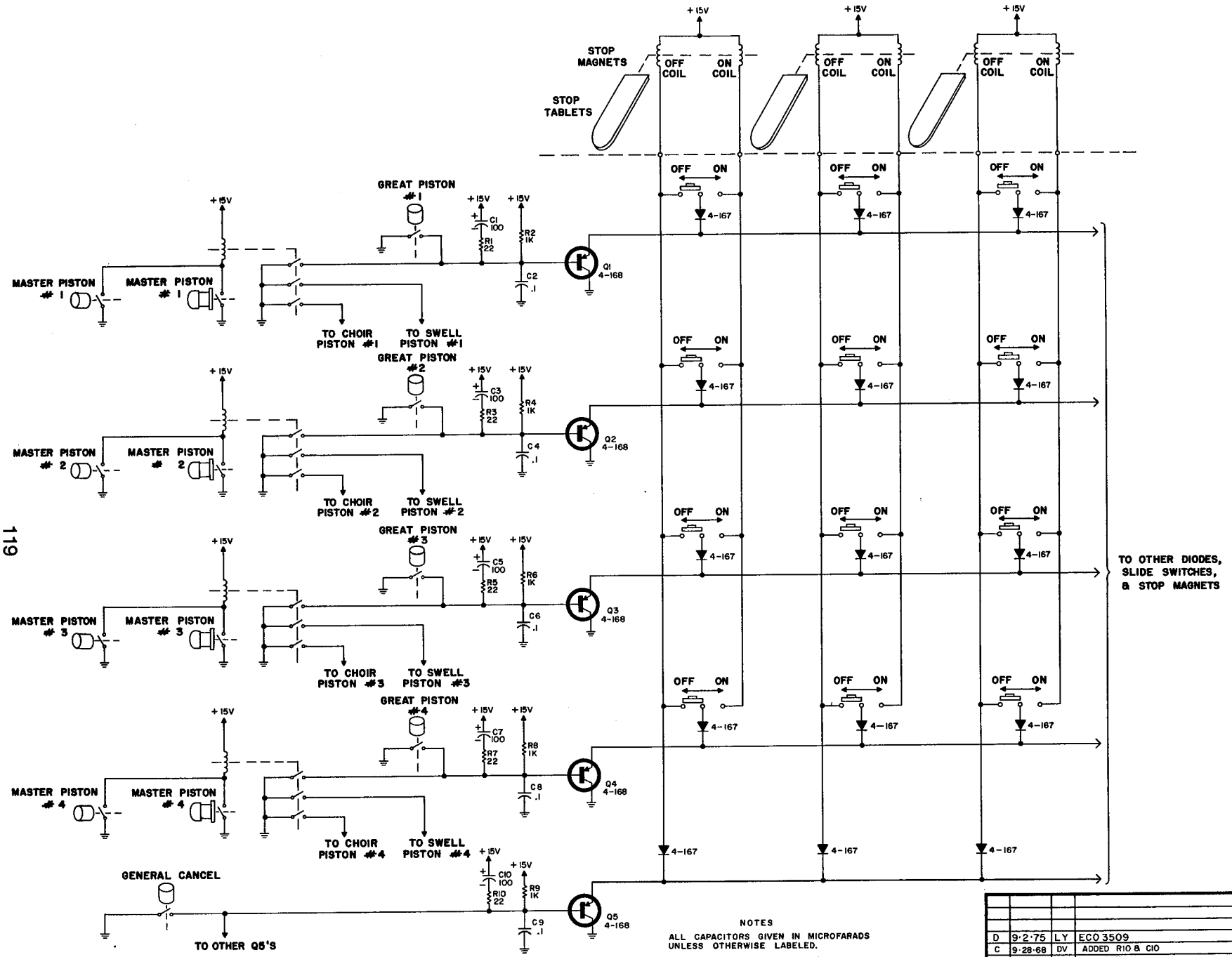
LTR	DATE	BY	DESCRIPTION
A	1-7-74	BT	ENGR

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
G.G.M.	9-8-71	25		1405 A
CHECKED	DATE	PRJ. ENG.	ENG. MNG.	REL. DATE

TITLE EXPRESSION INDICATOR



NOTE: TWO CONTACT MASTER PISTONS ARE USED ON 2 MANUAL ORGANS & CONNECT DIRECTLY TO THE SWELL & GREAT PISTONS (NO RELAYS).

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
B NATIONAL E: C:	TO-92 E: C: B:	C: B: E:	APPROX ZN TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPS	

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ALL RESISTORS & CAPACITORS ARE LOCATED ON STOP INTERCONNECT P.C. BOARD.

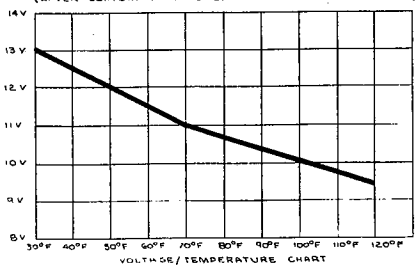
LTR	DATE	BY	DESCRIPTION
D	9-2-75	LY	ECO 3509
C	9-28-68	DV	ADDED R10 & C10
B	4-29-68	DV	REDRAWN

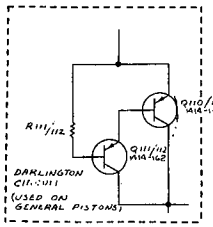
REVISIONS

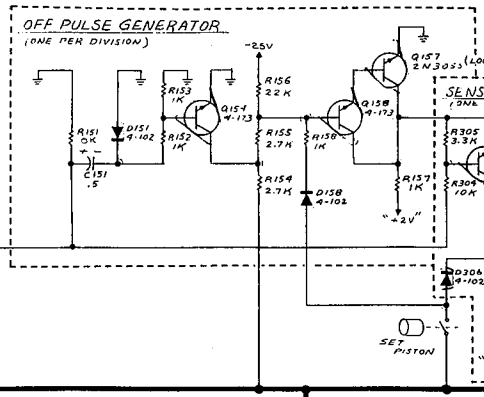
RODGERS ORGAN COMPANY

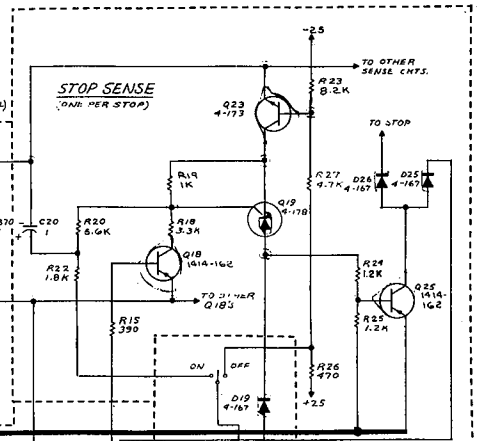
DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	7-6-67	30	SILICON	1216D

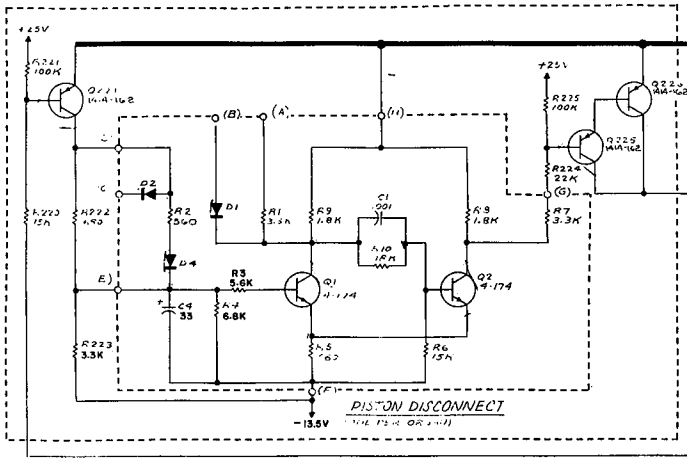
TITLE SETTERBOARD COMBINATION ACTION

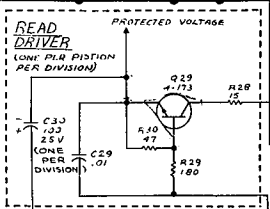


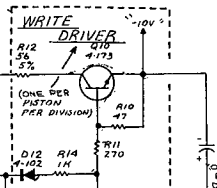


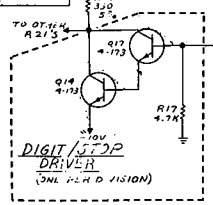


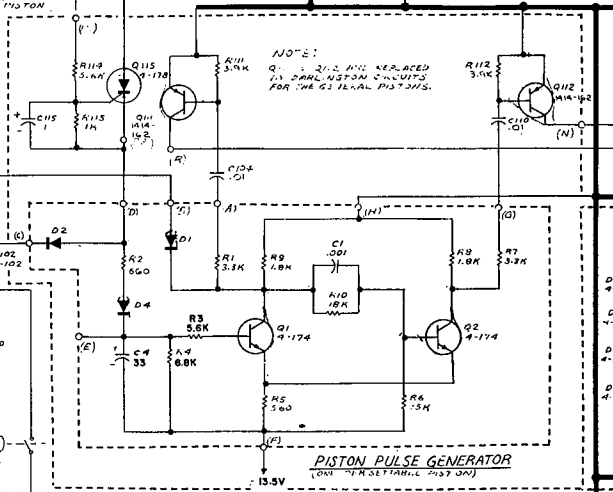


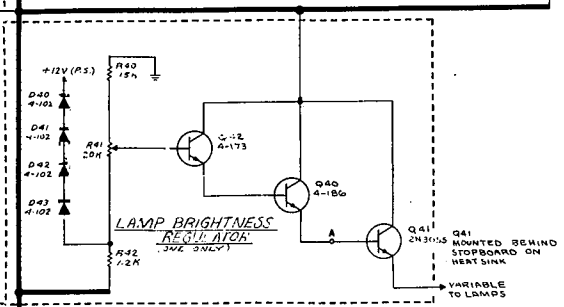


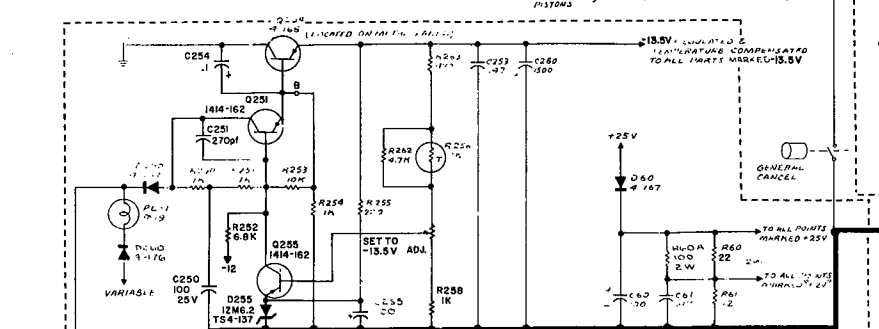


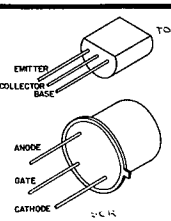










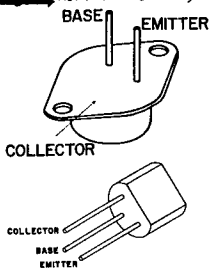


NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION	
A (NATIONAL)	B (TI)	C (MOT.)	APPROX. 2N TYPE	END COLOR SYMBOL
1414-162	1414-176	1414-162	3702	RED
1414-166	1414-173	1414-166	3706	BLUE
1414-167	1414-183	1414-167	3707	GREEN
1414-175	1414-174	1414-175	3708	WHITE
		1414-169	3904	2 GRN STRIPE



LOC. ON CIRCUIT BOARD ROC 1294-1295

LTR	DATE	BY	DESCRIPTION
F	12-9-75	LY	ECO 4137
E	11-14-75	LY	ECO 4031, 4045, 4046
D	8-28-75	LY	ECO 3251-3665
C	8-8-75	LY	ECO 3403
B	4-5-73	E	[illegible] CHANGES
A	11-9-71	GM	ECO-3137-3190

REVISIONS

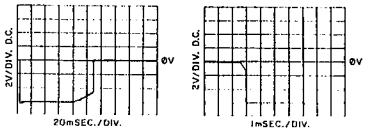
RODGERS ORGAN COMPANY

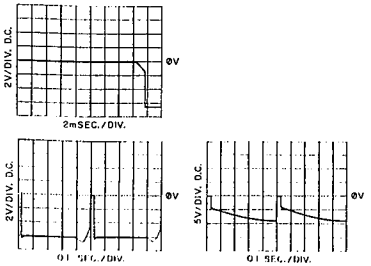
DRAWN	DATE	SCALE	MODEL	DWG. NO.
J.D.W.	6-7-71	.25	ALL	1396F
CHECKED	DATE	PRJ. ENG.	ENG. MRG.	REL. DATE

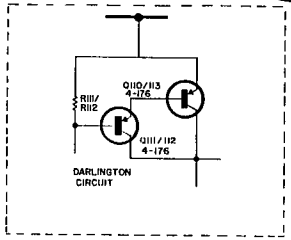
TITLE LIGHTED CAPTURE SYSTEM

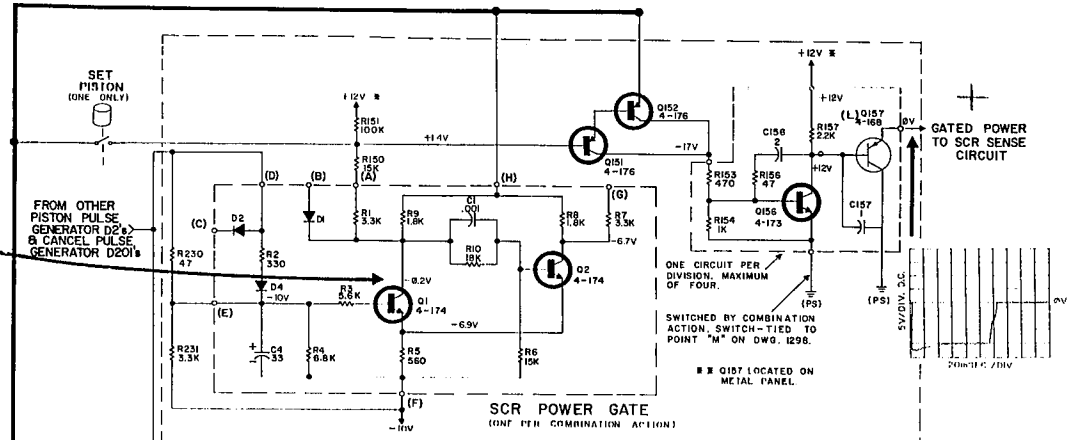
WAVEFORMS

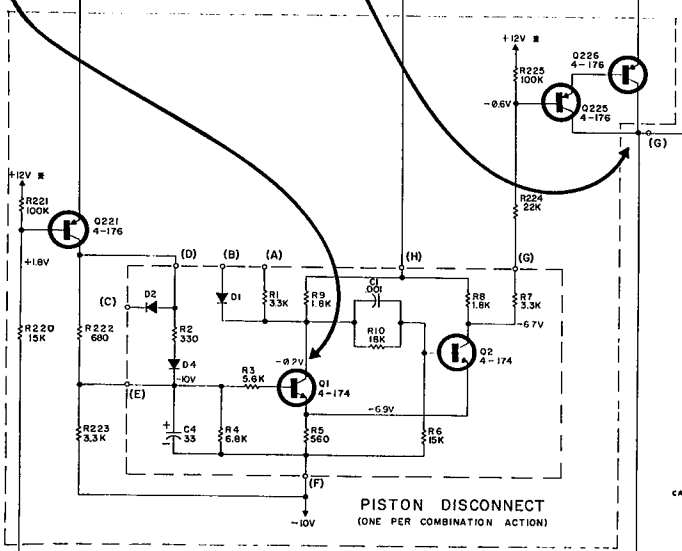
ORGAN: SETTABLE PISTON DEPRESSED
OSCILLOSCOPE TRIGGERING: +EXT.
TRIGGER SOURCE: COLLECTOR OF Q1, OF PISTON DISCONNECT SCHMITT.

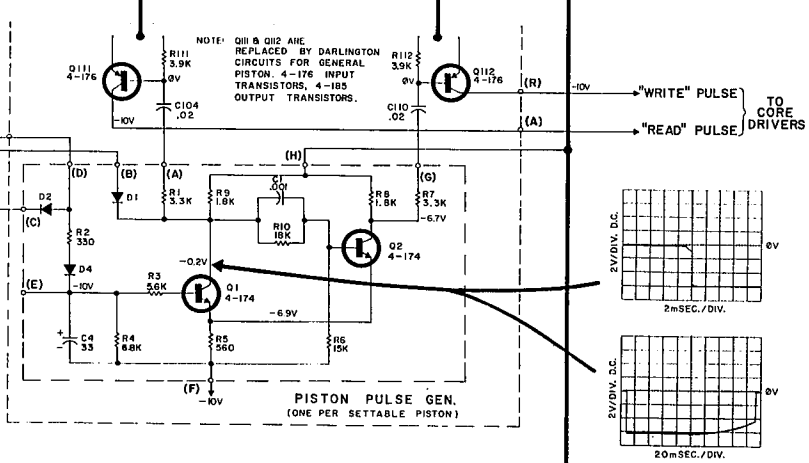






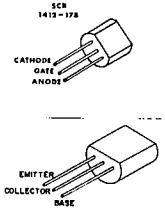






CAUTION
OSCILLOSCOPE MUST NOT BE GROUNDED.

• OSCILLOSCOPE GROUND IS CONNECTED TO +15V, ELECTRICALLY NEAR POINT BEING MEASURED.



(SYSTEM GROUND)
+15V (PS)
(ELEVATED +15V FROM POWER SUPPLY)

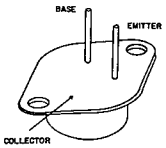
IMPORTANT:
VOLTAGE AMPLITUDE MEASUREMENTS AS SHOWN ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES AND TRANSISTOR CHARACTERISTICS.

VOLTAGES MEASURED WITH NO PISTONS DEPRESSED.

FROM OTHER CANCEL PULSE GENERATOR D1's

TO OTHER PISTONS

ALL VOLTAGES MEASURED WITH RESPECT TO SYSTEM GROUND (STOP ACTION FRAMES— HEAVY BLACK LINES ON SCHEMATIC— NO. 14 RED WIRES IN ORGAN.)
* VOLTAGES FROM DWG. 1298



NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

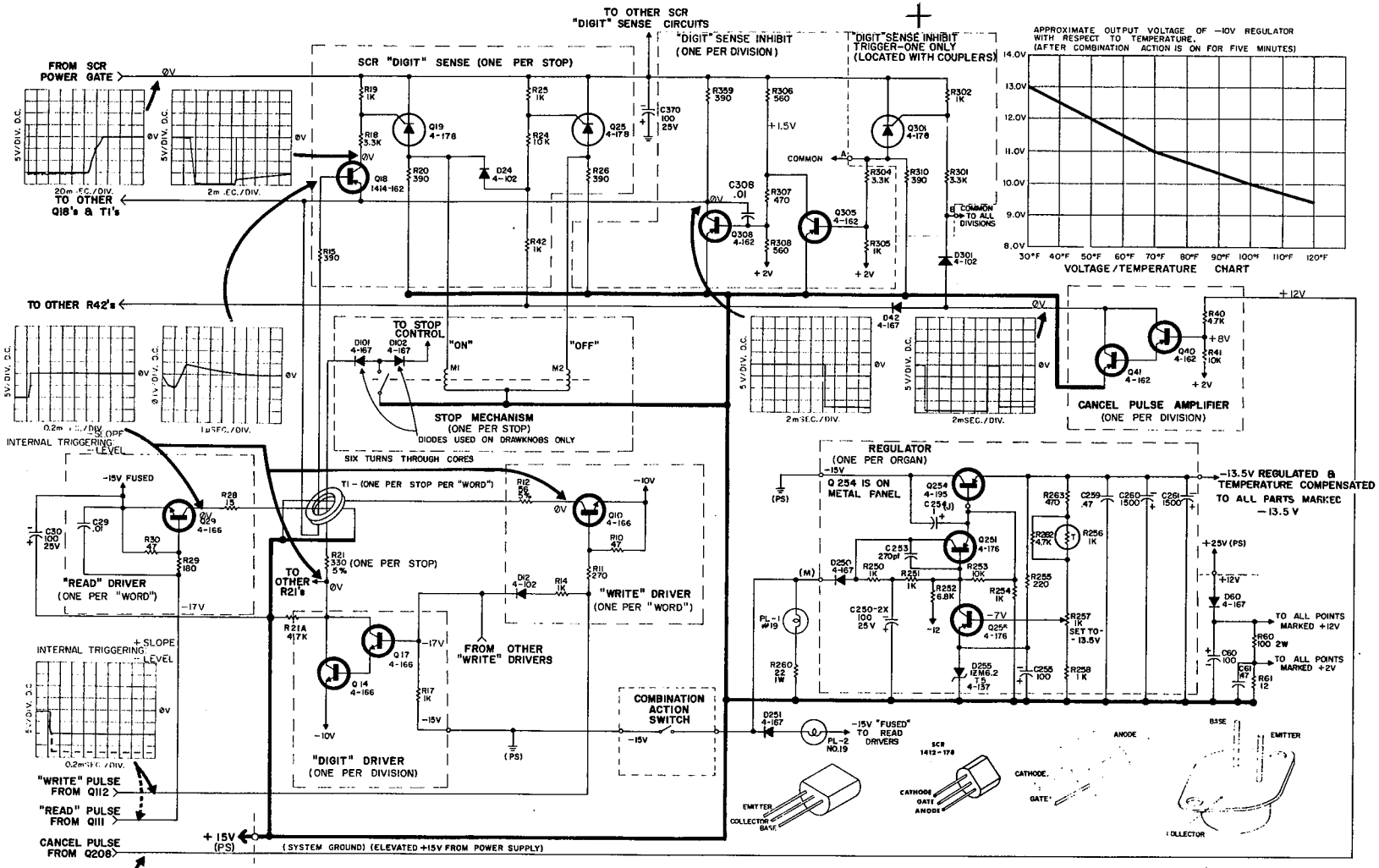
ALL RESISTANCES GIVEN IN OHMS; K=1,000 M=1,000,000.

ALL DIODES ARE 4-102

-10V IS TEMPERATURE COMPENSATED, SEE DWG. 1298 FOR CHART.

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION	
			STRIPE	END
1414-162	1414-176	1414-162	3702	RED
1414-166	1414-173	1414-166	3706	BLUE
1414-167	1414-183	1414-167	3707	GREEN
1414-175	1414-174	1414-175	3708	WHITE
		1414-169	3904	2 GRN STRIPES

			DWG. 1297H	
H	10-6-75	LY	ECO 3971,72,73,74,75,76	
G	4-18-75	LY	ECO 3665	
LTR	DATE	BY	DESCRIPTION	
			REVISIONS	
RODGERS ORGAN COMPANY				
DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	9-6-68	25		1297H
CHECKED	DATE	PRJ. ENG.	ENG. MRG.	REL. DATE
TITLE CAPTURE SYSTEM (ALSO SEE DWG. 1298)				



DWG. 1298 Q

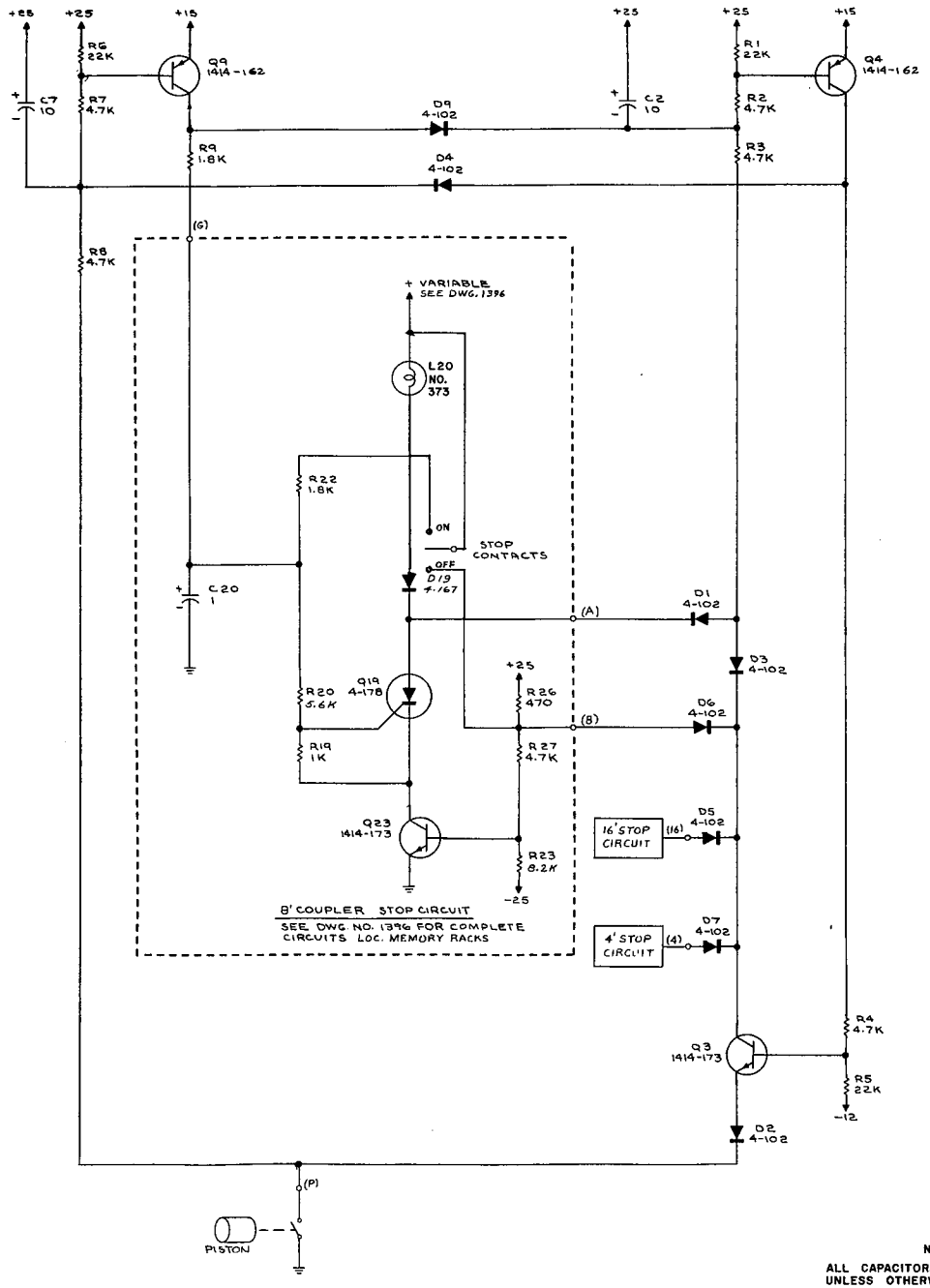
LTR	DATE	BY	DESCRIPTION
Q	5-11-79	E.B.	ECO 5778 REVISED
P	5-7-79	E.B.	ECO 5778
O	9-8-76	L.Y.	ECO 4587
N	11-14-75	L.Y.	ECO 4031, 4045, 4046
M	8-8-75	L.Y.	ECO 3386

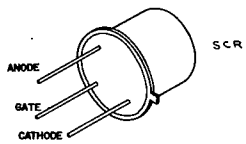
REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
D.M.V	9-8-68	25		1298Q
CHECKED	DATE	PRJ. ENG.	ENG. MRG.	REL. DATE

TITLE: CAPTURE SYSTEM (SEE DWG. 1297)





ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
B NATIONAL E C	TO-92 E C B	C B E	APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

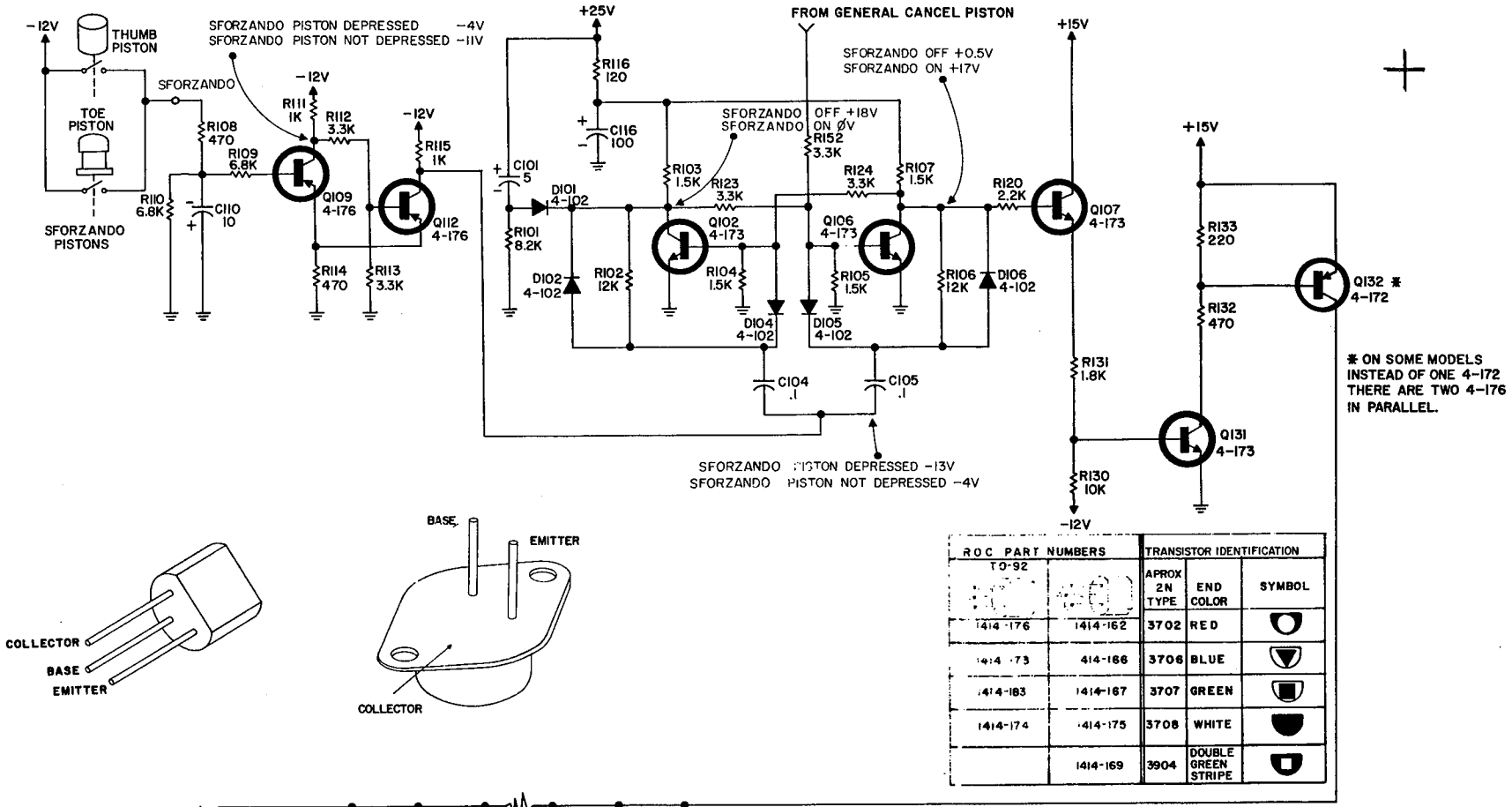
ALL RESISTANCES GIVEN IN OHMS; K = 1,000 ; M = 1,000,000.

LTR	DATE	BY	REVISIONS DESCRIPTION
C	7-26-71	WH	ADD. 250
B	9-3-75	LY	ECO 3250
A	3-14-72	GM	ECO-3217

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
G.G.M.	7-1-71	30	250	1401C
CHECKED	DATE	PROJ. ENG.	ENG.	REL. DATE
	7-26-71		7-26-71	5-26-72

TITLE: LIGHTED REVERSIBLE



ROC PART NUMBERS		TRANSISTOR IDENTIFICATION		
TO-92		APROX 2N TYPE	END COLOR	SYMBOL
1414-176	1414-162	3702	RED	
1414-173	414-166	3706	BLUE	
1414-183	1414-167	3707	GREEN	
1414-174	1414-175	3708	WHITE	
	1414-169	3904	DOUBLE GREEN STRIPE	

* NOTE: R151 NOT USED ON 220 II PRESET
SUBSTITUTE JUMPER

LOC. ON CIRCUIT BOARD ROC 1266

DWG. 12711

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.

NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.
ALL RESISTANCES GIVEN IN OHMS; K = 1.000 ; M = 1,000,000

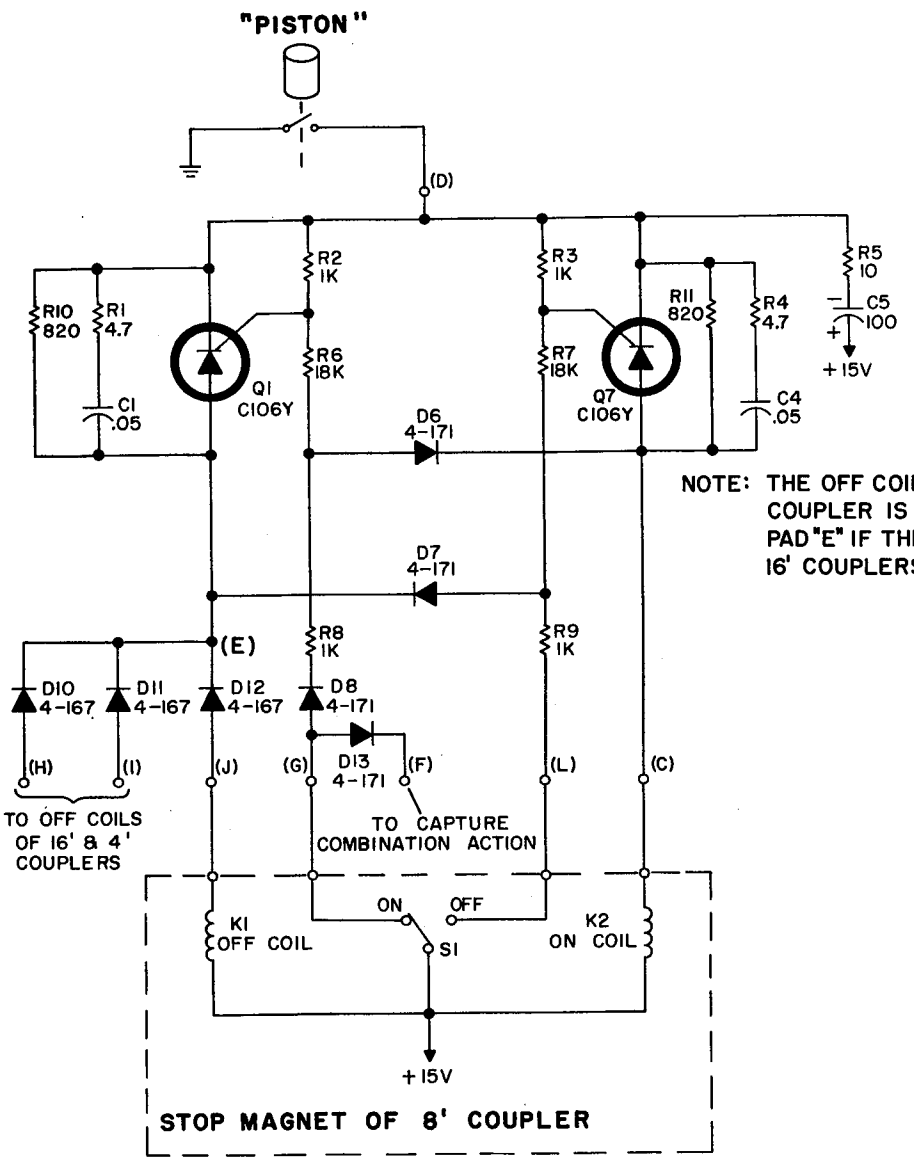
LTR	DATE	BY	DESCRIPTION
I	9-2-75	LY	ECO 3442
H	2-25-74	KC	ENG 145
G	4-5-73	O	PROTO CHANGE

REVISIONS

RODGERS ORGAN COMPANY

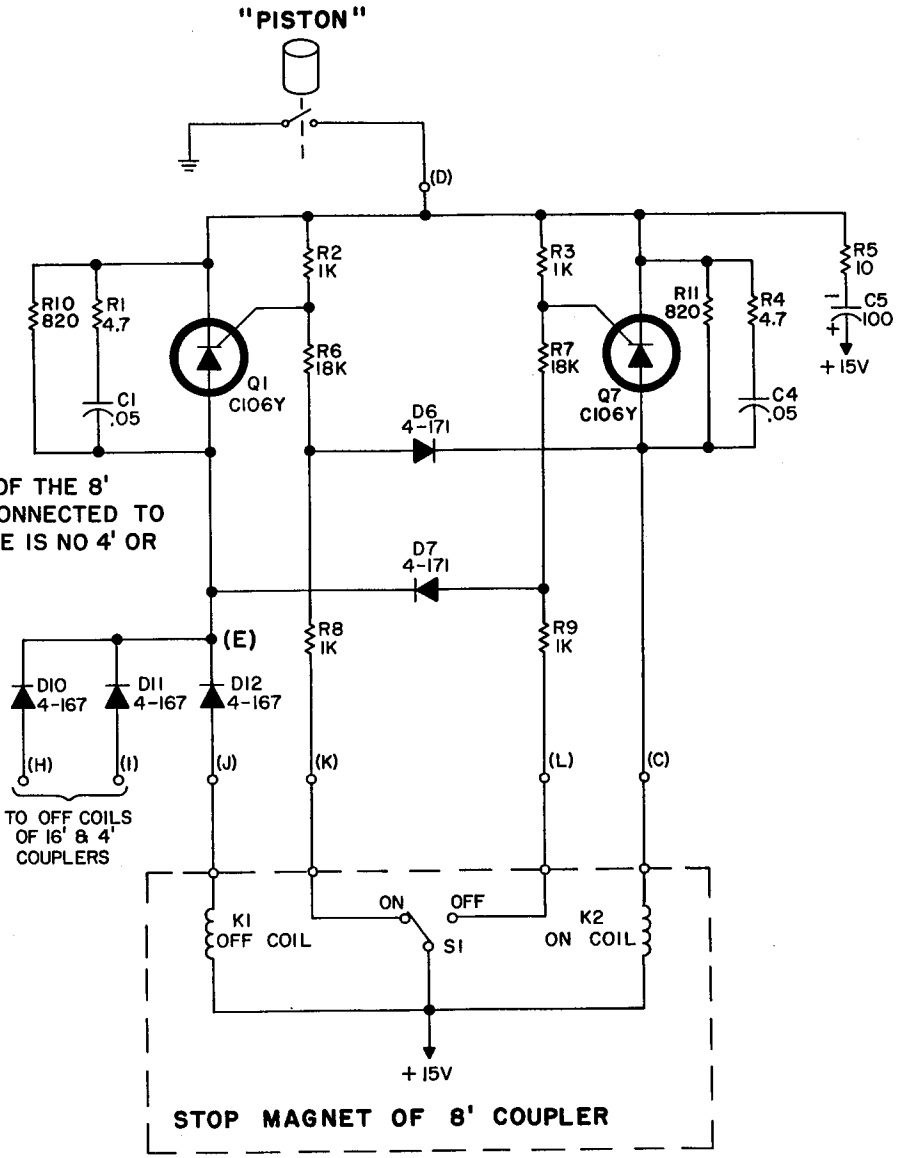
DRAWN	DATE	SCALE	MODEL	DWG. NO.
WRU	3-15-68	40		12711

TITLE
SILICON SFORZANDO (TUTTI)

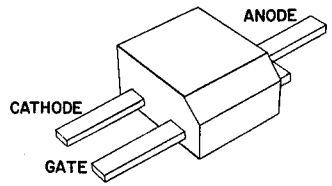


REVERSIBLE USED WITH CAPTURE SYSTEM

NOTE: THE OFF COIL OF THE 8' COUPLER IS CONNECTED TO PAD "E" IF THERE IS NO 4' OR 16' COUPLERS.



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.

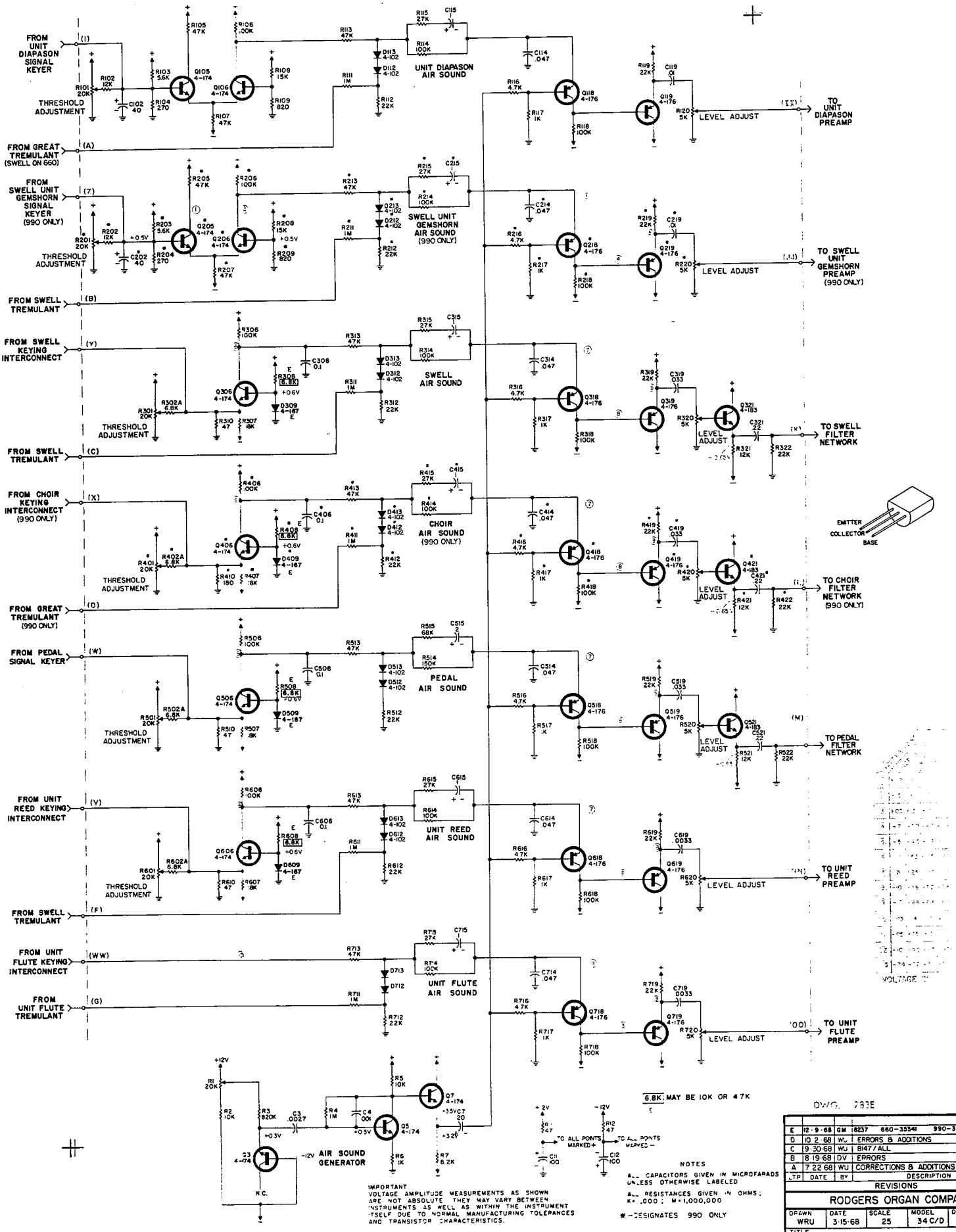
LTR	DATE	BY	DESCRIPTION
C	4-16-71	J.W.	ECO-3025
B	9-27-68	WU	CORRECTIONS – ADDITIONS
A	8-13-68	WU	CORRECTIONS – ADDITIONS

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	4-10-68	50		1280C

TITLE **REVERSIBLE FOR NPN ORGANS**



DWG. 783E

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED

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

*-DESIGNATES 990 ONLY

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.

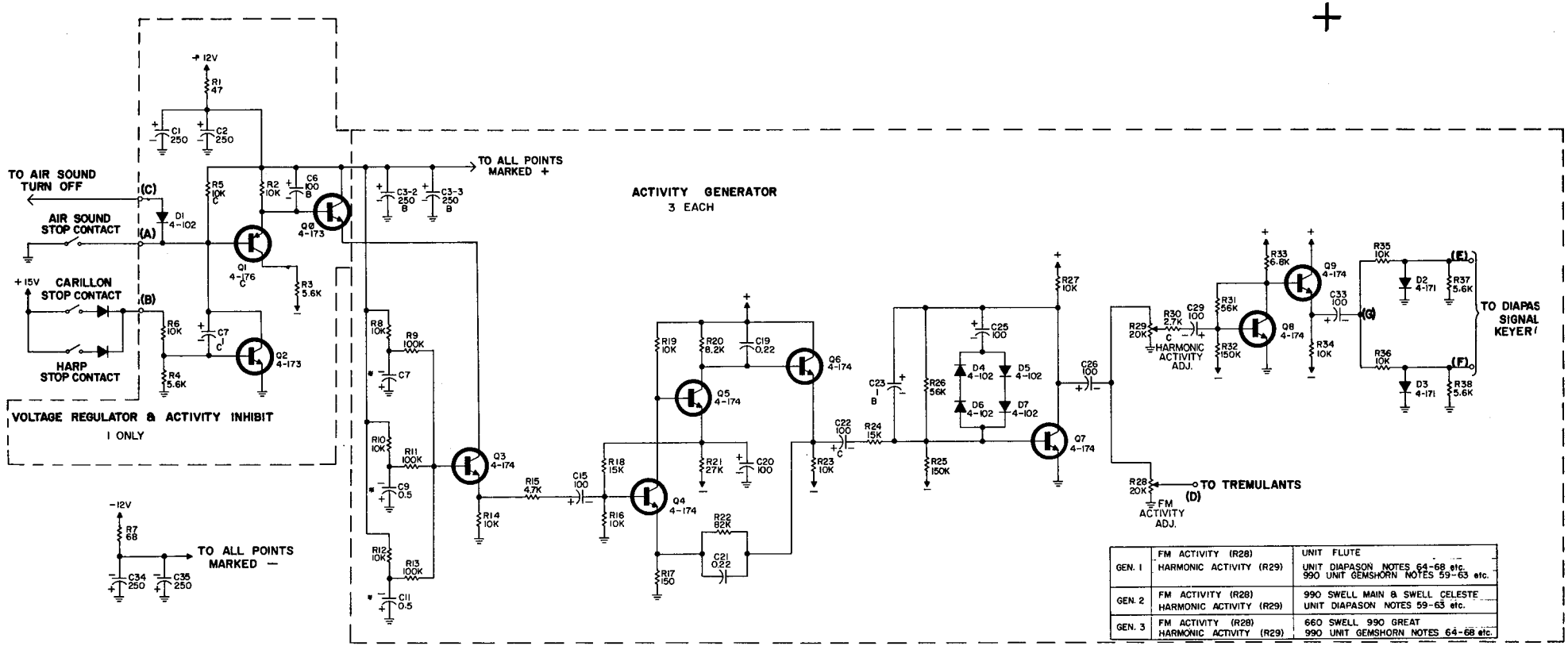
LTR	DATE	BY	DESCRIPTION
E	12-9-68	GM	8237 660-35341 990-38009
D	10 2 68	WU	ERRORS & ADDITIONS
C	9-30-68	WU	8147/ALL
B	8-19-68	DV	ERRORS
A	7 22 68	WU	CORRECTIONS & ADDITIONS

REVISIONS

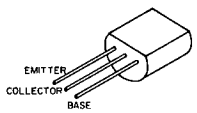
RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
WRU	3-15-68	25	34 C/D	1283E

TITLE 660/990 AIR SOUND



GEN. 1	FM ACTIVITY (R28) HARMONIC ACTIVITY (R29)	UNIT FLUTE UNIT DIAPASON NOTES 64-68 etc. 990 UNIT GEMSHORN NOTES 59-63 etc.
GEN. 2	FM ACTIVITY (R28) HARMONIC ACTIVITY (R29)	990 SWELL MAIN & SWELL CELESTE UNIT DIAPASON NOTES 59-63 etc.
GEN. 3	FM ACTIVITY (R28) HARMONIC ACTIVITY (R29)	660 SWELL 990 GREAT 990 UNIT GEMSHORN NOTES 64-68 etc.



NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

* THESE ELECTROLYTICS ARE REVERSE BIASED TO GENERATE LOW FREQUENCY NOISE.

DWG. 1281D

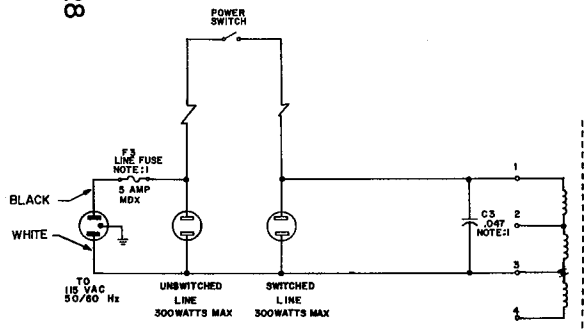
LTR	DATE	BY	DESCRIPTION
D	12-10-68	DV	ADDED TOP SCREEN NOTE
C	9-27-68	WU	8167/3530!(660), 8167/38000(990)
B	9-8-68	WU	8120/8121/8135
A	8-19-68	DV	REDRAWN

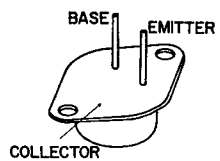
REVISIONS

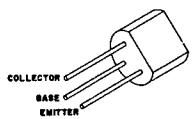
RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
D M V	8-19-68	30		1281D

TITLE: ACTIVITY GENERATOR







NOTE 2:-24VDC ALSO USED FOR MUSICK RACK LIGHTS

NOTE 3:-SINGLE PIN CONNECTOR LOCATED ON PRINTED CIRCUIT BOARD.

NOTE 4: @ NOT USED ON TYPE VIII

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

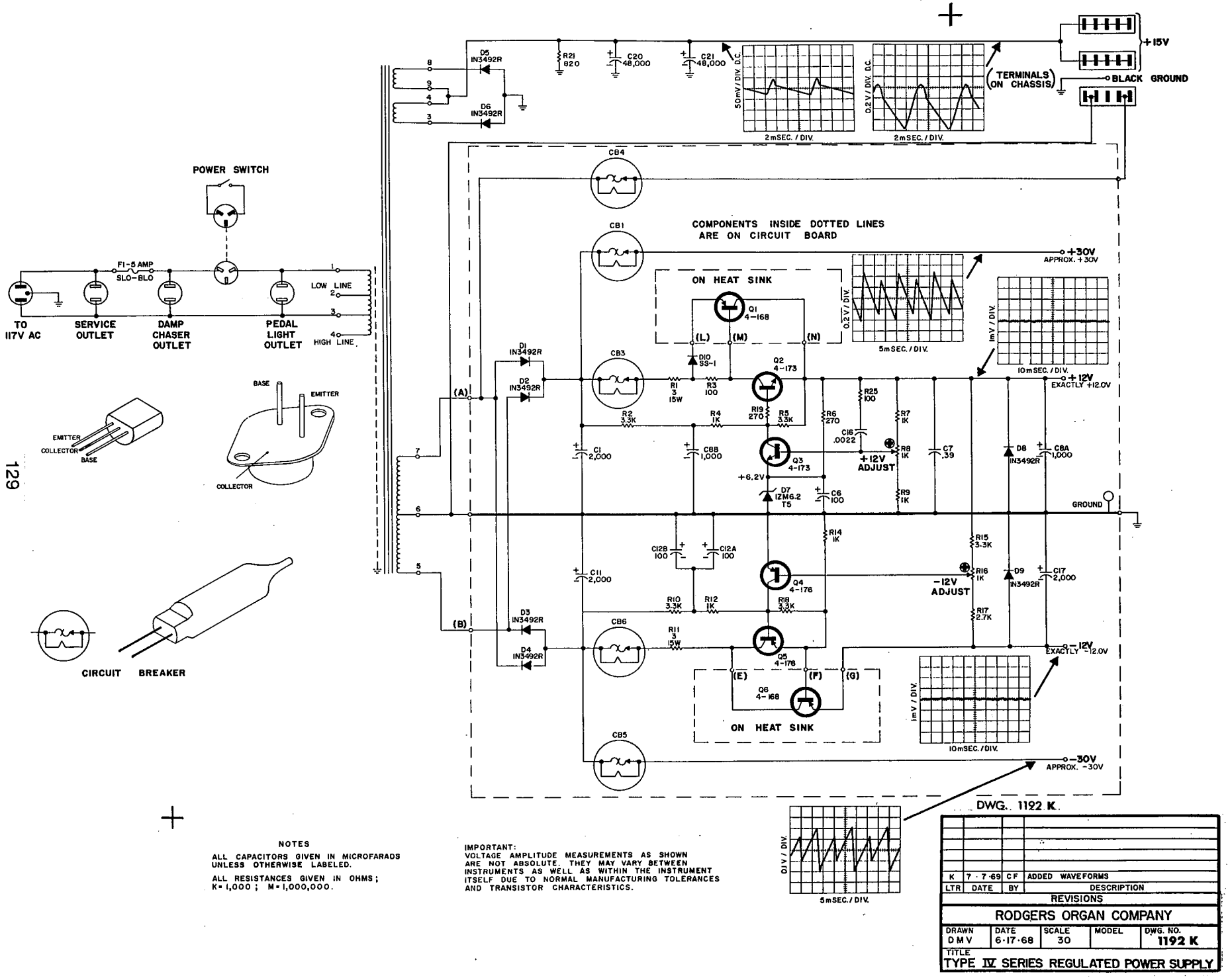
ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
B, NATIONAL	TO-92		APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

1	2-24-78	LY	ECO 4248	
H	10-6-76	LY	ECO 3934	
G	4-21-76	LY	ECO 3805	
LTR	DATE	BY	REVISIONS	

ROGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	
J.S.	9-20-73	25		
CHECKED	DATE	FULL	DWG.	DWG. NO.

TITLE TYPE VII POWER SUPPLY



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NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

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. 1192 K.

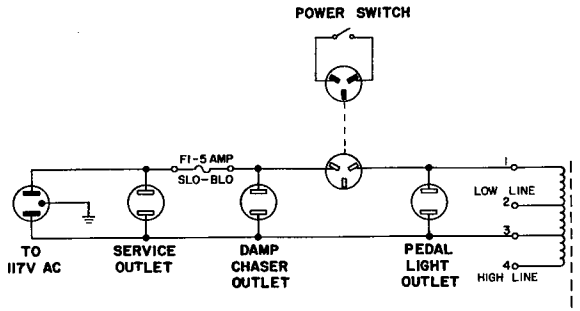
LTR	DATE	BY	DESCRIPTION
K	7 · 7 · 69	CF	ADDED WAVEFORMS

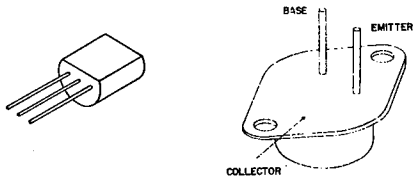
REVISIONS

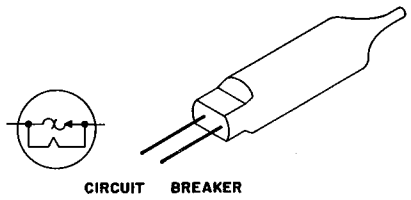
RODGERS ORGAN COMPANY

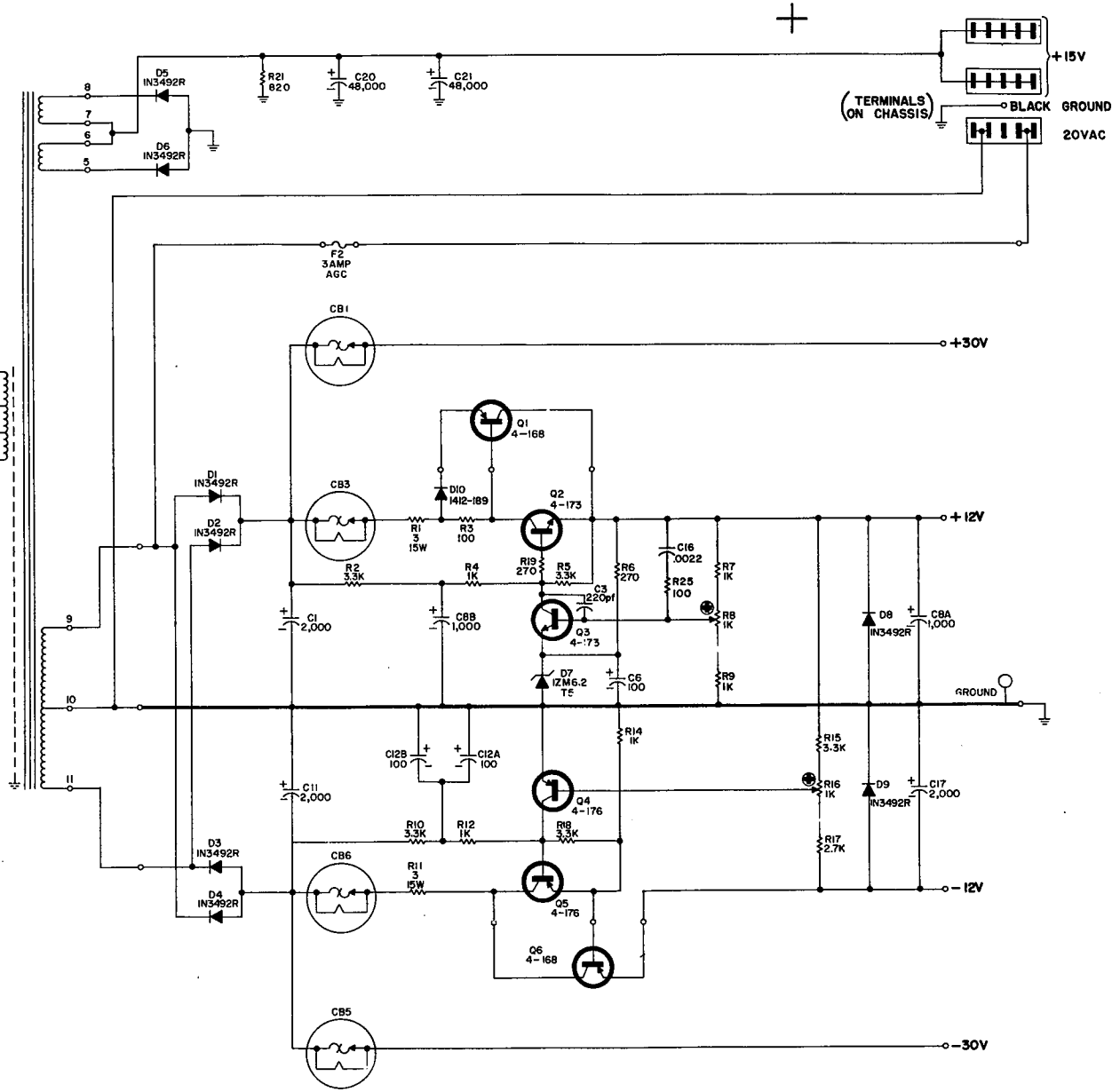
DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	6·17·68	30		1192 K

TITLE
TYPE IV SERIES REGULATED POWER SUPPLY









NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

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

ROC PART NUMBERS			TRANSISTOR I.D.		
B C E	B E C		APPROX JAN TYPE	END COLOR SYMBOL	
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
1414-169		1414-169	3904	2 GRN STRIPE	
1414-172		1414-172	3711 SPCL	VIOLET STRIPE	
1414-178		1414-178	DARL	2 ORN STRIPE	

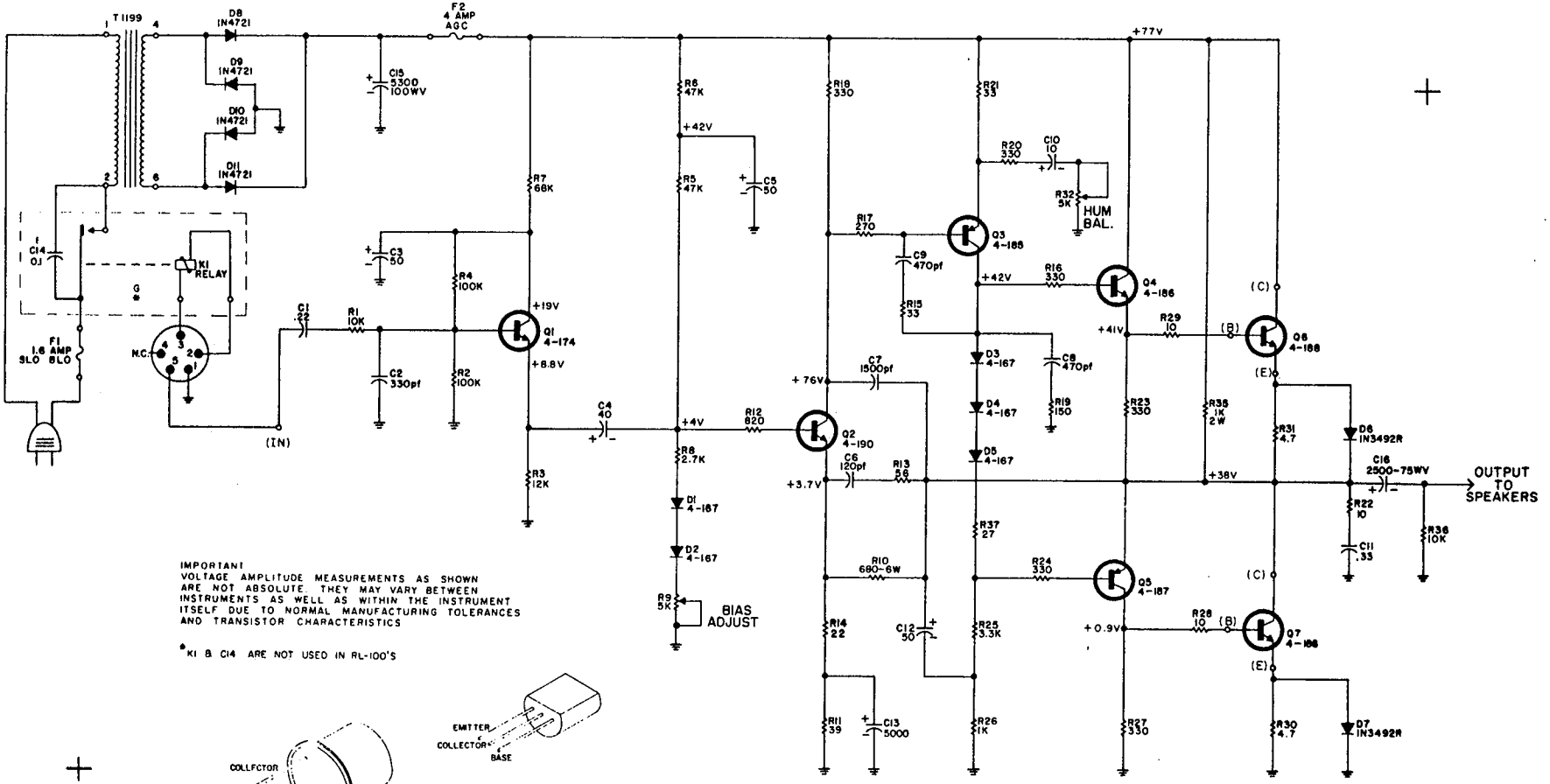
LTR	DATE	BY	DESCRIPTION
M	3-14-72	GM	ECO-3225
L	1-31-72	GM	ECO-2094/2603
K	7-7-69	CF	ADDED WAVEFORMS

REVISIONS

ROCKRIBS ORGAN COMPANY

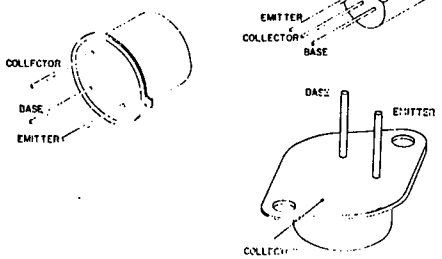
DMV 6-17-68 30 1192M

TYPE IV SERIES REGULATED POWER SUPPLY



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

*K1 & C14 ARE NOT USED IN RL-100'S



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

DWG. 1200G

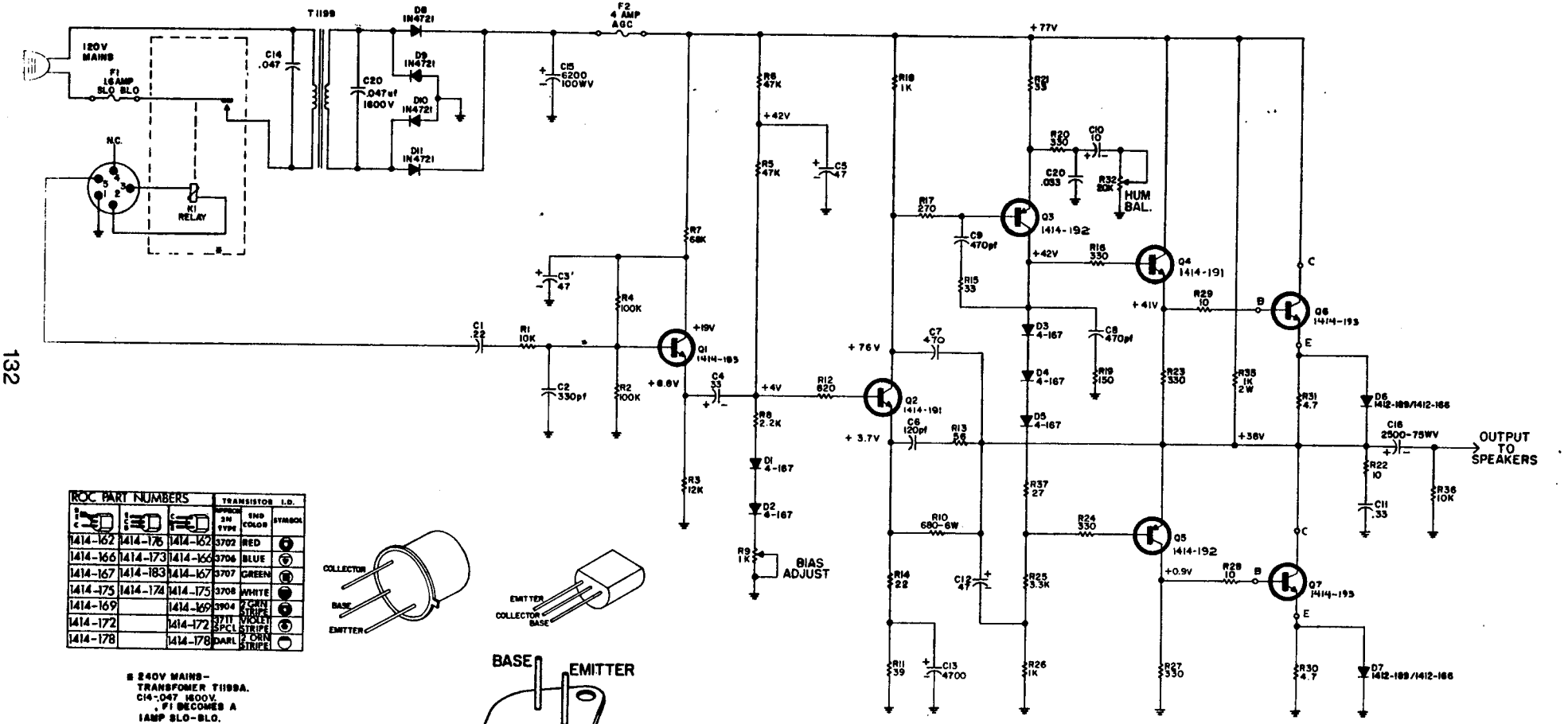
LTR	DATE	BY	DESCRIPTION
G	12-10-68	DV	ADDED A NOTE
F	10-24-68	WU	ERRORS
E	9-30-68	WU	8140
D	8-26-68	DV	Q2 = 4-190
C	11-2-67	DV	R14 = 22
B	8-18-67	D-B	MODIFIED CIRCUITRY

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DWB	8-18-67	30		1200G

TITLE: S-100B AMPLIFIER



ROC PART NUMBERS			TRANSISTOR I.D.		
B C E	C B E	E B C	APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
1414-169		1414-169	3904	2 GRN STRIPE	
1414-172		1414-172	2711 SPCL	VIOLET STRIPE	
1414-178		1414-178	DARL	2 ORN STRIPE	

240V MAINS-
TRANSFOMER T1199A.
C14-.047 1600V.
F1 BECOMES A
1AMP SLO-BLO.

1414-191 = 550150 OR 40409.
1414-192 = 550131 OR 40410.
1414-193 = 2 SD 555.

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.

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

K1 & C14 ARE NOT USED IN RL-100'S

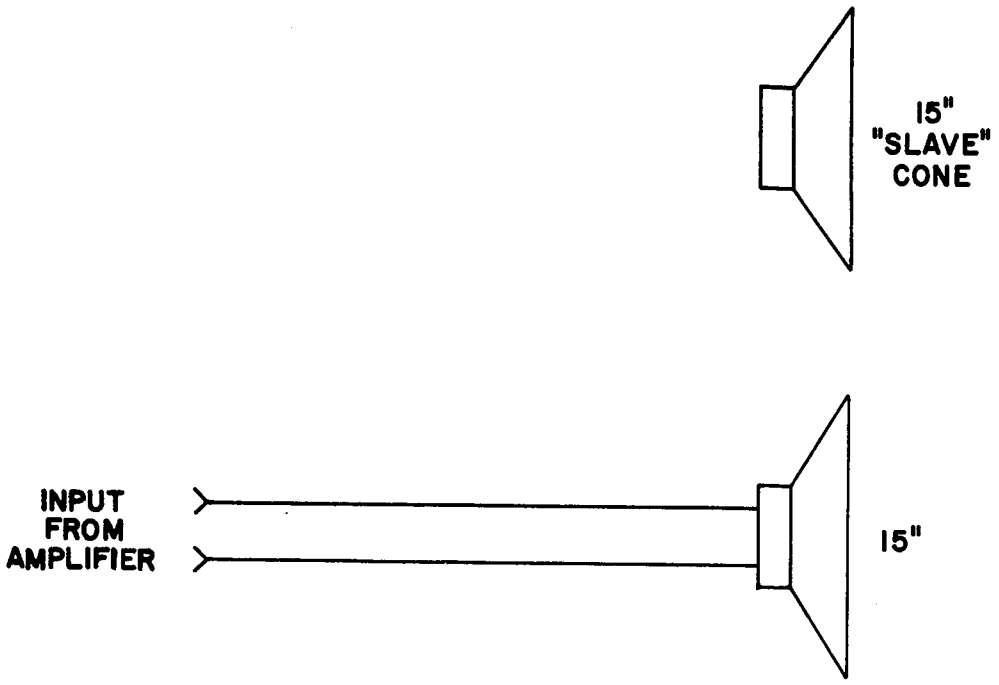
LTR	DATE	BY	DESCRIPTION
P	12-6-82	BC	CHG'D PER ECO# 8431
O	1-29-81	MAT	ECO 6396
N	10-18-76	LY	ECO 4576

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
D.W.B.	8-18-67	30		1200P

TITLE S-101 AMPLIFIER



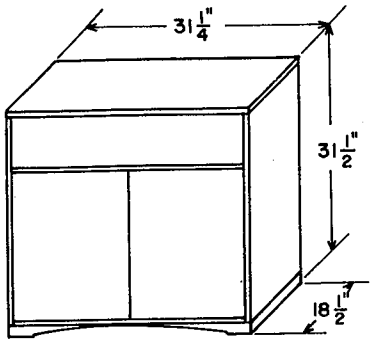
LTR	DATE	BY	DESCRIPTION

REVISIONS

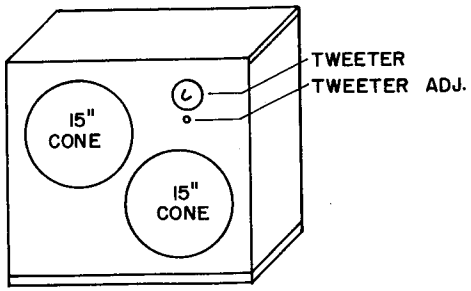
RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
D MV	9-23-66	65	ALL	1179

TITLE W2 SPEAKER SYSTEM

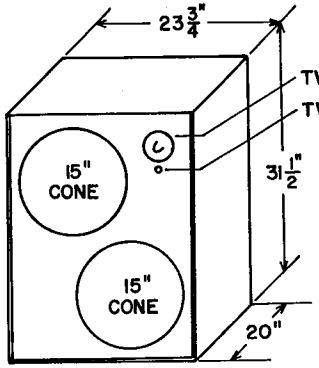


(FRONT)



(BACK)

RW3 - 100



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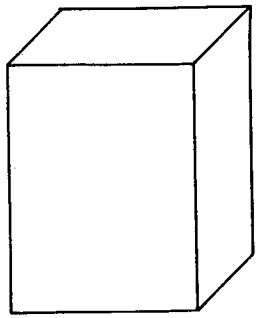
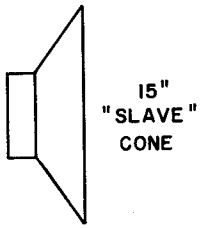
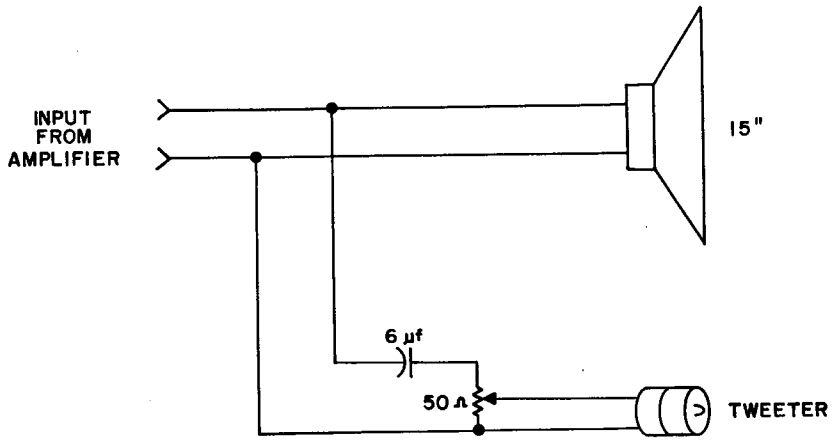


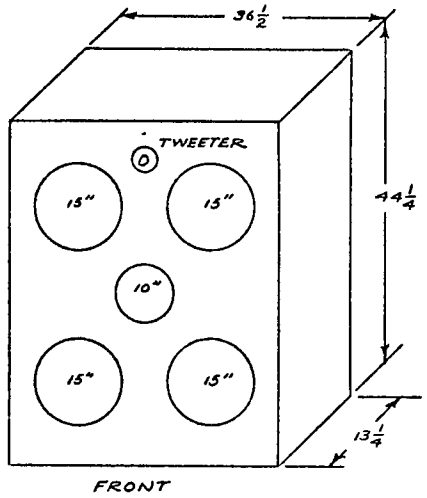
(BACK)

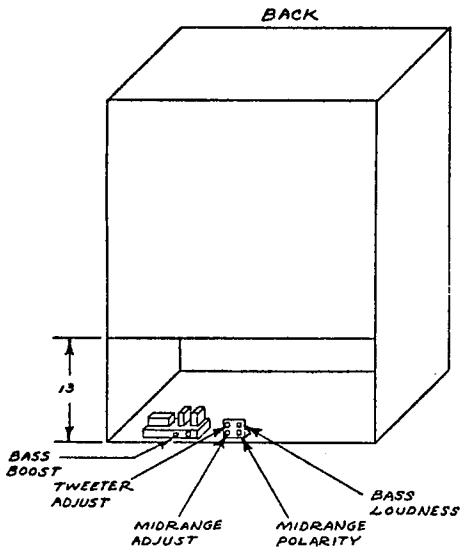
W3 - 100

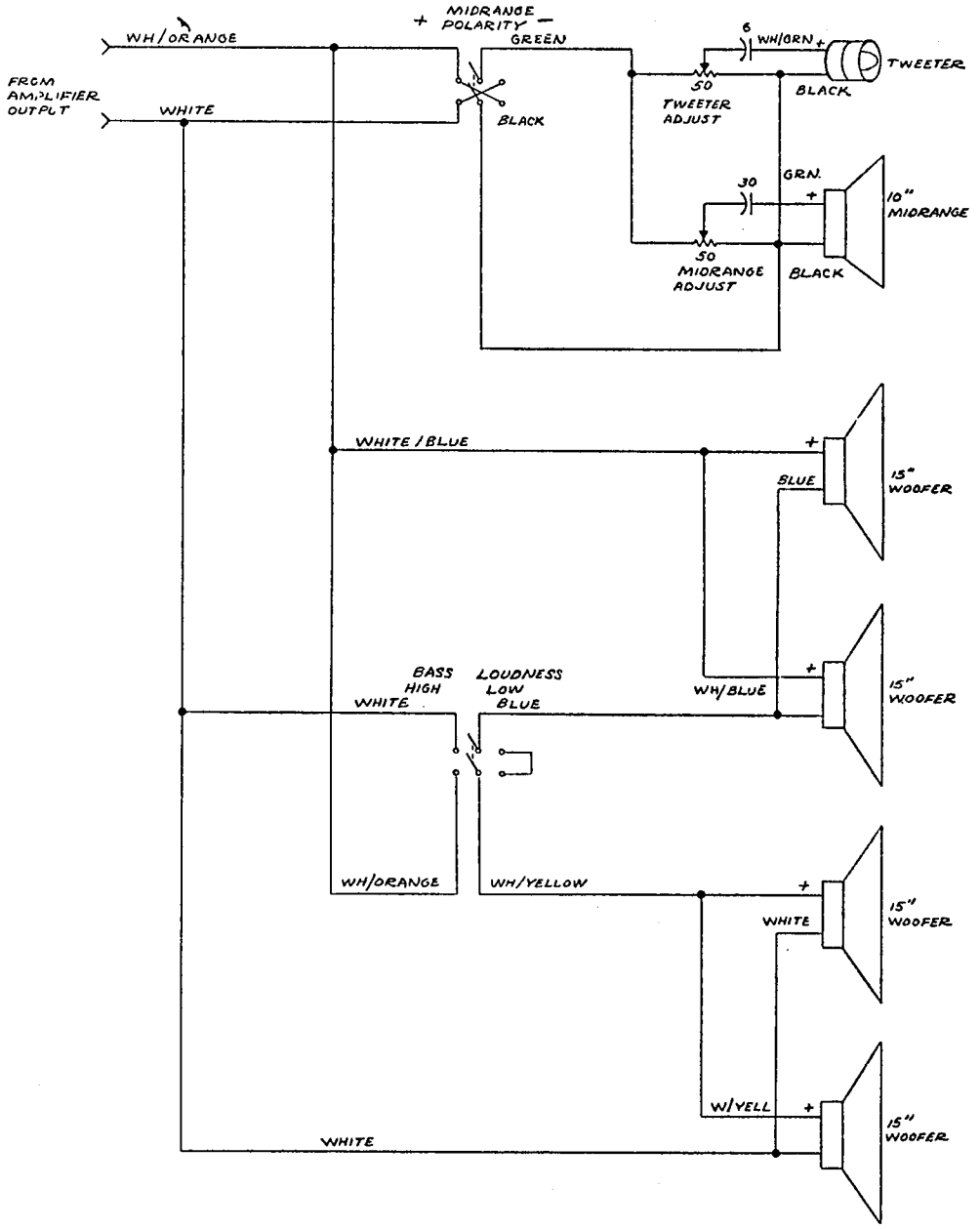




A	8-12-68	WU	CORRECTIONS
LTR	DATE	BY	DESCRIPTION
REVISIONS			
RODGERS ORGAN COMPANY			
DRAWN DMV	DATE 8-29-67	SCALE 50	MODEL ALL	DWG NO. 1246A
TITLE W-3 SPEAKER SYSTEM			







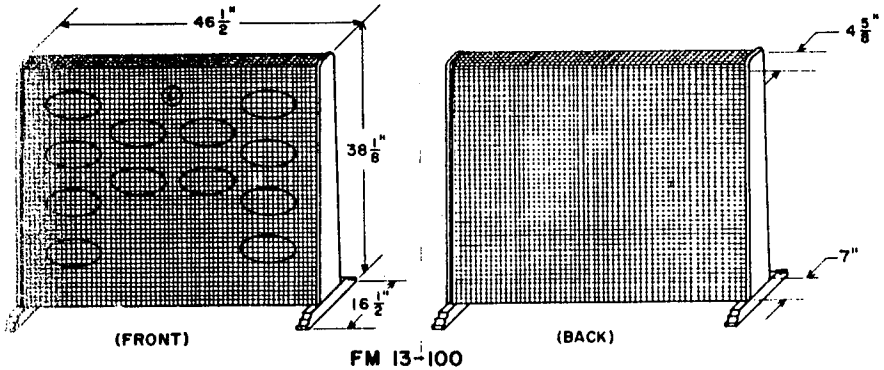
A	9-24-70	JW	REDRAWN
LTR	DATE	BY	DESCRIPTION

REVISIONS

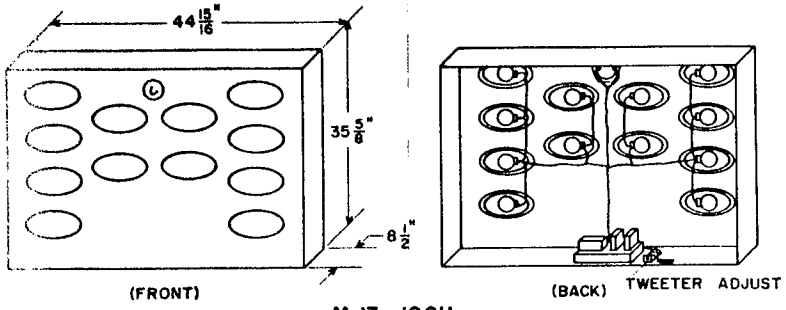
RODGERS ORGAN COMPANY

DRAWN G.O.M.	DATE 12-19-70	SCALE 40	MODEL	Dwg. No. 1314 A
CHECKED [illegible]	DATE 5 Feb 70	PRJ ENG	ENG MFG	REL. DATE

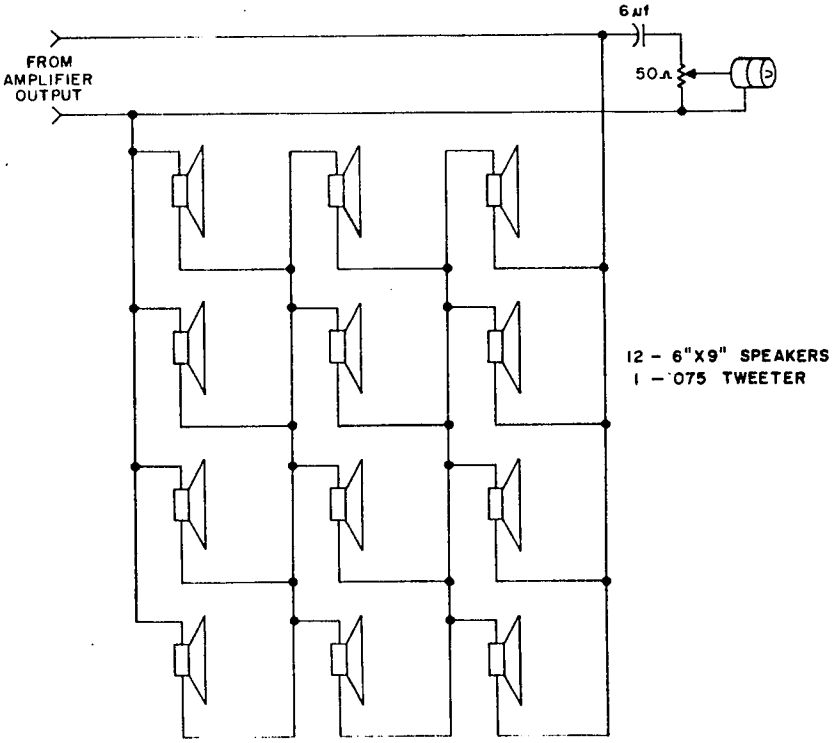
TITLE W6-100U SPEAKER SYSTEM

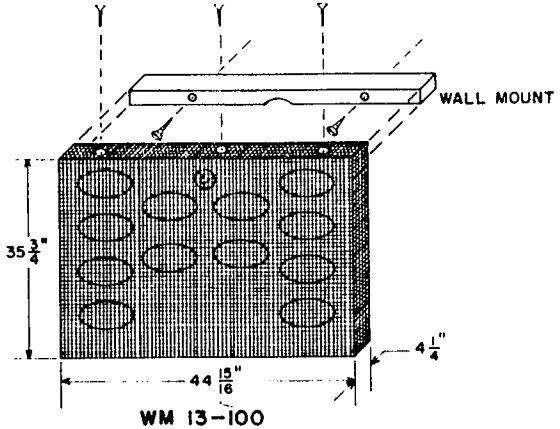


FM 13-100



M 13-100U





WM 13-100
(AMPLIFIER IS EXTERNAL)

LTR	DATE	BY	DESCRIPTION
C	1-28-74	JS	ECO 3788
B	4-9-68	DV	TM 13-100 DELETED
A	12-29-67	DV	REDRAWN

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
DMV	12-29-67	40		1247C

TITLE M-13 SPEAKER SYSTEMS

990 PEDAL OPTION
GENERAL DESCRIPTION

The 990 Pedal Option consists of a 200 series voltage keyed oscillator keyed through a pedal isolation diode which is fed directly from the pedal keys.

The output signals from the V.K. oscillators are fed to the 32' Pedal filter board ROC 1157. The voices produced in this optional package include the following:

32' Contra Principal
32' Untersatz
32' Contra Bombarde

These signals are fed, in turn, to the output board and then on to the output panel.

Information for assembling this package is contained in the following pages.

32' PEDAL

32' PEDAL OSCILLATOR: NOTES 001 to 8 200 Series

a. Stuffing Sample #808, Circuit Board #1130.
b. DO NOT STUFF the tremulant components C1, R1, and D1.
c. Stuff the entire oscillator with exception of the I.F. Reed and Flute.
d. See stuffing list provided.

INTERCONNECT:

a. STUFFING SAMPLE #201, Circuit Board #1158.

FILTER:

a. See sample of 990 Pedal Option Filter and Preamps.

TREMULANT:

a. No tremulant will be used on this set of oscillators.

BIAS BOARD:

a. This oscillator requires an external bias circuit. Use Circuit Board #1188. See diagram for components to go on this board. Diapason voicing circuitry is also located on this board.

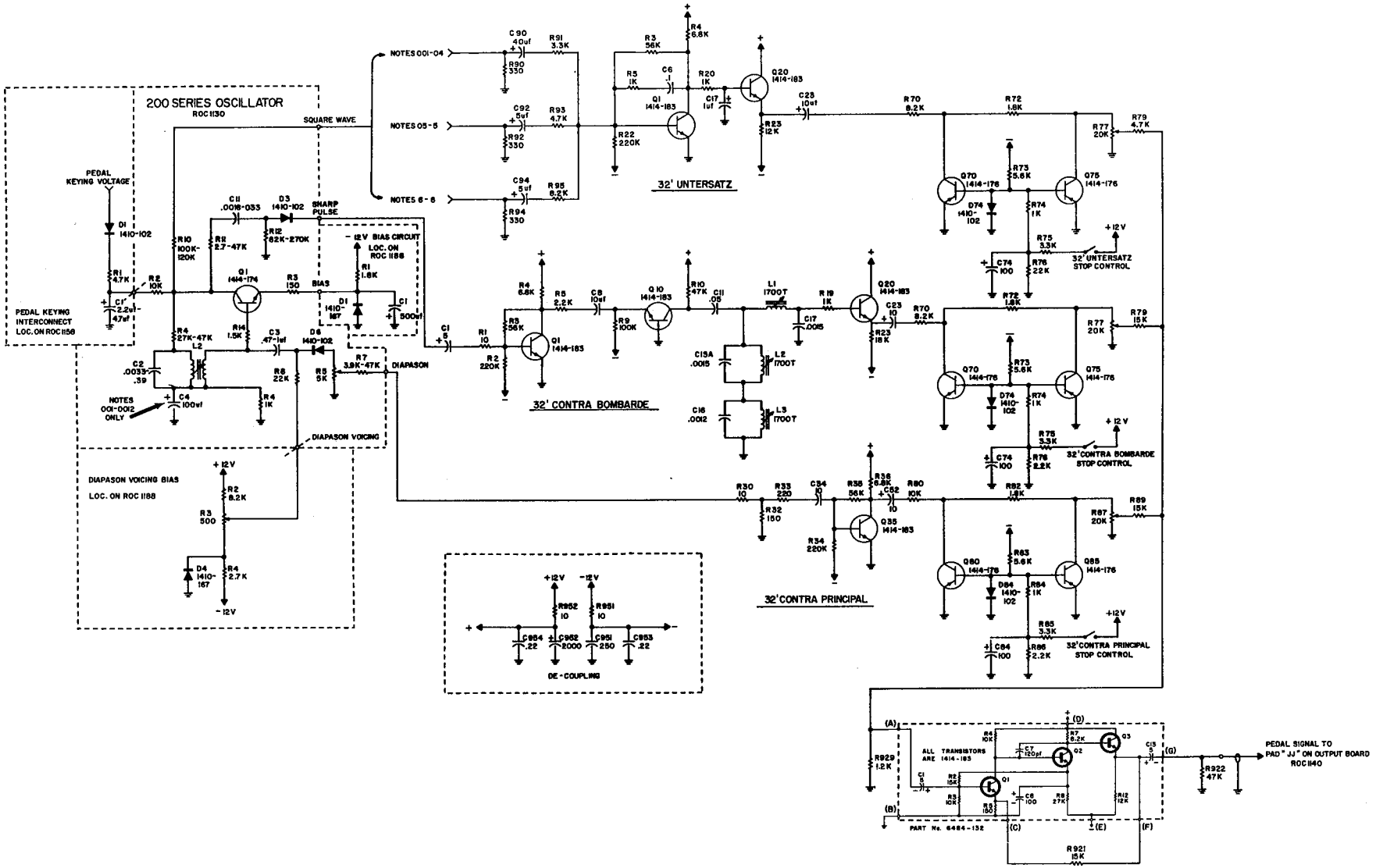
OUTPUT SIGNAL:

a. The output signal from otuput CC on the 32' Pedal Filter will feed into Pad JJ on the Output Preamps board via shielded cable.

GROUNDING NOTE: An additional peice of #14 White stranded wire from the Bias Board Ground to the Ground Buss on the Bottom Octave of the 32' Oscillators must be added.

AIR SOUND:

a. No Air Sound is required for this option.



NOTES
ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ROC PART NUMBERS			TRANSISTOR IDENTIFICATION		
E. NATIONAL	E. C. TO-92 B.		APPROX 2N TYPE	END COLOR	SYMBOL
1414-162	1414-176	1414-162	3702	RED	
1414-166	1414-173	1414-166	3706	BLUE	
1414-167	1414-183	1414-167	3707	GREEN	
1414-175	1414-174	1414-175	3708	WHITE	
		1414-169	3904	2 GRN STRIPE	

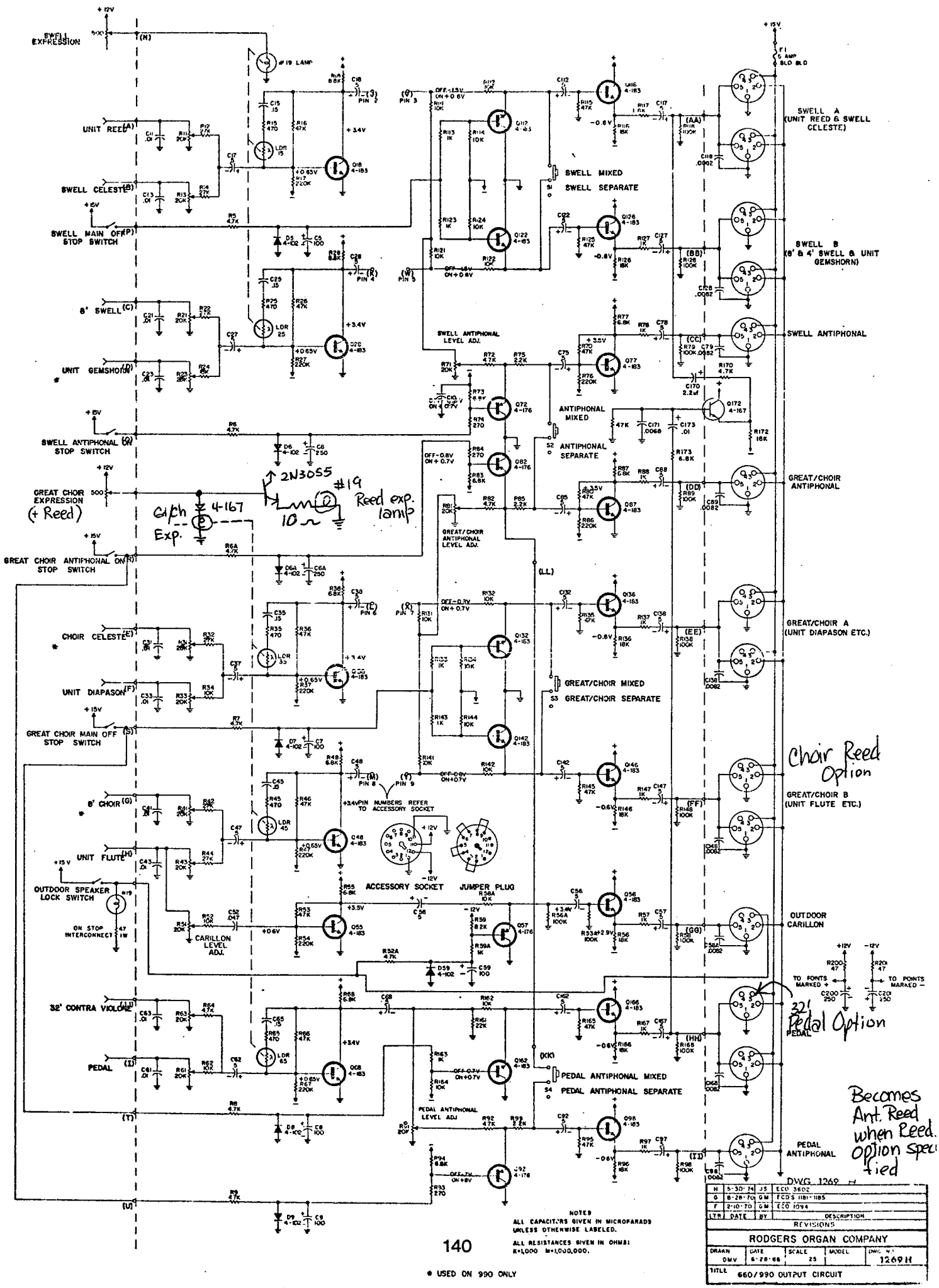
LTR	DATE	BY	DESCRIPTION
A	3-24-77	LY	ECO 4852, 4856

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
L·Y	1-22-76	25	990	1545 A
CHECKED	DATE	PRJ. ENG.	ENG. MNG.	REL. DATE

TITLE PEDAL OPTION



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

* USED ON 990 ONLY

DWG 1269 H

LTR	DATE	BY	DESCRIPTION
H	5-30-74	JS	ECO 3602
G	8-28-70	GM	ECO S 1181-1185
F	2-10-70	GM	ECO 1094

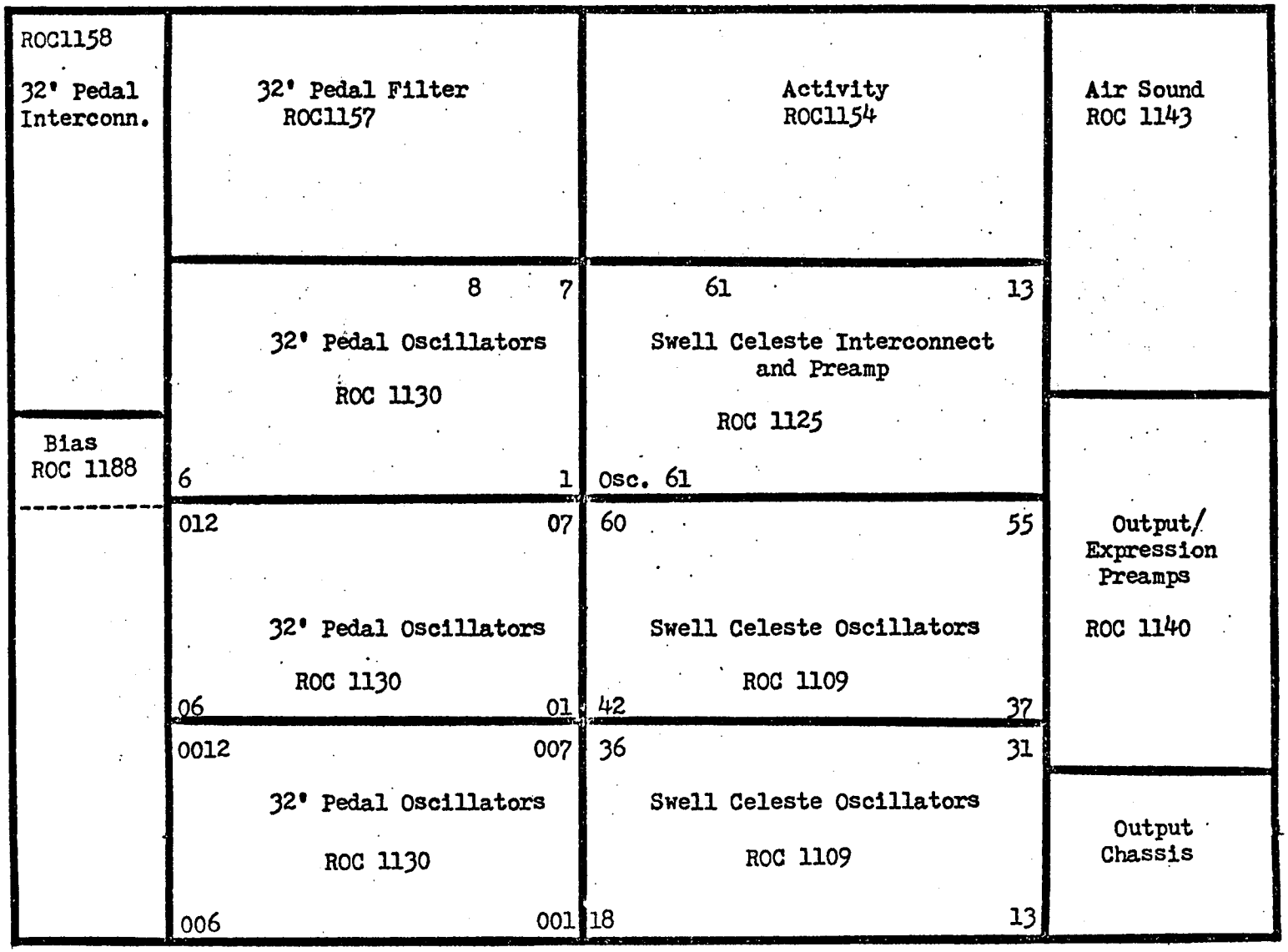
REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO
DMV	6-28-68	2/3		1269H

TITLE 660/990 OUTPUT CIRCUIT

VIEWED FROM COPPER SIDE



990 RACK #1 WITH PEDAL OPTION

Dave Bogner 1-14-76

990 CHOIR REED OPTION/990 ANTIPHONAL REED (Derived From Choir Reed)

Description

A type "C" Custom Reed keyer is used to produce a new voice specified by the customer. This option replaces the Choir Schalmei.

The new Choir Reed is normally expressed with the Great/Choir, and is normally independent of the Great/Choir Main Off. See the Specification Sheet as the customer may order otherwise. The Choir Reed has an independent output channel and speaker.

The Antiphonal Reed is a separate option. It is normally expressed with the Great/Choir, and is not affected by the Great/Choir Main Off or Antiphonal On. The customer may order otherwise, so refer to the Specification Sheet. The Antiphonal Reed has an independent output channel and speaker.

A section of ROC 1139B Custom Output board is used to obtain two additional output channels. This board also handles expression and switching of the new channels.

The Choir and Antiphonal Reed voices operate from the Great oscillators.

The 8' Schalmei formant and audio gate circuits on the 990 Choir Filter board are not used, and therefore are not stuffed.

An emitter-follower is added to the Choir expression pot to drive the additional expression lamps required.

Both Reed channels appear at the 990 Output Panel.

990 CHOIR REED OPTIONS (Cont.)

Final Assembly

Keyer

All Cabling is provided for the Choir Reed optional keyer.

Keying Nyleze and oscillator cables are wired according to their breakouts. The top screen layouts on pages 8 and 9 show the notes at the ends of each row.

White grounds from the 990 output board and from the Custom output board connect to the GND area on the upper keyer board (notes 1-40). White ground wire from the lower keyer board also connects here.

+12v and -12v from supply and from the Custom Output board connect at the +12 and -12 pads on the upper keyer board. Yellow decoupled +12 runs between the (+) lead of C30's on both boards. Green decoupled -12 runs between the (-) lead of C31's on both boards. The blue bias wire runs between the (+) pads for C29's on both boards. The audio cable center conductor runs between the center signal collection buss on each board. Both ends of the cable shields are grounded at the copper areas marked GND.

The other sheilded audio cable is run between the OUT pad on the upper keyer board and the INP pad (Choir Reed preamp circuit) on the Custom Output board. Ground the cable shield only at the Custom Output board. DO NOT ground at the keyer.

Custom Output Board

At the Custom Output Board, white ground connects to the copper area marked GND. +12v and -12v wires connect to the + and - pads under the decoupling capacitors.

If the Antiphonal Reed option is ordered, jumper together the INP pads for the Choir Reed preamp circuit and the Antiphonal Reed preamp circuit.

Connect the two stop control wires to the correct STOP pads. (The Antiphonal Reed stop control wire will not function if this option is not used.)

Exrpession

Since two additional LDR lamps are required for the new Choir (and Antiphonal channels, an emitter follower is used to control current through these lamps. Expression lamps are all #19's. The new lamps are wired in parallel with the existing lamp in the Great/Choir LDR housing on the standard output board.

A schematic diagram of the Expression circuit is on page 14.

990 CHOIR REED OPTIONS (Cont.)

Cabling

Run a 61-wire Nyleze cable from the Choir Reed isolation slide on the Choir ganging board to the two Reed Keyer boards.

Run a 61-wire cable from Great oscillators 1-61 to the two Reed Keyer boards.

Run a #14 white ground from the 990 Output board to the upper Reed Keyer board (notes 1-40).

Run a #20 red-white +12 and a #20 black-white -12 to the upper Reed keyer board. Use any source except Osc. +12.

Make a cable containing one #14 white ground, one #20 red-white +12, one #20 black-white -12, and one audio coax, to run from the upper Reed Keyer board to the Custom Output board. The audio coax must be 12" longer at the Output Board.

Make a cable containing one #14 white ground, one #20 yellow decoupled +12, one #20 green decoupled -12, one #20 blue bias, and one audio coax. Run between the two Reed Keyer boards (about 15 inches long.)

Make a cable containing one #20 black ground and one #20 red-white +12. Run from the power supply to the Expression Emitter Follower under the Choir expression pedal.

Run a #20 grey wire from the Choir Expression Emitter Follower to the Custom Output Board.

Run two shielded audio cables from the Custom Output Board to the 990 Output Panel.

Stop control wires for the Choir Reed and Great/Choir Main Off are run to the Custom Output board.

If the Antiphonal Reed option is used, this additional stop is wired to an added Memory core position. A stop control wire is run from the Stop Interconnect to the Custom Output board.

990 CHOIR REED OPTIONS (Cont.)

Printed Circuits

Isolation Slide

There are two unused positions on the Choir Ganging Board. Stuff a 61-note diode isolation slide in one position as shown on the Ganging Board Layout, page 8. Use 15K resistors in the slide.

Keyer

The optional reed keyer is on two ROC 1298 type "C" keyer boards. One board produces notes 1-40, the other produces notes 41-61. Use the top screen layouts on pages 8 and 9, and the stuffing lists on pages 10 and 11. A schematic is given on page 12.

DO NOT STUFF BIAS OR DECOUPLING ON THE (41-61) BOARD.

Custom Output Board

The output circuitry for the Reed options is on a peice of ROC 1139B board cut to 9 inches long (remains 12 inches wide). There is one production sample for all Reed options.

Memory

The Choir Reed option will use the Choir Schalmei memory core position. Only the name of the stop is changed.

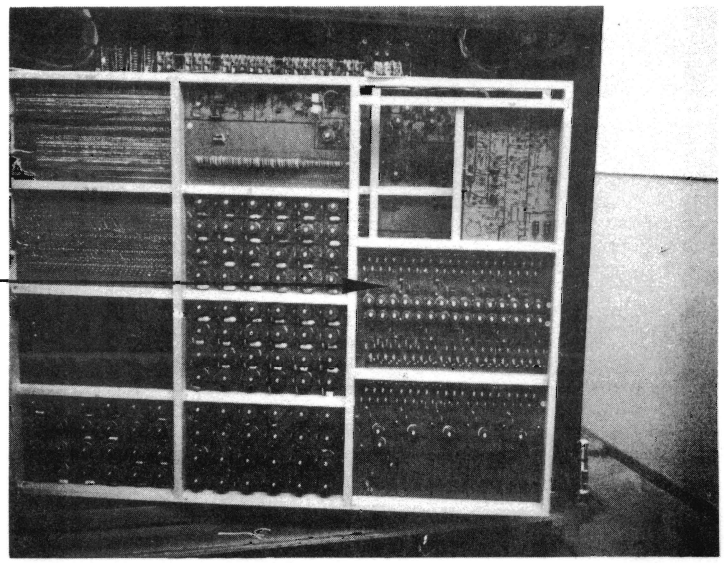
The Antiphonal Reed option will require an extra memory core position in the Choir division.

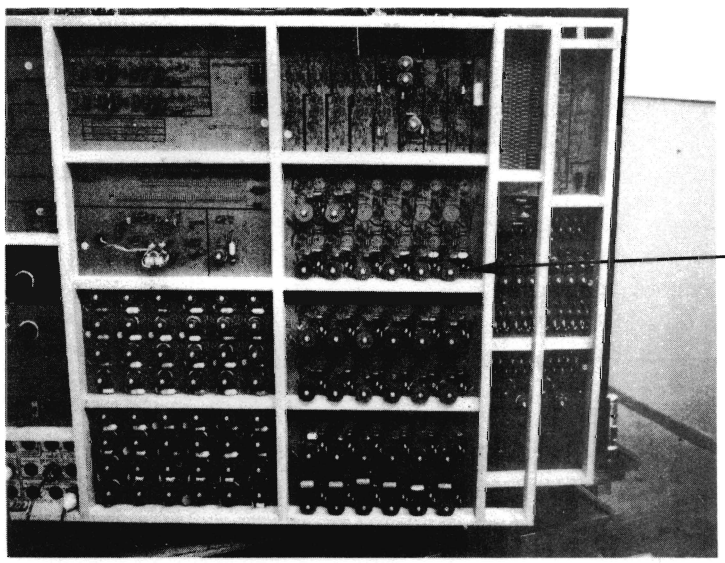
See the Capture System Core Position list for the Choir Division on page 6.

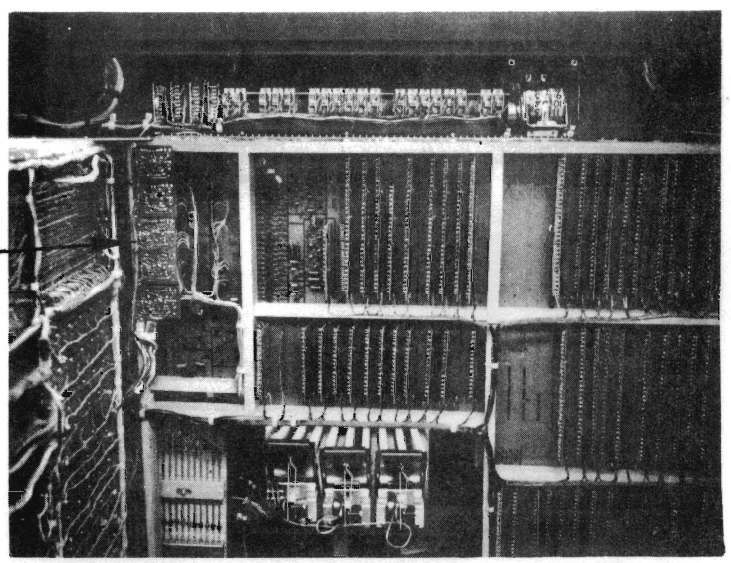
Expression Emitter Follower

An emitter follower is used to control current through the new Reed channel expression lamps. Stuff according to the Production Sample on a piece (Great section) of ROC 2150A Custom Expression Board. A schematic is given on page 14.

990 Fanfare Trumpet 32'
Pedal and Extended Reversibles

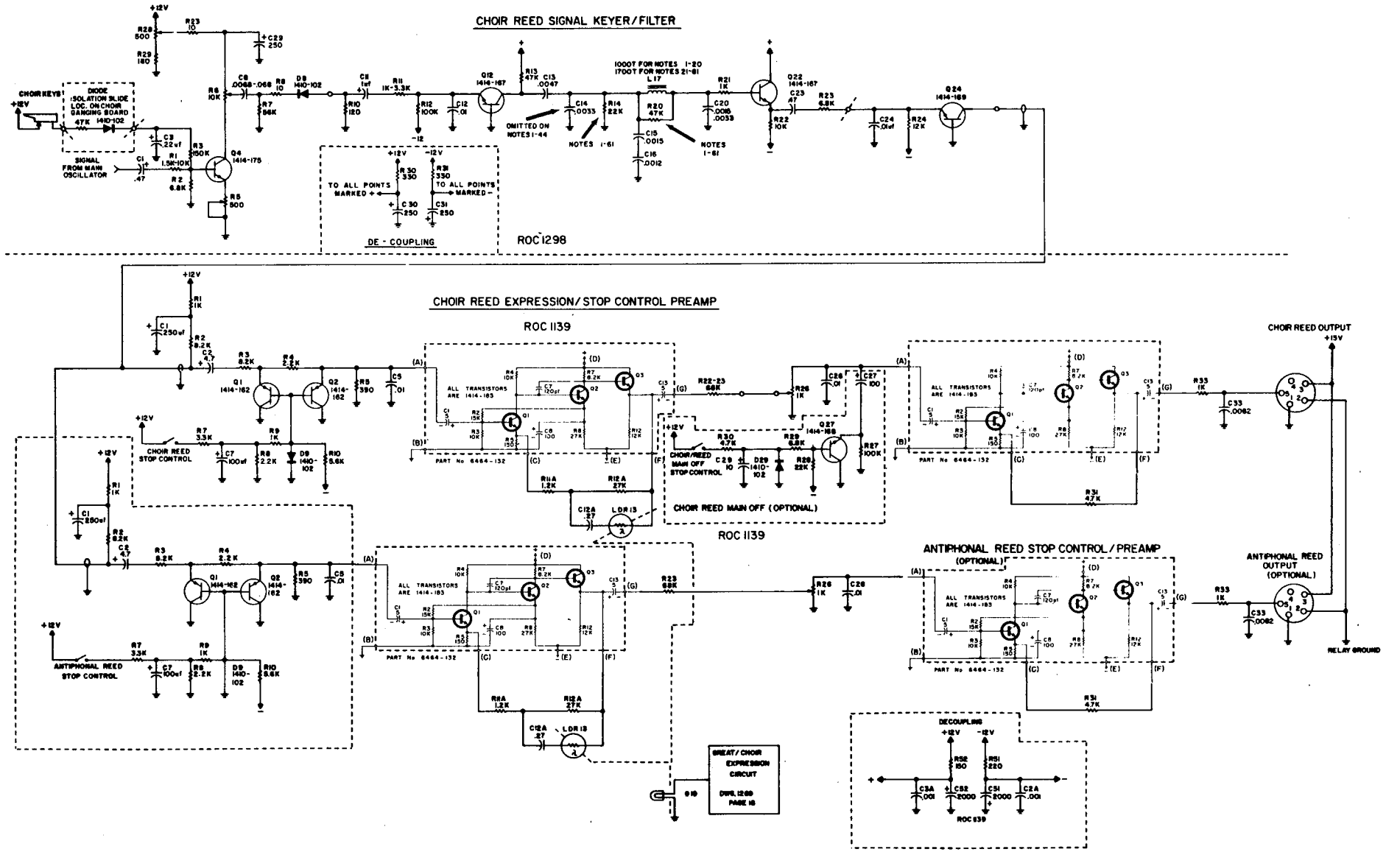






990 CHOIR GANGING BOARD

Transistor Switch Type	Stop Name	Keying Resistor
	CHOIR Coupler Current Amplifier	
	1' Sifflote	4.7K
	Chime "F"	4.7K
	1-3/5' Tierce	4.7K
	2' Flachflote	4.7K
	2-2/3' Nazard	4.7K
	4' Koppelflote	4.7K
	Chime "E"	4.7K
	8' Quintade	4.7K
	1-1/3' Nineteenth	180K
	4' Principal	68K
	CHOIR Isolation (Diode Slide)	10K
	CHOIR Drum Buss	4.7K
No Switch	CHOIR REED OPTION (Diode Isolation Slide)	15K



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NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

ROC PART NUMBERS					
1414-162	1414-176	1414-162	3793	RED	
1414-166	1414-173	1414-166	3796	BLUE	
1414-167	1414-183	1414-167	3797	GREEN	
1414-175	1414-174	1414-175	3798	WHITE	
		1414-169	3904		

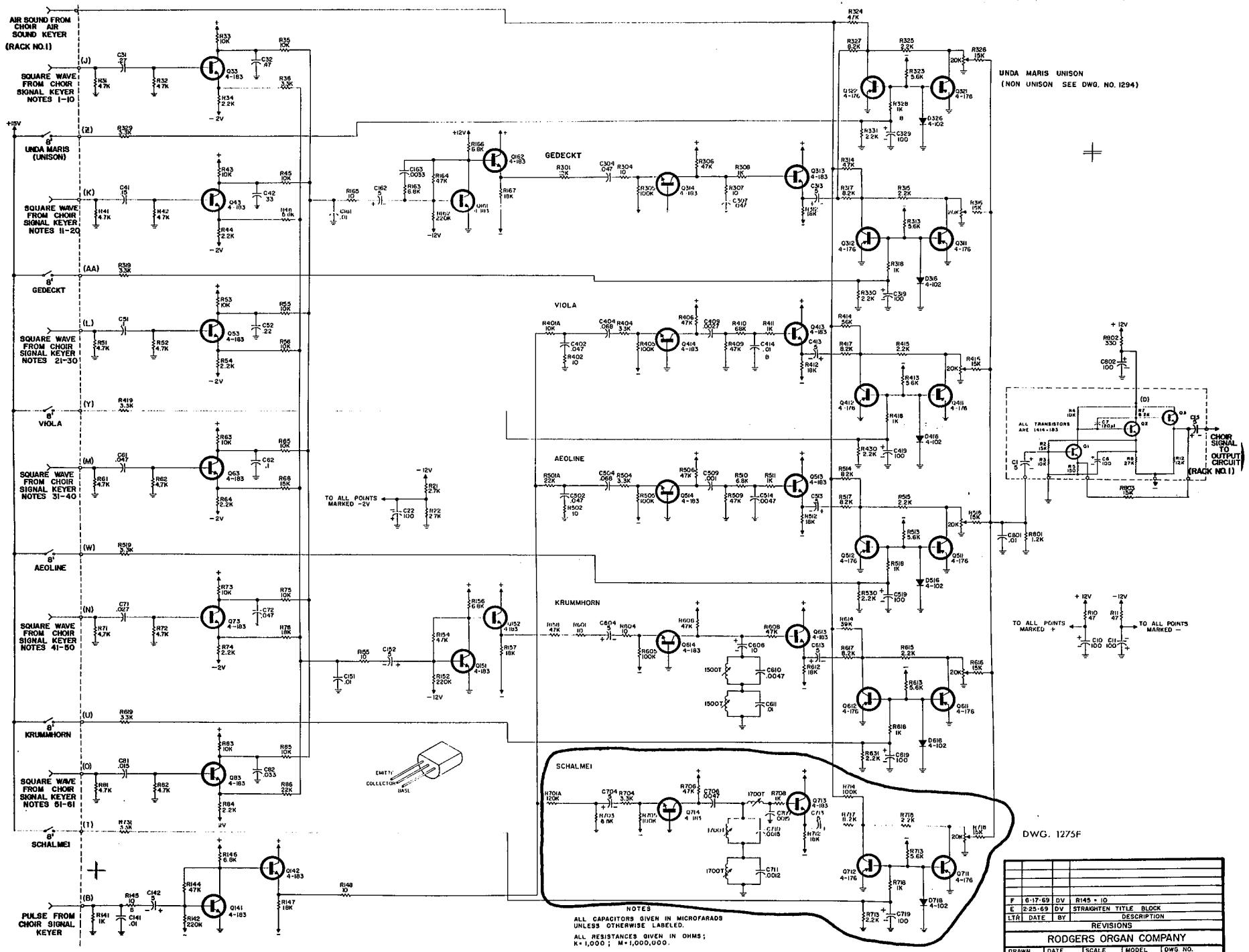
LTR	DATE	BY	DESCRIPTION
B	3-23-77	LY	EC04848
A	6-24-76	LY	EC04438

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
L.Y.	1-14-76	25	990	1344B
CHECKED	DATE	PRJ ENG	ENG MFG	REL. DATE

TITLE CHOIR REED OPTION



DWG. 1275F

CIRCLED CIRCUIT NOT USED WHEN CHOIR REED OPTION SPECIFIED.

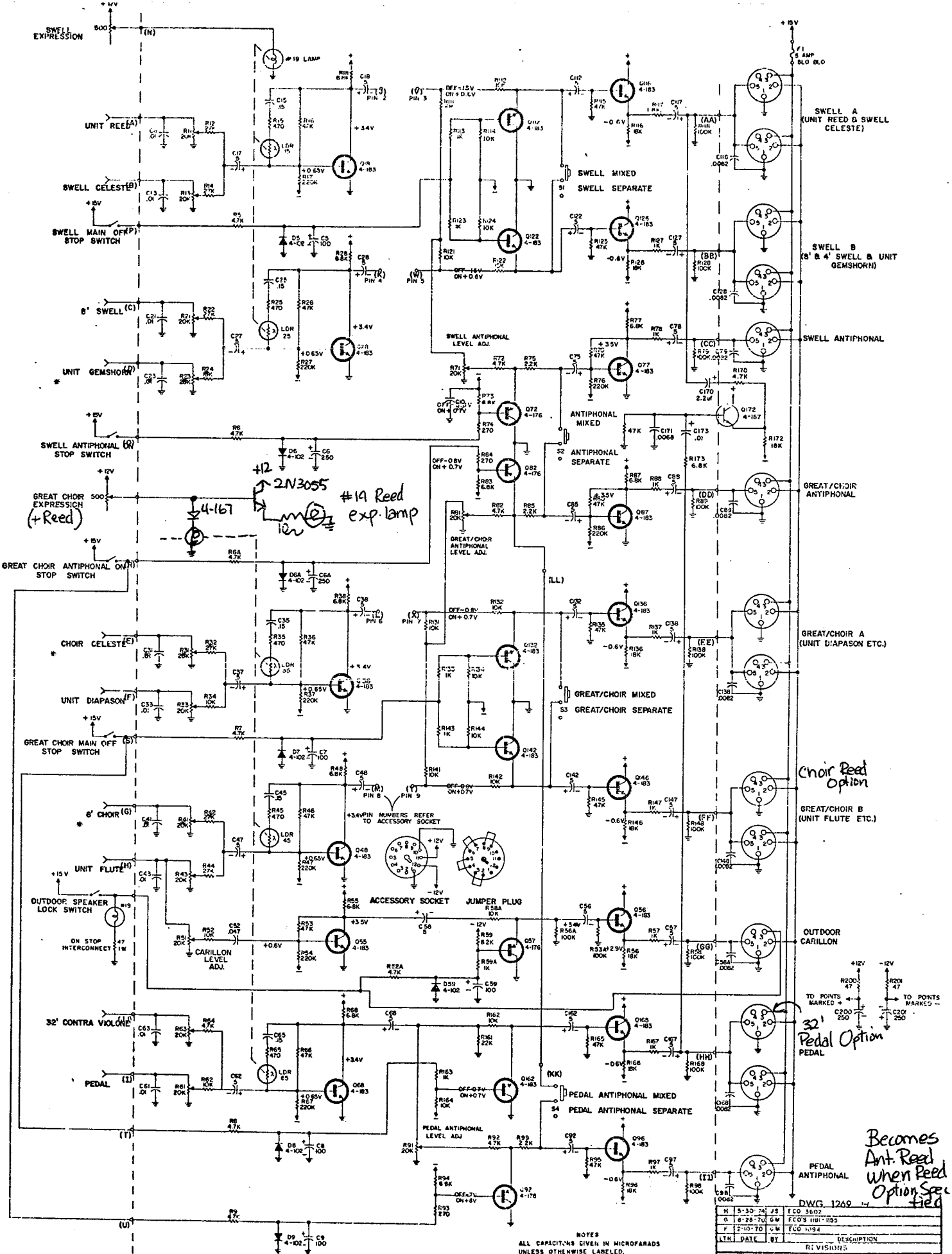
LTR	DATE	BY	DESCRIPTION
F	6-17-69	DV	R145 = 10
E	2-25-69	DV	STRAIGHTEN TITLE BLOCK

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
WRU	7-17-68	25	990	1275F

TITLE 990 CHOIR FILTER NETWORK



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

* USED ON 590 ONLY

150

LTR	DATE	BY	DESCRIPTION
H	5-30-74	JS	ECO 3602
G	6-28-70	GM	ECO'S 1181-1185
F	2-10-70	WM	ECO 1094

REVISIONS

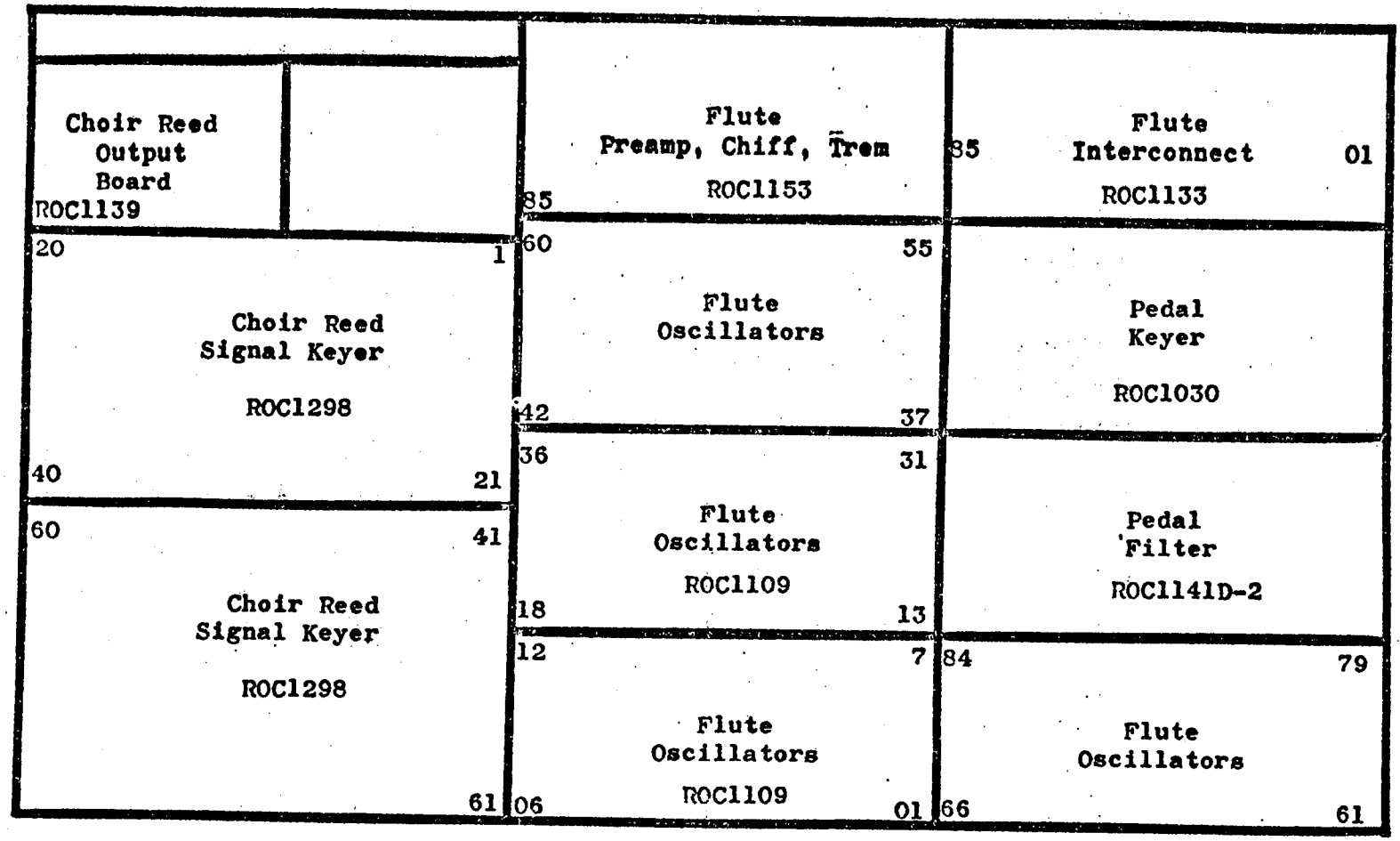
RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO
DMV	6-28-68	25		1269H

TITLE 680/990 OUTPUT CIRCUIT

DWG 1269

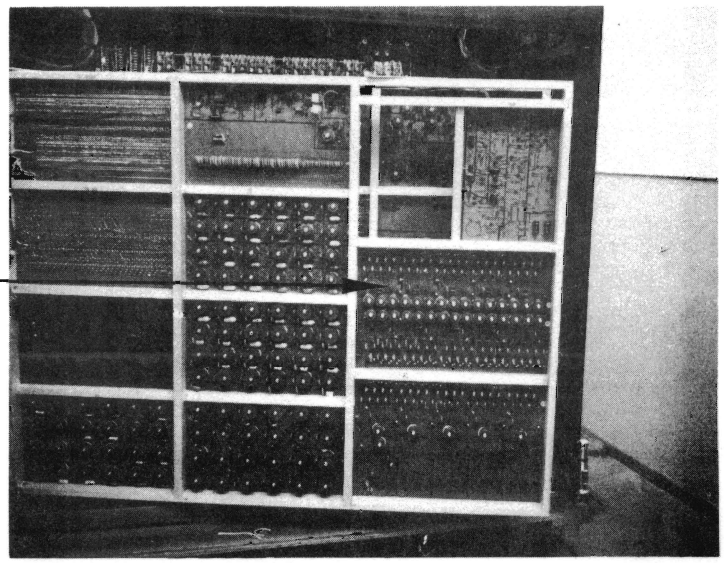
VIEWED FROM COPPER SIDE

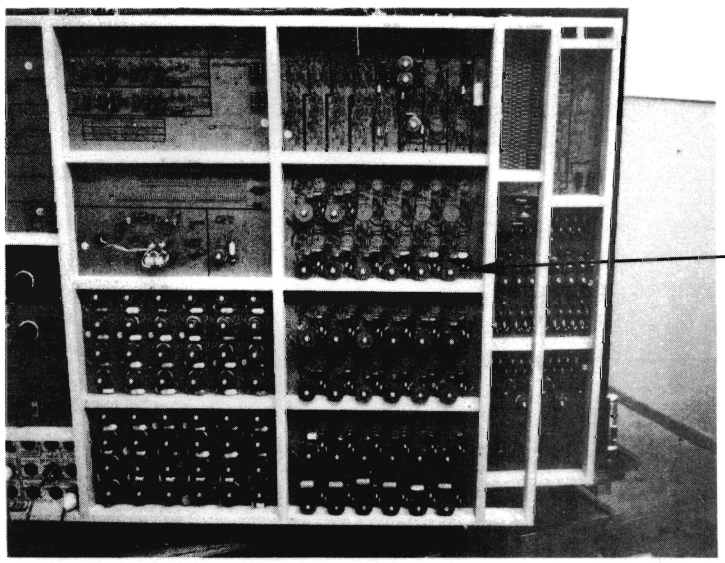


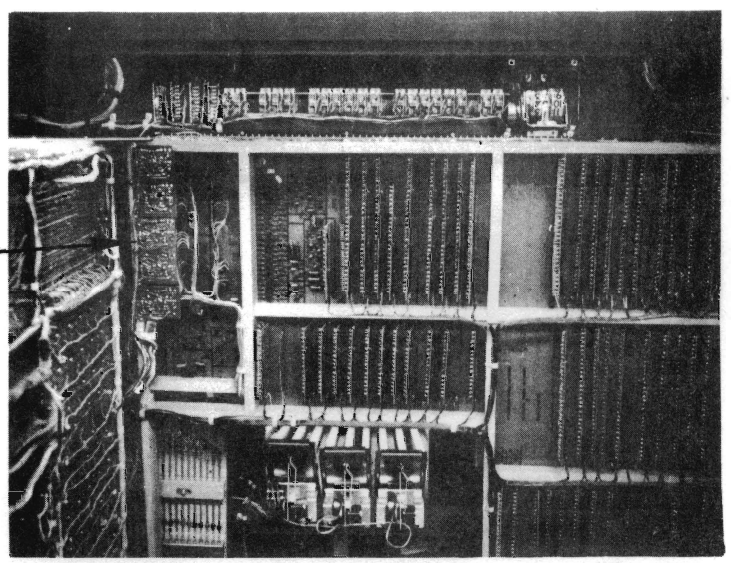
990 RACK #2 WITH CHOIR OPTIONS

Dave Bogner 1-9-76

990 Fanfare Trumpet 32'
Pedal and Extended Reversibles

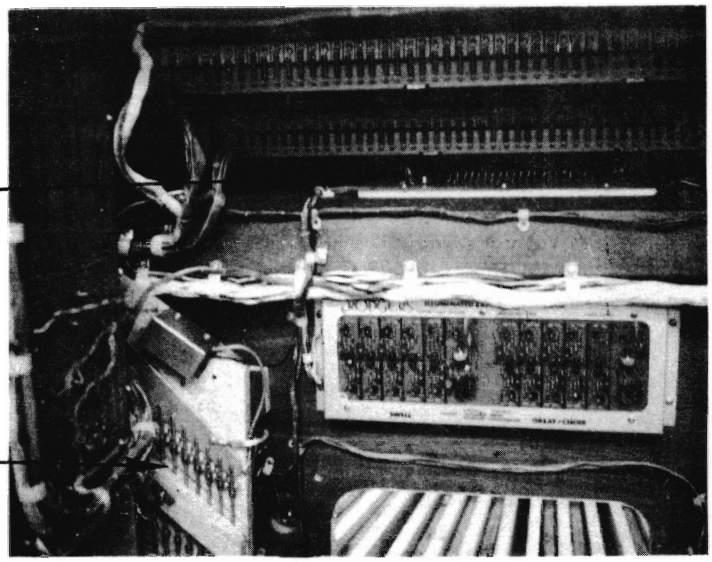






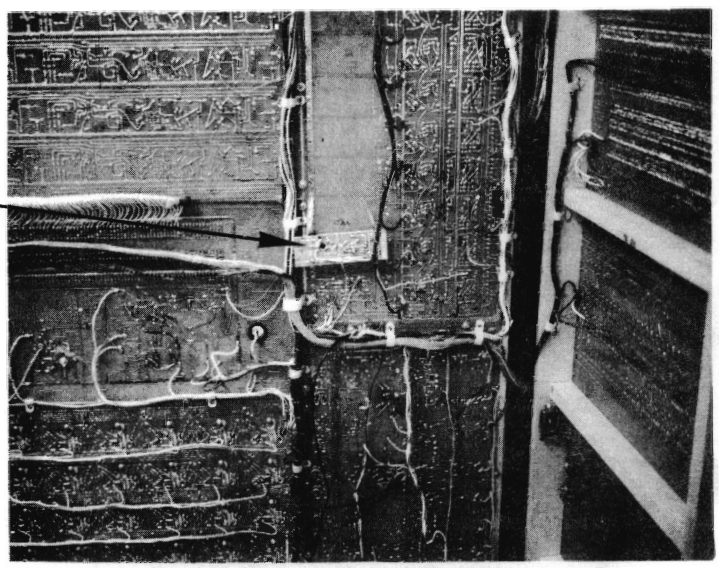
Chime Keyer and
"strike" adjust

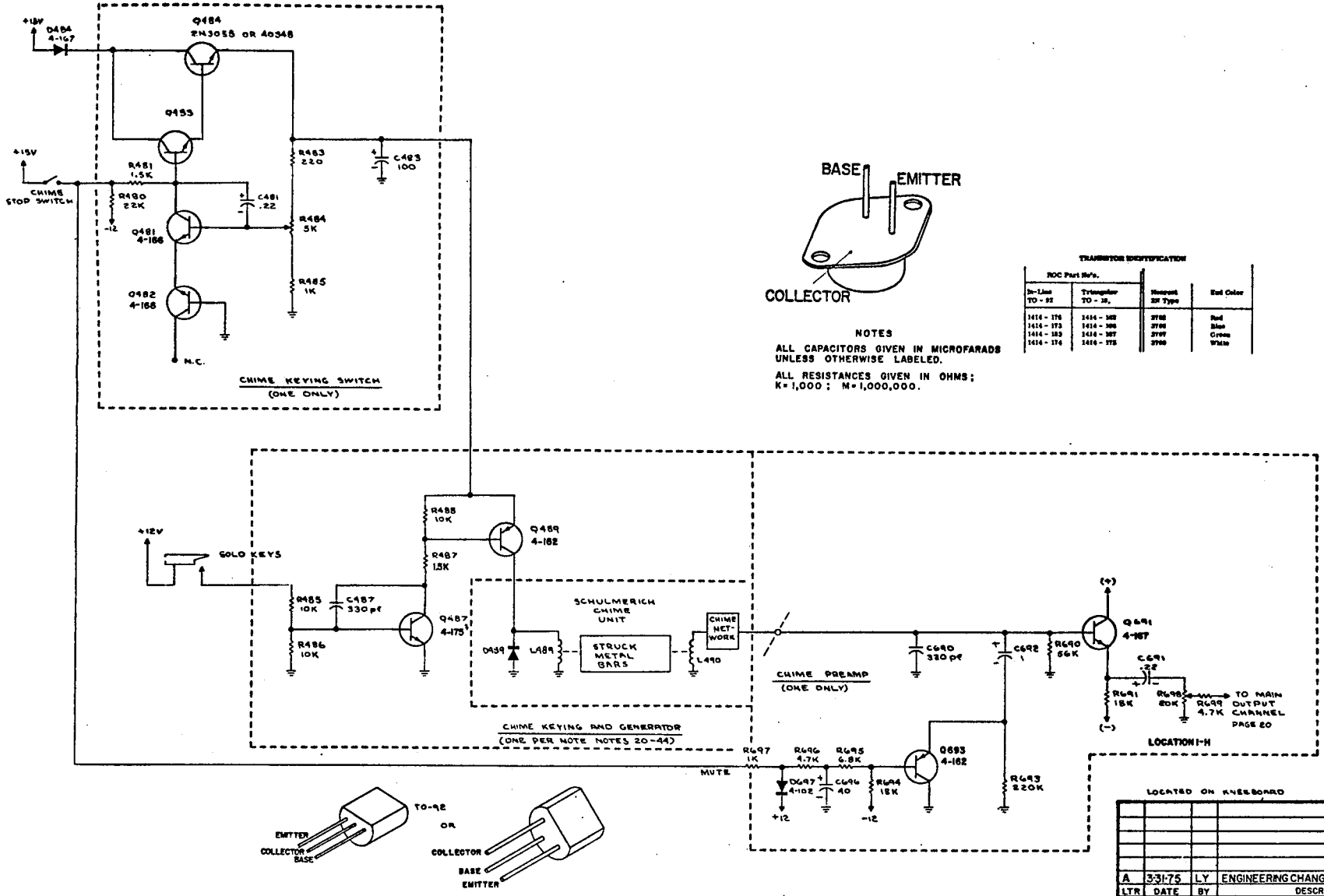
Chime Unit



Chime Mute

(Located on Rack #1
air sound board)





LOCATED ON KNEEBOARD

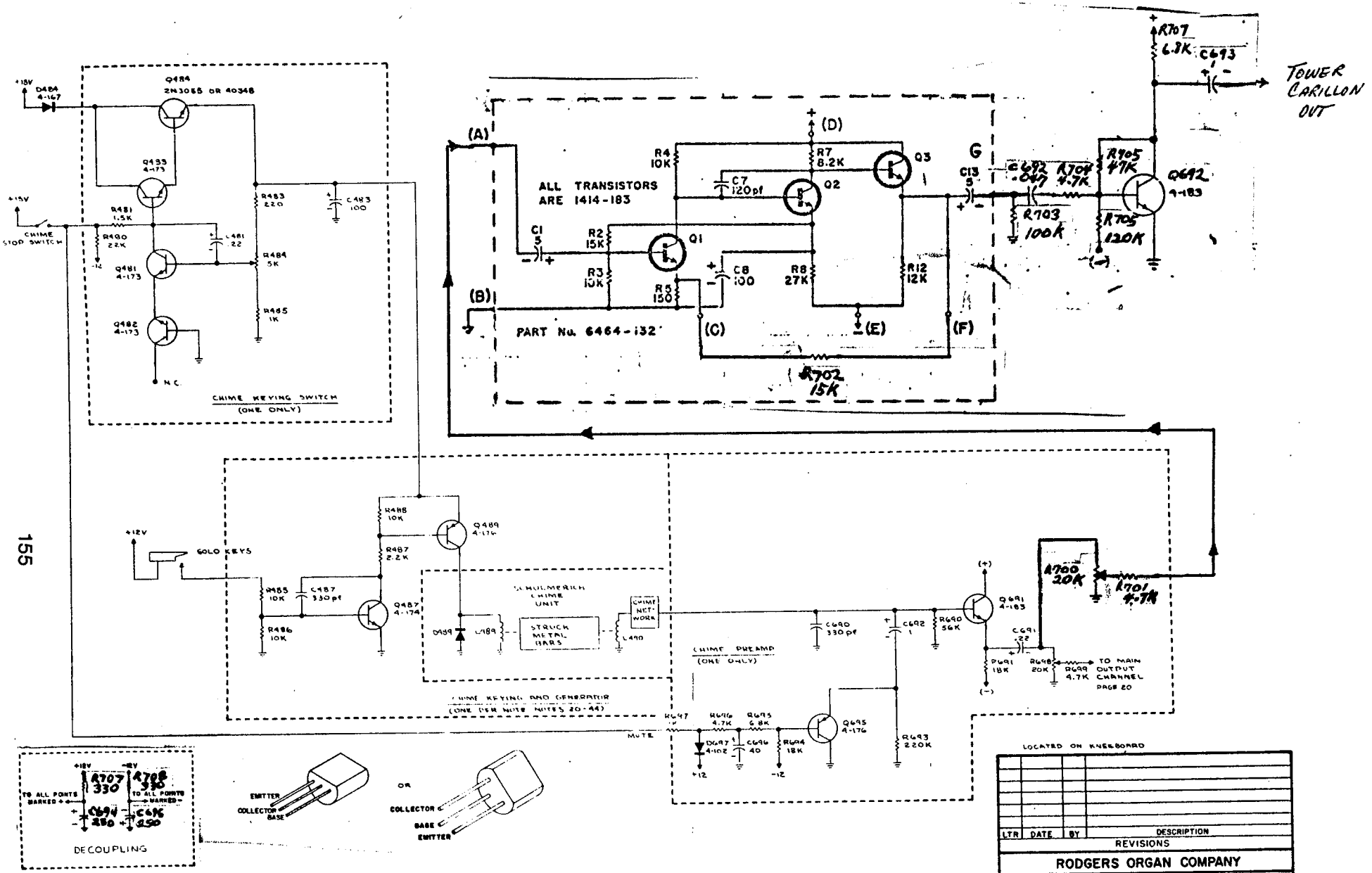
LTR	DATE	BY	DESCRIPTION
A	3-31-75	LY	ENGINEERING CHANGES

REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG. NO.
G.G.M.	1-7-71	30	340	1364A
CHECKED	DATE	PRJ. ENG.	ENG. MRG.	REL. DATE

TITLE: CHIME



TRANSISTOR IDENTIFICATION

R/K Part No's.		Nearest 2N Type	End Color
In Line TO-92	Transistor TO-18, TO-98		
1414-176	1414-182	3702	Red
1414-172	1414-186	3704	Blue
1414-183	1414-187	3707	Green
1414-174	1414-178	3708	White

NOTES

ALL CAPACITORS GIVEN IN MICROFARADS UNLESS OTHERWISE LABELED.

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

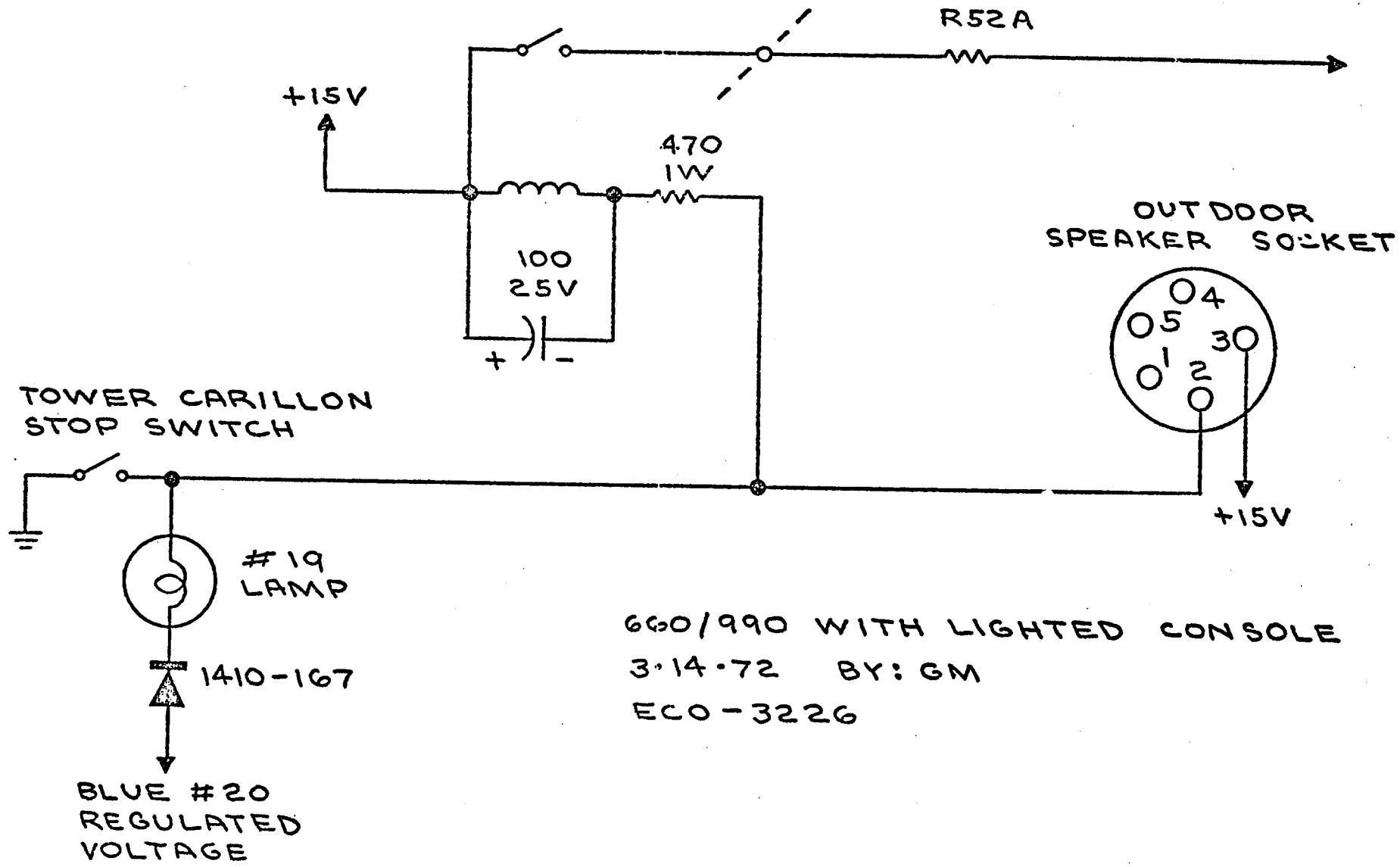
LOCATED ON KNEEBOARD

LTR	DATE	BY	DESCRIPTION
			REVISIONS

RODGERS ORGAN COMPANY

DRAWN	DATE	SCALE	MODEL	DWG NO.
G.G.M.	1-7-71	30	340	1364
CHECKED	DATE	PRJ. ENG.	ENG. MNG.	REL. DATE

TITLE: CHIME-990-Custom-GEMINI



660/990 WITH LIGHTED CONSOLE
3·14·72 BY: GM
ECO-3226